SOQUEL CREEK LAGOON MONITORING REPORT, 2005

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Prepared for

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December 2005 **Project #106-15**

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ACKNOWLEDGMENTS

We appreciate the efforts of the Capitola Public Works Department with Matt Kotila, heavy equipment operator, in forming and maintaining the lagoon. We again thank Cary Oyama for helping with seining for fish to relocate during sandbar construction. He has been a key man in preparing the flume and lagoon for the summer since our monitoring began in 1990. We appreciate the efforts of the Begonia Festival participants to avoid wading in the lagoon during the procession. The Begonia Festival organizers and other volunteers, under the supervision of Ed Garcia of the City Public Works staff, effectively removed flowers after the Begonia Festival in September. We thank Nels and Susan Westman again for the loan of their boat for fish censusing in October. We appreciated Ed Morrison's daily attention to managing the flume inlet as streamflow lessens through the summer and in preparation for storm events. He was successful in maximizing the longevity of the sandbar until after Thanksgiving in 2005.

We are grateful to the volunteers who do the annual fish censusing at the lagoon. They come mainly from Friends of Soquel Creek and Earth Links, with other interested volunteers and innocent bystanders who join in to lend a hand. We worked with two fishery biologists from NOAA Fisheries (Sue Sogard and Ellen Freund) in this, the fifteenth year of fish sampling, providing a valuable index of steelhead abundance in the lagoon. We captured 28 juvenile steelhead that had been previously PIT tagged by NOAA Fisheries. A high school student and his father were there both weekends, earning community service credit. Volunteers are very welcome to help on the first two Sunday mornings in October. The fun usually ends by 1:00 pm, in time for the 49er game.

REPORT SUMMARY

Sandbar Construction and Breaching. In 2005, sandbar closure was delayed until early June due to high streamflow. The flume did not require sand removal this year. Sandbar construction began on 6 June. Three artificial breaches were required. A lateral channel crossed the beach to the jetty, as normally occurs. The lateral channel was blocked off from the estuary, and the fish were rescued from it before the channel was covered over with sand. Fish captured included 1 young-of-the-year (YOY) steelhead (*Oncorhynchus mykiss*), 55 YOY and 3 yearling or older starry flounders (*Platichthys stellatus*), 18 YOY and 3 yearling staghorn sculpins (*Leptocottus armatus*) and 2 YOY and 1 yearling prickly sculpins (*Cottus asper*). Fish were relocated to the main estuary/lagoon. An auxiliary channel was not cut along the flume because creek overflow could pass out through the flume. The sandbar was fully constructed and closed for the summer on 9 June. On 1 December 2005, a facilitated breach of the sandbar as required to prevent flooding. The stream flowed through the pre-cut notch due to lagoon filling during the third storm event of the winter season. The flume was moving water at full capacity at the time of the breach. Stormflow reached approximately 150 cubic feet per second at the USGS gage in Soquel Village overnight after the late afternoon breach. The sandbar remained open at the time of this writing.

Stream Inflow to the Lagoon. Habitat conditions in the 2005 lagoon followed a winter with numerous storm events, with the highest baseflow since the El Niño winter of 1997-98, which had been substantially more than any other of the last 15 years of monitoring (**Table 10**). The early summer inflow was slightly less than in 1995 and 1996. Stream inflow to the lagoon on 1 June was fourth highest in the last 15 years and sixth highest on 1 October. This was in contrast to a comparatively low stream inflow in 2004, which had the twelfth highest streamflow on 1 June and 1 October. August streamflow in 2005 was similar to those in 1995, 1996, 1999 and 2000. Streamflow just above the lagoon was measured at 2.93 cfs on 8 October 2005 at Nob Hill, compared to 1.33 cubic feet per second (cfs) on 1 October 2004, 1.92 cfs there in 2003, 1.28 cfs near the Grange in 2002 and 1.58 cfs in 2001 near the Grange. Lagoon water temperature and stream inflow were cooler in 2005 than 2004, as were regional summer air temperatures. The 2005 summer lagoon was approximately the same depth as in 2004 at the Stockton Avenue Bridge and upstream of the trestle. In 2004, the lagoon was 2 feet deeper under the Stockton Avenue Bridge and 1 foot deeper upstream of the railroad trestle compared to 2003. This deepening was due to scour that returned lagoon depth to 2002 levels in these locations. There was no tidal overwash in 2005, though some saline water had remained in the deeper portion of the lagoon near the trestle for at least 10 days after sandbar closure.

Water Temperature. In analyzing temperature data from the 6 data loggers throughout the water column just upstream of the railroad trestle, results were consistent with temperature data collected at monitoring stations over the past 15 years. There was no thermocline, with complete mixing of the water column. In the 2005 lagoon, the steelhead management goal of early morning temperature less than 20°C near the bottom was met throughout the lagoon period. The

2005 lagoon came close (all but 7.4% of the monitored days) to meeting the coho management goal of keeping maximum water temperatures below 20°C (68°F) in the presence of steelhead. However, coho prefer to have temperatures below 16°C (depending on food abundance).

In 2005, the lagoon was consistently cooler than in 2004, with water temperature rated "good" (< 20°C at dawn) at all four stations throughout the summer within 0.25 meters of the bottom (**Table 3, Figures 3a-c; Appendix A**). Maintenance of a deep lagoon for most of the summer without tidal overwash helped to minimize water temperature near the bottom. Also, stream inflow had a cooling down effect on the lagoon overnight. This was likely more of a factor in 2005 with substantially more streamflow than in 2004 (**Table 10**). Added to this, the water temperature of the stream inflow was cooler in August through mid-October (intervals 4.5-9.5 on the graph) in 2005 compared to 2004 (**Figure 3e**). Air temperature also played a part in determining water temperature. Based on monthly average air temperatures at the Watsonville Airport, which is near the coast approximately 10 miles south of the lagoon, air temperatures were slightly warmer in July, cooler in August and cooler still in September 2005 compared to 2004 (**Table 4**). Cooler air temperatures in August and September 2005 likely contributed to a cooler lagoon in 2005.

Water temperature warmed somewhat through the water column through the day, with it being coolest near the bottom except for the first 10 days after sandbar closure when a slight saline layer existed, causing a slightly warmer temperature near the bottom near the trestle. The daily difference for the maximum temperature between the near bottom and near top of the water column in 2005 ranged from –0.58°C (1.04° F) and 1.15°C (2.06°F) from bottom to top (**Table 5; Figures 4a-b and 4k-l**). Juvenile steelhead likely spent most of their time near the bottom, except when feeding on emerging aquatic insects.

The warmest water temperatures recorded near the bottom at the 4 stations during 2-week intervals occurred on afternoon of 15 July with readings of 20.0, 19.8, 20.1 and 19.7°C at Stations 1-4, respectively (**Figures 3a-d; Appendix A**). The warmest temperature recorded by the data loggers near the bottom near the trestle was **21.3°C** (70.4°F) on 12 July.

Water temperatures in the lagoon closely mirrored temperatures in the stream inflow in 2005 as in 2003 and 2004. Daily *minima* in the lagoon were consistently warmer than the stream above in 1999-2005. The daily *maxima* were warmer in the lagoon than the stream in 1999 and 2001-2005, but not in 2000. The daily stream temperature fluctuated more in the stream than the lagoon. At the creek site near Nob Hill in 2005, water temperature failed to meet the steelhead management goal of *no more than 4 hours a day at greater than 20°C (68°F)* 5% of the time.

Aquatic Vegetation. Filamentous algae was first noted on 1 July 2005 during our second two-week monitoring, 3 weeks after sandbar closure (**Appendix A**). Pondweed was first noted on 10 September 2005, 13 weeks after sandbar closure (although it may have gone unnoticed earlier due to its initial scarcity). In 2005, the pondweed seemed to be visible primarily in Reach 1 downstream of the Stockton Bridge. Pondweed was less abundant in 2005 than 2004.

In 2005, surface algae occurred relatively early (Reach 3) in 2005, 4.5 weeks after sandbar closure. Surface algae in 2005 varied between 0 and 20% coverage of Reach 3, with very little in the lower 2 reaches (maximum was 2%) (**Appendix A**). The most extensive surface algae in 2005 was observed in late September, with it back down to 2% by 8 October and absent by November.

At the mouth of Noble Gulch, surface algae in 2005 ranged from 0 to 2% through 10 September. Then on 25 September it covered 60% of the surface within 50 feet of the mouth. However, it went back down to 2-3% coverage through October and was absent in November. The heavy appearance of surface algae coincided with a period of considerable gray water input from Noble Gulch that presumably contributed nutrients to stimulate plant growth.

Algae mats on the lagoon bottom increased in thickness steadily through September in all three reaches, with their thickness increasing in an upstream direction in late August and September (**Table 9**). Algae concentration was recorded at a maximum on 25 September. Then, average algae thickness on the bottom was 2 feet in Reaches 1 and 2 and 3 feet in Reach 3, with bottom coverage of near 100%. Surface coverage

Oxygen Levels. Oxygen concentrations were either "fair" or "good" for steelhead *near the bottom at dawn* at all stations during monitorings. In 2005, as in 2003 and 2004, morning oxygen concentrations near the bottom were usually least near Noble Gulch (Station 4), particularly from mid-July to early October in 2005 (**Figure 9g; Appendix A**). The lower oxygen at Noble Gulch was perhaps due to the higher density of algae and pondweed in the vicinity and more cell respiration through the night to depress oxygen levels. On 6 of the 13 monitorings (46%), the stream site had higher oxygen concentrations than any of the lagoon stations near dawn. Station 3 under the trestle is subject to pigeon droppings that encourage algae production and decomposition that lead to greater oxygen depletion at night.

As in 2003 and 2004, during the two-week monitorings in 2005, oxygen levels were usually higher in the afternoon than in the morning at all stations within 0.25 m of the bottom throughout the lagoon season (**Figures 9h-k; Appendix A**). Exceptions to this trend occurred on the very overcast and cloudy 1 July at the flume and late in the season with a lower sun angle and more lagoon shading on 17 November at the Stockton Avenue Bridge station.

Begonia Festival Observations and Water Quality Findings. The lagoon depth was maintained at maximum levels of 2.52 throughout the nautical parade on Sunday, 5 September. There were 5 floats in the nautical parade. Each float was propelled differently. None of the floats was pulled by waders. The secchi depth was to the bottom before and after the parade. There were 21 additional rowboats in the water after the parade. Floats were dismantled on Monday, and begonias were cleaned out of the lagoon on Tuesday. More than 90% of the begonias were collected. Water temperature and oxygen levels were within normal ranges before and after the parade on 4 September. Water quality samples taken in Reaches 1 and 2 before and immediately after the parade indicated a slight decrease in sulfide in the water column in both reaches. Reach 1 was 0.6 mg/l before and <0.2 mg/l after. Reach 2 was 0.8 mg/l before and <0.2 mg/l after. Water quality measurements and observations on 10 September detected no oxygen depletion resulting from decomposing begonias. Oxygen concentrations on the day of the Festival were some of the lowest measured during the season. The low readings before the festival may have resulted from higher respiration during the previous night or low oxygen production the previous day. The lower than usual oxygen levels after the festival at 2 of 3 stations may have been due to slight turbidity that may have inhibited photosynthesis and the measurements were taken an hour earlier than usual. Oxygen levels were rated "fair" at 2 sites and "good" at another site in the morning and "good" in the afternoon at all 3 monitored sites. At 2 of the 3 sites in the afternoon the water was supersaturated with oxygen.

Fall Steelhead Sampling. Our steelhead population estimate based on mark and recapture for fall 2005 was 1,454 juveniles +/- 347 (**Table 11, Figure 18**). Other species captured were 3 starry flounders, one prickly sculpin, one juvenile Sacramento sucker and abundant threespine sticklebacks. We concluded from the size distributions of juveniles captured that juvenile steelhead grew less in the 2005 summer lagoon than in the 2004 lagoon, despite cooler water temperatures, lower metabolic requirements and less competition from a smaller juvenile population. This may be partially due to a 15-day shorter lagoon period prior to sampling in 2005 compared to 2004, with sandbar closure on 9 June and 26 May in respective years. Nineteen steelhead captured on 2 October had been previously PIT-tagged by NOAA Fisheries biologists. Nine PIT-tagged individuals were captured on 9 October.

Pollution Sources. The lagoon near the beach was closed to human contact due to bacterial levels above the maximum acceptable level. The gulls are a primary source of pollution, both for bio-stimulating nutrients and bacteria. They forage through the human refuge left on the beach. They bathe and defecate in the lagoon. They roost and defecate on the buildings surrounding the lagoon. Reducing the gull population at Soquel Creek Lagoon would be a major step in reducing pollution. The use of gull sweeps has been observed to be successful in other locales to prevent gull roosting. A better method of refuge disposal is needed. Some of the refuge cans on and around the beach had dome lids that could not be easily removed. Some cans had flat lids that could be more easily removed and provided a food source to gulls when the cans became overfilled and the lids could not be positioned. Gulls had access to refuse that they dragged onto the beach. Refuse containers with gull-proof lids may reduce gull numbers. The City has received funding to deter gull use on restaurant roofs, to redirect restaurant gutter systems away from the lagoon and to provide waste cans with gull-proof lids. On 17 November, parallel wires were positioned over restaurant roofs that effectively deterred roosting of gulls and pigeons. However, the wires appeared to have been removed by 1 December. Rock doves (pigeons) are another source of bird pollution as they circulate between the wharf and the railroad trestle over Soquel Creek Lagoon. As stated in the original Management Plan, the trestle could be screened to eliminate roosting areas.

Regarding pollution from urban runoff, 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. The City has obtained grant money to install silt and grease traps on 4 storm drains that empty into the lagoon.

Ideally, all storm drains leading to the lagoon would be re-directed away from the lagoon in summer, including the culvert draining Noble Gulch. Considerable gray water was observed entering the lagoon from Noble Gulch in September, and this pollution coincided with increased algae in the lagoon. The City is currently seeking grant funding to improve the drainage system, repairing broken pipes and redirecting summer flow where feasible. By minimizing stream inflow from Noble Gulch, there would be reduced nutrients and bacteria entering the lagoon and reduced algal production. Another drain into the lagoon is situated under the railroad trestle, where slight oxygen depletion has been detected in recent years. This drain could be capped if summer runoff was re-directed into the sewer. It is our understanding that grant money has been obtained to put grease and silt traps on several of these storm drains.

There has been a pollution problem and high flashiness in streamflow in the past after the first small storms of the fall. At times, the lagoon required breaching prematurely because the flume could not accept all of the stormflow, and flooding was imminent. Retrofitting of storm drainage systems with holding tanks or percolation basins could reduce the sudden increase in street runoff and pollution during early storms. Drains leading from Wharf Road (across the Rispin property), the Auto Plaza and 41st Avenue businesses north of Highway 1 are some of the sources of this problem.

Critique of the Current Santa Cruz County-Wide Lagoon Study. There have been serious errors in the underlying ecological assumptions quantitative comparisons between lagoons that were used in the progress report for the County-wide lagoon study and the and methodology used. Questions and evaluation of the progress report have been submitted by the City of Capitola to the researchers, and a response is not forthcoming at this time. Refer to Appendix D for the City's comments on the progress report.

Continuing Recommendations and Those Not Yet Implemented

1. Replace all of the flat-lid refuse cans on and around the beach with ones having domed, gull-proof lids. Use enough refuse containers to satisfy the demand for refuse disposal at the beach.

2. Look into installing gull sweeps on restaurant roofs. The stringing of wire above roofs as observed in November should be continued.

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

4. Repair the cracked flume. Its integrity is jeopardized, and the beach craters created by flume underflow are a safety hazard.

5. As stated in previous reports, if the streamflow in Soquel Creek in the vicinity of Soquel Village approaches the point of losing surface flow, notify Tiedemann Nursery and the Fish and Game Department of the streamflow conditions so that direct water pumping from the stream may be reduced or discontinued until flow returns. Loss of surface flow should be prevented.

6. Regarding the Begonia Festival, continue to recommend surfboard paddling for float propulsion rather than wading. If participants choose wading, recommend that the organizers set a limit of 3 waders per float. Allow passage of these floats in one direction only, presumably downstream, and then to the dismantling location near the Stockton Avenue Bridge.

7. If wading during the Begonia Festival is requested, continue to perform more detailed water quality monitoring before and after the Begonia Festival to determine the effects of wading. Continue to measure hydrogen sulfide levels.

8. Continue to retain large woody material in the lagoon for fish cover.

9. 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.

10. In anticipation of a sandbar breach in the fall, the notch in the sandbar should be cut slightly lower than the piling bolt. *Continue to make the notch a 20-30 foot wide swath across the beach to maximize the possibility of maintaining an estuary with some depth after the breach.* Continue to place secondary berms near the flume exit and entrance to prevent tidal overwash through this swath. 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.

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

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

LAGOON AND ESTUARY FORMATION

Results of Fish Seining Prior to Construction Activities

6 June 2005. The Creek flowed laterally across the beach and emptied into the Monterey Bay at the jetty. The channel was blocked off to allow rescue of fish. Eight seine hauls were made in the lateral channel with a beach seine that was 30 ft x 4 feet with 1/8-inch mesh. Cary Oyama of the Capitola Public Works Department assisted Don Alley in the fish relocation. The overflow from the lagoon ran through the flume, which had not filled with sand during the winter and was clear for water transport. Fish captured included 1 young-of-the-year (YOY) steelhead (*Oncorhynchus mykiss*), 55 YOY and 3 yearling or older starry flounders (*Platichthys stellatus*), 18 YOY and 3 yearling staghorn sculpins (*Leptocottus armatus*) and 2 YOY and 1 yearling prickly sculpins (*Cottus asper*). Rescued fish were relocated near the Stockton Avenue Bridge in the main lagoon/ estuary.

As required in the permit, a fisheries biologist was present during all activities that could affect the fish habitat in the lagoon/estuary during sandbar construction. This was the fifteenth year of monitoring and assisting in activities associated with sandbar construction at Soquel Creek Lagoon. Reports for the first 14 years are available at the City (**Alley 1991-2004**). As stated in the Soquel Lagoon Management and Enhancement Plan (**1990**), all instream removal of kelp, sea grass and other organic debris was to be accomplished without the use of heavy equipment in the stream channel except within 25 feet of the flume. The bulldozer/tractor could traverse the area adjacent to the flume.

Monitoring of Flume Maintenance and Sandbar Construction

Sandbar construction was delayed this year due to high spring streamflow. Streamflow was measured on 12 May (33.7 cubic feet per second) and 27 May (25.6 cubic feet per second) to compare with the USGS stream gage estimates in Soquel Village. The USGS gage estimates were 3-6 cfs lower than the actual measurements. By 6 June, the gage estimate was below 20 cfs, which was judged sufficiently low to be passed through the flume.

6 June 2005. The sandbar construction began this day. Soquel Creek was flowing out to the Monterey Bay in a channel that went laterally across the beach to the jetty. As in most years past, the stream channel flowed laterally along the sea wall east to the jetty. Unlike previous years, the flume remained clear of sand through the winter and required no sand removal. Sand was stockpiled beginning at 0600 hr next to the lateral channel. The lateral channel was blocked off from the estuary at 0940 hr, and the fish were rescued from it before the channel was covered over with sand. Fish were relocated to the main estuary/lagoon. An auxiliary channel was not cut along the flume because creek overflow could pass out through the flume. By 1250 hr, the flume was 10-12 inches deep and spilling over the 3 boards in the flume inlet on the east side and more numerous in 2005 than previously. A total of 59 pelicans were observed on the beach at one time near the surf line, east of the flume. A V-formation of 51 pelicans was observed the previous day.

9 June 2005. The sandbar dam was breached at 0530 hr. It had rained lightly overnight in the mountains. The stream gage reading had increased from 17 cfs the previous day to 21 cfs overnight. The 7 personnel began raking at 0600 hr. Raking ceased at approximately 0830 hr. More than 90% of the kelp and seagrass had been raked from the area between the flume and Stockton Avenue Bridge. Little plant material existed upstream of there. The pad around the flume was prepared for final sandbar closure. A layer of filter fabric was laid down with a layer of visquine on top. The plastic sheeting was held in place with sandbags. Sandbags were laid around the flume inlet to prevent water leakage alongside the flume. The visquine was covered with sand.

The internal baffle was repaired and placed in the flume at the first portal. A piece of the flume had fractured off at the top of the inlet opening where the flashboards fit into their channeled grooves. It was glued back into place. The flume inlet on the east side was filled halfway with boards with a half screen place on top. The west side of the flume inlet was left boarded up. Final sandbar closure was made at 1030 hr with a sand dam being constructed across the channel next to the flume. The dam was track rolled to prevent seepage and a potential washout. After the work was done around the lagoon, the tractor work continued east toward the jetty. Sand was pushed up to the sea wall at the public beach access locations. The summer beach was taking shape.

No excavation of the sand was deemed beneficial adjacent to Venetian Court. The winter streamflow had scoured a deeper than usual channel on the west side with a steep bank. Only substantial grading on that side would provide deep habitat. This was impractical. The lagoon would be narrower and deeper on the Venetian side this year compared to past years. The high sandbar was constructed on that side. The interior weir was replaced in the flume. Three planks still remained in the flume exit on 26 May.

The deepest portion of the estuary was under and just downstream of the trestle, adjacent to the bedrock outcrop, as was the case in previous years. The streambed did not appear to have scoured more in this area or under the Stockton Avenue Bridge compared to the previous year. However, the area adjacent to the restaurants near the beach appeared more scoured, with old pilings being observed protruding out of the streambed.

10 June 2005. From this day onward until project completion, Ed Morrison, the city staff person in charge of field operations, monitored the beach preparation. Grading work was done along the Venetian Court area to lower the sand level below the drains in the wall along the walkway. The area long the east side of the lagoon was shored up with another layer of sand. Low-lying areas along the beach were filled to prepare the beach for weekend visitors. Matt Kotila, the city's tractor operator, has become skilled in locating and leveling these low areas.

The fishery biologist placed water temperature sensors in the lagoon and upstream as required by the Fish and Game permit. Water depth at the lagoon temperature monitoring station was approximately the same depth as in 2004. The lagoon gage height was 2.03 on this day.

12 June 2005. Water quality measurements off the Stockton Avenue Bridge at 1055 hr indicated no saline layer on the bottom of the lagoon. The lagoon was 1.75 meters deep in the thalweg (deepest location) under the bridge. The gage height had increased to 2.15.

13 June 2005. The berm of new sand that had formed after the weekend's high tides was graded up the beach to fill in low areas and level out the beach. Work was ended at 1300 hr due to the large crowd using the beach.

14 June 2005. Due to the shortage of sand on the beach this year, sand had to be imported to fill in the public access area near the Esplanade Park and jetty. Twenty truckloads of sand were delivered, approximating 417 tons of material, and spread along the eastern seawall near the jetty. Funding for the sand came from the Santa Cruz Littoral Cell/ Sand Mitigation Fund. The sand came from a sand plant in Marina.

15 June 2005. The areas adjacent to Venetian Court and near the jetty where sand was imported were graded level. The final beach grading was completed shortly before 1200 hr, and the bulldozer/tractor was hauled off the beach at 1300 hr.

In conclusion, during the entire sandbar construction and beach preparation, the City's tractor operator paid special attention to avoid working in the waters of the Monterey Bay by grading below the high tide line only after the tide had receded well below the work area.

Effect of Sandbar Construction on Tidewater Gobies in 2005

It was likely that if tidewater gobies were present, they used habitat upstream of the construction area, where there was less tidal fluctuation and salinity. No mortality of tidewater goby was observed during the construction activities. However, artificial water level fluctuations were created during sandbar construction activities. Three sandbar breaches were required during sandbar preparation in 2005, with 3 breaches allowed by the permit without regulatory consultation. In 2005, the artificial breaches closely mimicked normal tidal fluctuations of an estuary. With each lowering of the water in the estuary, tidewater gobies would have to retreat to deeper water as water surface receded in the upper estuary. There were likely few, if any tidewater gobies left in Soquel Creek after the past torrential stormflows of the 1997-98 winter. No tidewater gobies were detected during the fall 2004 lagoon sampling. The channel lacked sheltered backwaters for fish to escape high water velocity during high stormflows. However, tidewater gobies have been detected recently in Moran Lake and Aptos Lagoon after years of no detection, and they may repopulate Soquel Lagoon in the future from adjacent populations.

Effect of Sandbar Construction on Steelhead in 2005

No negative impacts to the steelhead population were detected in 2005. Access through the flume was maintained throughout the sandbar construction period. Water quality was diminished in the rake zone during the kelp and sea grass removal. However, shaded habitat under the bridge was not disturbed. In 2005, the only juvenile steelhead observed in the main estuary during sandbar construction was a young-of-the-year (YOY) steelhead rescued from the lateral channel and 2 observed in an isolated pool on one of the days across from Noble Gulch. When we walked the upper estuary during the 3 daily drawdowns, only the 2 steelhead were observed. The Creek was surveyed as far upstream as the downstream end of the Rispin parcel. Earlier sampling by NOAA Fisheries indicated that juvenile steelhead, both young-of-the-year and smolts, were present in May in the estuary.

The seasonal effect of removing organic material and constructing the sandbar is to create good summer rearing habitat for steelhead and tidewater goby. Compared to allowing natural lagoon formation, a lagoon is created with cooler, freshwater conditions, with reduced potential for eutrophication and associated increased biological oxygen demand from plant decomposition and night respiration by live algae. Kelp and sea grass removal and sandbar closure create better fish habitat for tidewater goby and steelhead than if the sandbar was allowed to close naturally. Natural closure would allow considerable kelp and sea grass to become trapped in the lagoon to decompose. Under natural sandbar formation, much more saltwater would also be trapped to create an unmixed, anoxic lagoon bottom, which would collect heat and raise lagoon temperature. The naturally formed sandbar would be lower in stature, allowing more tidal overwash of saltwater during especially high tides. Increased tidal overwash would further elevate water temperature, making the lagoon less hospitable for steelhead.

Recommendations for Lagoon Preparation and Sandbar Construction

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

2. 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 that weekend.

3. Continue to rake as much kelp and sea grass out of the lagoon as possible before final closure, from the Stockton Avenue Bridge downstream, including plant material trapped under the restaurants in depressions around the bridge piers. It is best to minimize time required to stockpile sand, rake out the decomposing organic material and prepare the flume inlet for fish passage. This will minimize the number of instances of artificial fluctuation of lagoon water level. Sufficient City staff should be assigned to quickly rake out decomposing kelp and clear the sand-filled flume. The three days of artificial breaching in 2004 required for sandbar construction was typical. However, raking time and grading time were severely reduced in 2004 because of the requirement of avoiding isolated pool formation. Fortunately, below normal amounts of seagrass and kelp were in the estuary this year.

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

5. 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.

6. Annually evaluate the structural integrity of the flume and its supports. Repair cracks and supports as necessary. (A grant has been secured for flume repair.)

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

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

9. Maintain the underwater portal in the flume intake for out-migration of adult steelhead

until June 15, while maintaining a notched top plank for out-migration of smolts until 1 July.

10. Maintain the 1-foot high baffle inside the flume until July 1 for safe entrance of out-migration of smolts into the flume inlet as they enter the Monterey Bay.

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

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

A tractor is used in the fall to cut a notch in the sandbar adjacent to the flume. 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 facilitates sandbar breaching. A tractor is used to re-cut the sandbar notch so that the sandbar breaches prior to flooding. If the flume is able to receive all of the stormflow and flooding does not become a threat, boards are replaced in the flume inlet after the stormflow has passed.

Sandbar Breaching During the 2005-2006 Rainy Season.

28 November 2005. At 2100 hr, Morrison removed 5 boards (20 inches) were removed from the restaurant side and 4 boards (16 inches) were removed from the Venetian Court side of the flume inlet in preparation for nighttime rain. Screens were inserted in the gaps created.

29 November 2005. At 0600 hr as reported by Morrison, the screens were fouled with debris. The lagoon level was 1 inch above the flume top. The debris was removed and the lagoon level lowered to the flume top as of 0645 hr as reported by Morrison. Morrison reported that streamflow peaked at about 25 cfs at the USGS gage during the night and was 14 cfs at 0615 hr, according to the USGS website. More rain is forecasted for Wednesday evening (30 November).

30 November 2005. By afternoon, the notch in the sandbar was deepened and the berm at the lagoon margin was lowered to correspond to the flooding elevation. Boards remain out. Lagoon elevation about 16 inches below the flume top, reported by Morrison. Heavy rain was forecasted for the evening. With rain in the forecast, Jennifer Nelson of the Fish and Game Department was notified of the likely need for facilitated breaching of the sandbar that evening or the next day. Streamflow at the gage at 1815 hr was 7.5 cfs.

1 December 2005. Streamflow at the gage was 12 cfs at 1015 hr. The lagoon level rose 5 inches in 3 hours during the morning with rain in the mountains. By 1400 hr, the decision was made to facilitate breaching with rain increasing. The City biologist was notified of the intent and arrived at the lagoon at 1450 hr. An opening was made in the berm nearest the surf. Under the supervision of Ed Morrison of Capitola Public Works, a channel was re-cut through the beach to the berm nearest the lagoon. The sand became spongy, preventing the tractor from working on the lagoon berm. Shovels were used to notch the lagoon berm and begin the stream channel through the beach. At this time, the lagoon level was approximately 8 inches below the lower bolt. The water slowly streamed onto the beach and a channel began to cut through the beach by 1600 hr. The lagoon level continued to rise to within 5 inches of the lower bolt. The stream channel widened to approximately 20 feet by 1700 hr, and the lagoon level had begun to recede. The public works crew left the beach at this time. By 1800 hr, as reported by Morrison, the streamflow at the Soquel Village gage reached over 60 cfs. By 2300 hr, streamflow reached 150 cfs at the Soquel Village stream gage. With a flume capacity of only 25-30 cfs, flooding would have occurred had sandbar breaching not been facilitated. The sandbar would have breached with or without facilitation.

2 December 2005. By 0615 hr, streamflow at the gage had declined to 78 cfs. The sandbar remained open to the ocean.

Recommendations Regarding Sandbar Breaching

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

2. The notch in the sandbar should be cut slightly lower than the piling bolt. *Make the notch at least 20-30 foot wide across the beach to 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.

3. Just as the first storm of the fall season begins, remove one board from each side of the flume if a small storm is anticipated. Remove two boards from either side if a large storm is anticipated. Clear the exit to the flume by removing the plate from one side of the exit. Clear the sand away from the top of the flume back to the first portal cover. As stated in the 1993 monitoring report, management options to delay sandbar breaching include installation of a perimeter fence around the flume inlet to collect algae and the opening of the first flume portal behind the flume inlet. The portal must be screened and isolated from human access to prevent a hazard to public safety. Replace the boards after the stormflow subsides, removing them for each succeeding storm until the sandbar is eventually breached during later, larger storms usually occurring after Thanksgiving. Remove the first flume portal cover and screen it if the entrance of the flume cannot handle the volume of the stormflow in October and early November. There is now a grated opening on top of the flume inlet. After the stormflow subsides, replace the cover until the next storm.

4. After the first storm of the season with the sandbar still intact, lower the lagoon level to a point where light may penetrate to the lagoon bottom. In doing so, the plant life in the lagoon may continue to photosynthesize and is kept viable. Thus, vegetation mortality and stressfully low oxygen levels are prevented until the water clarity is re-established. Re-install boards to increase lagoon depth after the lagoon clears up.

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

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

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

WATER QUALITY MONITORING IN 2005

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. Stress to freshwater acclimatized steelhead would probably not occur until conductivity levels reach 12,000 to 15,000 umhos, associated with sudden increases in salinity to 10- 12 parts per thousand. Water temperatures above 22° C (72° F) (**Table 1**) and oxygen levels below 5 parts per million (mg/L) are thought to stress steelhead. However, steelhead have been found surviving in pools in the Carmel River at 1-2 mg/L for 1-2 hours at dawn. Based on 1988 monitoring, steelhead appear to survive in Soquel Lagoon at water temperatures of 23-25°C for 1-2 hours toward the end of the day (**Habitat Restoration Group 1990**). Water temperature may rise as much as 3-5°C during a sunny day from a minimum at dawn.

Oxygen levels critical to steelhead 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 20° C were rated "good" while those 20-21.5° C were rated "fair." Temperatures between 21.5 and 23° C were rated "poor," while those greater than 23° C at dawn were rated "critical." High levels of dissolved carbon dioxide in water will inhibit absorption of oxygen by fish. However, in the alkaline conditions of Soquel Creek Lagoon, carbon dioxide is poorly dissolved and is not a problem (**J. Smith, personal comm.**). Therefore, its monitoring was unnecessary.

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

Locations and Timing of Water Quality Monitoring

As required under the CDFG permit for 2005, 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. The first station was at the flume inlet (**Figure 1**). The second station was on the downstream side of the Stockton Avenue Bridge in the deepest thalweg area. The third was just downstream of the railroad trestle on the east side. The fourth station was at the mouth of Noble Gulch. A fifth station was monitored in the morning in Soquel Creek near the Nob Hill shopping center, just upstream of where it entered the lagoon. The data at the stream location was used as a point of comparison with lagoon conditions when oxygen levels would be at a minimum.

In 2005, 6 HOBO temperature loggers were placed just upstream of the railroad trestle in Reach 3 at 1-foot intervals through the water column beginning at 0.5 feet above the bottom and ending 5.5 feet from the bottom, as required by the CDFG permit. This was a deeper portion of the lagoon. These loggers were launched on 10 June 2005. Another logger was placed in Soquel Creek near the Nob Hill Shopping Center. All 7 loggers were removed on 9 October 2005.

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. If it had, then the shrouds would be placed on the flume inlet to draw the heavier saltwater off the lagoon bottom to hasten the freshwater conversion in the lagoon. In 2005, the CDFG permit required that monitoring occur in the early morning and late afternoon. Prior to 2003, water quality had been measured in the early morning after dawn because the most limiting factor, oxygen concentration, is at a minimum at that time.

Table 1. Temperature Conversions From Degrees Celsius to Degrees Fahrenheit.

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

Table 2. Water Quality Criteria for Measurements Within 0.25 Meters Off the Bottom at Dawn and Gage Height Readings.

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

In 2005, a total of 4 water samples were collected before and immediately following the Begonia Festival Procession on 4 September. The two sampling locations were located in Reach 1, approximately 25 feet downstream of the bridge, and in Reach 2, midway between the trestle and the Stockton Avenue Bridge (**Figure 1**). Water samples were taken near the water surface.

Water Temperature Goals for Soquel Creek and Lagoon

Regarding Soquel Creek Lagoon in summer, where food is more abundant than upstream, a management goal for steelhead should be to maintain water temperature below 20°C (68°F) at dawn within 0.25 m of the bottom and the afternoon maximum below 22°C (71.6°F) near the bottom. This early morning goal coincides with a "good" rating at monitoring sites (**Table 2**). This management goal is somewhat higher than the enhancement goal we established for Soquel Creek, where the goal was to maintain water temperature below 20°C. Maximum daily water temperature in the lagoon should not reach 26.5°C (79.5°F). Although Coche (**1967, cited in Kubicek and Price 1976**) determined that temperatures between 20 and 24°C were responsible for high maintenance requirements and low conversion efficiency of food into growth for his stock of juvenile steelhead, our annual sampling of juvenile steelhead in Soquel Lagoon indicates that growth rate in the lagoon has been greater than in the upstream stream reaches (**Alley 2003**), with nearly all young-of-the-year juveniles in the lagoon reaching smolt size the first summer each year. This indicates that higher water temperature has not prevented relatively rapid growth of juveniles in the lagoon.

Water temperatures above 20°C (68°F) are considered limiting to juvenile coho salmon in the presence of steelhead (depending on food abundance), and lagoon temperatures below 16°C (60.8°F) 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 20°C (68°F). However, we do not believe that Soquel Creek Lagoon may be cooled sufficiently to support juvenile coho salmon.

The management goal for water temperature in stream habitat upstream of the lagoon should be maintenance below 20°C (68°F) in April and May when baseflow still remains above summer low-flow and juvenile salmonids are feeding and growing rapidly. From June1 to September 1, the water temperature should not rise above 20°C (68°F) more than 4 hours a day (15% of the month) and preferably the maximum daily temperature, averaged weekly, should not rise above 21°C (70°F). These goals are based on literature review of physiological relationships between fish metabolic rate and water temperature (**Kubicek and Price (1976); Brett (1959, cited in Kubicek and Price 1976); and Snyder and Blahm (1971, cited in Kubicek and Price 1976)**).

The temperature optimum is a moving target, increasing and decreasing with food supply. According to Moyle (**2002**), Baltz et al. (**1987**) reported that optimal temperatures for growth of rainbow trout (not steelhead) to be around 15-18°C, a range that corresponded to temperatures selected in Sierran streams when possible. According to Moyle (**2002**), regarding temperature optima, "The optimal temperatures for growth of rainbow trout are around 15-18°C, 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 16-18°C. However, many factors affect choice of temperatures by trout (if they have a choice), including the availability of food." The Santa Ynez River Technical Advisory Committee (SYRTAC) proposed guidelines with upper limits of 20°C average daily temperature and 25°C daily maximum as providing acceptable habitat conditions for steelhead in the Santa Ynez River (**SYRTAC 2000**) further south. The SYRTAC (**2000**) decided that a mean daily temperature of 22°C 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 23°C.

The management goal regarding water temperature prior to re-introduction of coho salmon to Soquel Creek should be that water temperatures in specified reaches meet the criteria that average daily water temperature (averaged weekly) during summer/fall months (June 1 to October 1) be 16.7°C (62°F) or less in the warmest week and that the weekly maximum temperature be 18.0°C (64°F) 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. We do not believe that the mainstem Reaches 1-6, downstream of the Moores Gulch confluence can become sufficiently shaded to reach this goal.

Results of Water Quality Monitoring of the Lagoon After Sandbar Closure

Lagoon Level. **Appendix A** provides detailed data on water quality. **Table 3** rates habitat conditions. The lagoon level was monitored 15 times in 1 to 2-week intervals from 12 June to 1 December 2005, including September 4, the day of the Begonia Festival. For 2005, the measurements of lagoon level as measured on the staff gage were rated "good" (**Table 2**) on 12 occasions, "fair" on 2 occasions and "poor" on one occasion (**Table 3; Figure 2a**). The fair ratings occurred early in the lagoon season when streamflow was still high and adjustments were being made with flashboards to accommodate the high, but declining, outflow. There was also a 7-day period from 20 October to 26 October in which the lagoon level was in the "poor" range. In the cases of poor ratings, flashboards had been removed in anticipation of storms and could not be avoided. The final poor rating was on the last day of the season for the lagoon with breaching occurring in the afternoon. Maintenance of lagoon gage height has improved since the pre-1996 summers, particularly late in the dry season (**Figures 2a-c**). In 2005, the gage height was lower than in 2004 early in the season and similar to 2004 height the remainder of the season after all of the flashboards had been stacked into the flume inlet. All of the flashboards were in place much earlier in the lower flow year of 2004, allowing for maximum lagoon depth sooner. In the past, backpressure through the flume has likely dislodged boards to allow leakage through the flume, resulting in reduced water surface elevation. However, there was no indication that this occurred in 2004 or 2005, with the use of plywood nailed to the boards to hold them together. With no saltwater trapped in the lagoon in 2005, the shrouds were not needed. There was no tidal overwash. Presence of the grated hole in the top of the flume for the third year allowed for more secured flashboards than previously.

No vandalism of the flume inlet was detected in 2005. The plywood protected against both back-pressure and vandalism. Wedges were used to secure the top boards, as well. A better method is still needed to secure the flashboards against vandalism on the one hand, while allowing convenient adjustment or removal of boards by City staff when necessary. While the wedges discourage all but the most determined vandals, they do not allow easy removal of boards when surface algae and debris near the flume needs to be drained out or when sandbar breaching is to be prevented by increasing the volume through the flume. The grated hole in the top of the flume alleviates the need for rapid board removal and replacement during small stormflows.

Flume Passability. According to the Management Plan (**1990**), fish passage is to be maintained until July 1. A flume depth of 12 inches or deeper was desired at the entrance until that time. The flume had been mostly cleared of sand without human intervention in 2005. This was the first time in 15 years that the flume was clear without the need for manual flushing. Thus, steelhead smolt passage was insured during and after sandbar construction. Sufficient baseflow in 2005 resulted in excellent passage for steelhead smolts throughout the lagoon's existence in 2005 (**Table 3**). The baffle near the flume entrance had to be replaced at the beginning of the summer. The sandbar breached with assistance on 1 December 2005. The flume was flowing at full capacity at the time of the sandbar breach, and the channel through the beach was 20-30 feet wide within an hour of breaching.

Table 3. Morning Water Quality Ratings in Soquel Creek Lagoon, 2005, Within 0.25 M of Bottom.

Date	Flume Passage	Gage Height	Water Temperature	Oxygen	Salin-ity	Lagoon In-flow Visual est. (cfs)
12June05	open	2.15	-	-	-	
		fair	good	good	good	
			-	-	-	
			-	-	-	
19June05	open	1.85	good*	good	good	15 cfs
		fair				
01July05	open	2.39	good	good	good	
		good		fair		
				fair		
				fair		
15July05	open	2.05	good	good	good	8 cfs
		fair		good		
				fair		
				fair		
29July05	open	2.59	good	good	good	8 cfs
		good				
14Aug05	open	2.56	good	good	good	6.5 cfs
		good		fair		
				fair		
				good		
27Aug05	open	2.50	good	good	good	
		good				
04Sep05	open	2.48	-	-	-	
Begonia		good	good	fair	good	
Festival			good	fair	good	
			good	good	good	
04Sep05	open	2.48	-	-	-	
(afternoon)		good	good	good	good	
			good	good	good	
			good	good	good	
10Sep05	open	2.50	good	good	good	6 cfs
		good		good		
				good		
				fair		
25Sep05	open	2.54	good	good	good	4.5 cfs
		good		good		
				good		
				fair		
08Oct05	open	2.43	good	good	good	2.93 cfs measured
		good		good		
				good		
				fair		
18Oct05	open	2.44	good	good	good	3 cfs
		good		fair		
				good		
				good		
03Nov05	open	2.48	good	good	good	3 cfs
		good				
17Nov05	open	2.56	good	good	good	3.5 cfs
		good				
01Dec05	open	1.83	good	good	good	12 cfs at USGS gage
		poor				

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

<u>Water Temperature Results from Two-Week Monitoring.</u> In 2005, the lagoon was consistently cooler than in 2004, with water temperature rated either "good" (< 20°C at dawn) at all four stations throughout the summer within 0.25 meters of the bottom (**Table 3, Figures 3a-c; Appendix A**). Maintenance of a deep lagoon for most of the summer without tidal overwash helped to minimize water temperature near the bottom. There was tidal overwash in 2004, which allowed saltwater to stagnate on the bottom and heat up for a short period. Use of the shrouds hastened the evacuation of saltwater. However, in 2001, there was a 14-day period with a saline bottom layer that heated up to between 23 and 26°C. Also, stream inflow had a cooling down effect on the lagoon overnight. This was likely more of a factor in 2005 with substantially more streamflow than in 2004 (**Table 8**). Added to this, the water temperature of the stream inflow was cooler in August through mid-October (intervals 4.5-9.5 on the graph) in 2005 compared to 2004 (**Figure 3e**). Air temperature also played a part in determining water temperature. Based on monthly average air temperatures at the Watsonville Airport, which is near the coast approximately 10 miles south of the lagoon, air temperatures were slightly warmer in July, cooler in August and cooler still in September 2005 compared to 2004 (**Table 4**). The mean daily air temperature in July 2005 was 1° C warmer than in July 2004, with identical averages for monthly maximum and minimum daily temperature. The monthly maximum, mean and minimum daily air temperature averaged for August 2005 was 1° C lower than in August 2004. In September 2005, the monthly average maximum daily air temperature was 4° C cooler and the average mean daily air temperature was 2° C cooler compared to September 2004. Cooler air temperatures in August and September 2005 likely contributed to a cooler lagoon in 2005.

In 2005, the water temperature at dawn within 0.25 m of the bottom of the lagoon became warmer as the monitoring stations progressed down the lagoon to the flume (**Figure 3f**). In the afternoon near the lagoon bottom, Station 1 at the flume was usually the warmest and Station 4 at the mouth of Noble Gulch was usually the coolest (**Figure 3g**). However, at 2 of the monitoring times the water temperature was warmest at the railroad trestle for near-bottom measurements. Sometimes the water temperature was the same at more than one station. Station 4 at the mouth of Noble Gulch usually had the warmest surface water temperature in the afternoon and showed the greatest reduction in water temperature down through the water column to the bottom at that time (**Appendix A**). The warmest water temperatures observed near the bottom at the 4 stations during 2-week intervals occurred on 15 July with readings of 20.0, 19.8, 20.1 and 19.7°C at Stations 1-4, respectively (**Figures 3a-d; Appendix A**).

Table 4. Monthly Statistics for Air Temperature at the Watsonville Airport in July – August in 2004 and 2005.

July 2004 Monthly Statistics for Air Temperature at the Watsonville Airport.

Temperature	Max	Avg	Min
Max Temperature	82 °F / 27 °C	72 °F / 22 °C	62 °F / 16 °C
Mean Temperature	68 °F / 20 °C	62 °F / 16 °C	58 °F / 14 °C
Min Temperature	59 °F / 15 °C	54 °F / 11 °C	46 °F / 7 °C

July 2005 Monthly Statistics for Air Temperature at the Watsonville Airport.

Temperature	Max	Avg	Min
Max Temperature	91 °F / 32 °C	72 °F / 22 °C	64 °F / 17 °C
Mean Temperature	71 °F / 21 °C	63 °F / 16 °C	58 °F / 14 °C
Min Temperature	57 °F / 13 °C	54 °F / 12 °C	51 °F / 10 °C

August 2004 Monthly Statistics for Air Temperature at the Watsonville Airport.

Temperature	Max	Avg	Min
Max Temperature	90 °F / 32 °C	73 °F / 22 °C	66 °F / 18 °C
Mean Temperature	73 °F / 22 °C	64 °F / 17 °C	60 °F / 15 °C
Min Temperature	61 °F / 16 °C	55 °F / 12 °C	50 °F / 10 °C

August 2005 Monthly Statistics for Air Temperature at the Watsonville Airport.

Temperature	Max	Avg	Min
Max Temperature	86 °F / 30 °C	71 °F / 21 °C	64 °F / 17 °C
Mean Temperature	67 °F / 19 °C	62 °F / 16 °C	60 °F / 15 °C
Min Temperature	57 °F / 13 °C	53 °F / 11 °C	48 °F / 8 °C

September 2004 Monthly Statistics for Air Temperature at the Watsonville Airport.

Temperature	Max	Avg	Min
Max Temperature	97 °F / 36 °C	78 °F / 25 °C	62 °F / 16 °C
Mean Temperature	76 °F / 24 °C	64 °F / 17 °C	56 °F / 13 °C
Min Temperature	57 °F / 13 °C	51 °F / 10 °C	44 °F / 6 °C

September 2005 Monthly Statistics for Air Temperature at the Watsonville Airport.

Temperature	Max	Avg	Min
Max Temperature	90 °F / 32 °C	71 °F / 21 °C	64 °F / 17 °C
Mean Temperature	70 °F / 21 °C	61 °F / 15 °C	55 °F / 12 °C
Min Temperature	55 °F / 12 °C	50 °F / 10 °C	44 °F / 6 °C

<u>Results from Continuous Temperature Data Loggers.</u> In analyzing temperature data from the 6 data loggers throughout the water column just upstream of the railroad trestle, results were consistent with temperature data collected through the water column at monitoring stations over the past 15 years. However, the following analysis pertains to the vicinity of these data loggers only. Bare in mind that our 2-week monitoring at the 4 sites indicated that Station 4 near the mouth of Noble Gulch usually had cooler water temperatures near the bottom than Site 3 near the trestle **(Figures 3g-f)**.

Juvenile steelhead likely spent most of their time near the bottom, except when feeding on emerging aquatic insects at dusk and dawn. This assumption was based on years of underwater observations of salmonids. Therefore, the water temperatures recorded near the lagoon bottom (within 0.25 m) have greatest relevance to assessing habitat quality.

Lagoon water temperatures **(Figures 4a- 4l)** closely mirrored temperatures in the stream inflow **(Figures 5k-l)** in 2005, as in past years. Daily temperature *minima* in the lagoon were consistently warmer near the bottom than the stream inflow in 1999-2005(**Figures 4a and 5k** for 2005). Daily temperature *maxima* were warmer in the lagoon than the stream in 1999 and 2001-2004, but not in 2000 or 2005. The daily stream temperature fluctuated more than the lagoon temperature.

As in past years, no thermocline was detected by the data loggers or at any of the 4 monitoring stations during the summer in 2005, with complete mixing of the water column on a diurnal cycle. The lagoon was likely 7-8 feet deep at most and subject to daily inland breezes. Water temperature was somewhat cooler at depth compared to nearer the surface by afternoon, being coolest near the bottom in 2005. Each night, water temperature cooled to the bottom, with the surface sometimes being slightly cooler than deeper layers at dawn (**Figures 4a- 4l**).

From 10 June through 8 October 2005, the daily maximum water temperature of the stream inflow ranged from a minimum of **14.1°C** (57.4°F) on 4, 5 and 8 October to a maximum of **21.3°C** (70.4°F) on 9, 11 and 12 July (**Figures 5k and 5l**). In 2004 the maximum water temperature ranged from **15.2°C** (59.4°F) on 20 September to **22.1°C** (71.8°F) on 20 July **(Figures 5i and 5j)**.

As the 2-week monitorings indicated, the data loggers also showed that the 2005 lagoon was cooler than the 2004 lagoon. Refer to the discussion related to the 2-week monitoring results for the explanation for the differences. The daily maximum water temperature in 2005 near the lagoon surface ranged from **16.0°C** (60.8°F) on 8 October to **22.9°C** on 12 July **(Figures 4k and 4l)**. In 2004 the maximum surface temperature ranged from **17.1°C** (62.8°F) on 30 September to **24.0°C** (75.2°F) on 20 July (**Figure 4n**). Near the lagoon bottom, maximum water temperature ranged between **15.2°C** (59.4°F) on 6 October and **21.3°C** (70.4°F) on 12 July (**Figures 4a and 4b**). In 2004 the range was **17.5°C** (63.5°F) on 30 September to **24.0°C** (75.2°F) on 20 July **(Figure 4m)**.

The greatest increase in water temperature recorded from morning to afternoon near the bottom in 2005 was **3.1°C** (5.5°F) on 19 June (**Figures 4a-b**). The greatest increase near the lagoon surface was an amazing **8.4°C** (15.1°F) (**Figures 4k-l**). In 2004 the greatest increase at the surface was only **2.3°C** (4.1°F) on 8 June and 20 July (**Figure 4n**).

Days when lagoon water temperatures exceeded 22°C near the bottom would likely be stressful for juvenile steelhead. In 2005, water temperature near the bottom never reached this threshold. It only went above 22°C once (12 July) at the surface. In 2004, this occurred near the bottom for 5 days after tidal overwash on 19 July, 4 days in August (2 days at a time in early and late August) and 2 days in early September (**Figure 4a**). But conditions were more stressful in 2001 when there had been two major tidal overwashes. In 2001, daily temperatures near the bottom fluctuated between approximately 23 and 26°C (73.4- 78.8°F) for 14 days (**Alley 2003c**).

In the 2005 lagoon, the steelhead management goal of early morning temperature less than 20°C near the bottom was met throughout the lagoon period. In the 2004 lagoon, 27% of the days measured (34 of 125 days – 1 April- 3 October) failed to meet the management goal. This was compared to 19% in 2003 and 10% in 2002. In 2005, the lagoon also met the steelhead management goal of maximum daily temperatures below 22°C near the bottom. In the 2004 lagoon, a total of 8.8% of the days (11 of 125 days in 2004) did not meet this management. This was compared to 7.1% in 2003 and 2% in 2002.

The 2005 lagoon came close to meeting the coho management goal of keeping maximum water temperatures below 20°C (68°F) (depending on food abundance) in the presence of steelhead. However, they prefer to have temperatures below 16°C (depending on food abundance). There were only 9 days in July (7.4% of the 121 days monitored) in which the daily maximum near the bottom went above 20°C, with the maximum of 21.3°C on 12 July.

The most significant water temperature differences from one day to the next in 2005 likely resulted from differences in water temperature of the stream inflow on those days and differences in air temperature/ solar insolation. There were two conspicuous cooling incidents near the lagoon bottom around 17 June and 4 July, presumably caused by fog and cloudy days, when daily water maxima declined approximately 1.5°C near the bottom from one day to the next. At the surface, the cooling incidents occurred around 17 June (2.5°C decline from one day to the next) and on 13 July (almost 4°C decline). Then, the later half of the lagoon season from mid-August onward must have had considerable cloud cover to keep the lagoon cooler than usual.

Detailed water temperature measurements expressed at 10-day intervals showed that the difference between maximum daily temperatures in the late afternoon at 0.5 feet from the bottom and 5.5 feet from the bottom (less than 0.5 feet from the surface) varied between –0.58°C (1.04° F) and 1.15°C (2.06°F) from bottom to top (**Table 5; Figures 4a-b and 4k-l**). The negative difference, indicating warmer conditions on the bottom than the surface presumably resulted from a slight saline layer on the bottom for a short period after sandbar closure. The range was 0 to 1.15 C in 2002-2004 (**Tables 6-8**). The average maximum temperature difference from bottom to top was **0.58°C** (1.06°F) for 14 days analyzed in 2005 (**Table 5**). In 2004 the average difference was **0.41°C** (0.74°F) for the 14 days analyzed in 2004 (**Table 6**), compared to 0.60°C (1.07°F) for the 14 analyzed days in 2003 (**Table 7**) and **0.72°C** (1.31°F) for the 10 days considered in 2002 (**Table 8**).

The difference in minimum daily temperatures in the morning from bottom to top of the water column was more than the maximum daily temperature difference through the column, ranging from –1.91 C (3.4 F) to 0.76 °C (1.37°F) (**Table 5**). The negative difference resulted from 2 very cool nights followed by very warm days. In 2004, the difference in minimum daily temperatures ranged from 0 to 0.76 °C (1.37°F) (**Table 6**). It ranged from zero to 0.38°C (0.69°F) in both 2003 and 2002 (**Tables 7 and 8**).

At the creek site near Nob Hill in 2005, water temperature failed to meet the management goal of *no more than 4 hours a day at greater than 20°C (68°F)* on 6 of 120 monitored days (**5%**; 10 June- 8 October) (**Figure 5k**). In 2004, 9 of 125 monitored days (**7%**; June-early October). September was unusually cool in 2004 and 2005 (**Figure 5i**). At the Creek site near Nob Hill in 2003, 22 of 127 monitored days (**17%**; June-early October) failed to meet the management goal (**Figure 5g**). For comparisons with 2002, beginning in July 2003, 16 of 96 days (**17%**) of the days failed to meet the management goal (**Figures 5e-f**), indicating warmer stream temperatures than in 2002. At the 2002 creek site for the same 96 days, only 4 days (**4%**) failed to meet the management goal.

With a water temperature goal of having the average weekly temperature of 16.7° C (62° F) or cooler for coho salmon, considerably more stream shading will be required to make lower Soquel Creek habitable for this species.

Water temperatures in the lagoon closely mirrored temperatures in the stream inflow in 2005 as in 2003 and 2004. Daily *minima* in the lagoon were consistently warmer than the stream above in 1999-2005 (**Figures 4a and 5k**). The daily *maxima* were warmer in the lagoon than the stream in 1999 and 2001-2005 (**Figures 4k and 5k**), but not in 2000. The daily stream temperature fluctuated more than the lagoon.

Table 5. 2005 Maximum and Minimum Water Temperatures from Continuous Data Loggers at 0.5 Feet and 5.5 feet from the Bottom (Near Surface) in the Water Column Upstream of the Railroad Trestle, Reach 3 of Soquel Lagoon.

Depth Above Bottom>>>>	Max/Min Temp °C(°F)/ °C(°F) **5.5 ft**	Max/Min Temp °C(°F)/ °C(°F) **0.5 ft**	Daily Temp. Difference of Max/ Min Temp. for 5.5 to 0.5 ft from Bottom **°C(°F) / °C(°F)**
11 June	18.28 (64.91)/ 15.23 (59.42)	18.66 (65.59)/ 16.0 (60.82)	-0.58 (-0.78)/ -0.77 (-1.38)
20 June	19.42 (66.96)/ 14.09 (57.35)	18.66 (65.59)/ 16.0 (60.8)	0.76 (1.37)/ -1.91 (-3.45)
30 June	19.42 (66.96)/ 18.28 (64.91)	19.42 (66.96)/ 17.52 (63.54)	0 (0)/ 0.76 (1.37)
9 July	20.57 (69.02)/ 18.28 (64.91)	20.95 (69.71)/ 18.28 (64.91)	-0.38 (-0.69)/ 0 (0)
19 July	20.95 (69.71)/ 19.04 (66.28)	19.81 (67.65)/ 18.66 (65.59)	1.14 (2.06)/ 0.38 (0.69)
29 July	20.19 (68.33)/ 18.66 (65.59)	19.04 (66.28)/ 18.28 (64.91)	1.15 (2.05) 0.38 (0.68)
8 August	19.81 (67.65)/ 18.66 (65.59)	18.66 (65.59)/ 18.28 (64.91)	1.15 (2.06)/ 0.38 (0.68)
18 August	18.28 (64.91)/ 17.14 (62.85)	17.9 (64.22)/ 17.14 (62.85)	0.38 (0.69)/ 0 (0)
28 August	19.81 (67.65)/ 17.9 (64.22)	18.66 (65.59)/ 17.9 (64.22)	1.15 (2.06)/ 0 (0)
7 September	17.9 (64.22)/ 17.14 (62.85)	17.52 (63.54)/ 16.76 (62.17)	0.38 (0.68)/ 0.38 (0.68)
17 September	17.9 (64.22)/ 16.0 (60.8)	16.76 (62.17)/ 15.62 (60.11)	1.14 (2.05)/ 0.38 (0.69)
27 September	17.52 (63.54)/ 15.62 (60.11)	16.38 (61.48)/ 16.04 (60.8)	1.14 (2.06)/ -0.38 (-0.69)
2 October	17.9 (64.22)/ 16.76 (62.17)	17.52 (63.54)/ 16.38 (61.48)	0.38 (0.68)/ 0.38 (0.69)
8 October	16.0 (60.8)/14.35 (58.73)	16.0 (60.8)/14.85 (58.73)	0 (0)/0 (0)

Table 6. 2004 Maximum and Minimum Water Temperatures from Continuous Data Loggers at 0.5 Feet and 5.5 feet from the Bottom (Near Surface) in the Water Column Upstream of the Railroad Trestle, Reach 3 of Soquel Lagoon.

Depth Above Bottom>>>>	Max/Min Temp °C(°F)/ °C(°F) **5.5 ft**	Max/Min Temp °C(°F)/ °C(°F) **0.5 ft**	Daily Temp. Difference of Max/ Min Temp. for 5.5 to 05 ft from Bottom **°C(°F) / °C(°F)**
1 June	20.19 (68.33)/ 18.28 (64.91)	19.04 (66.28)/ 17.9 (64.22)	1.15 (2.05)/ 0.38 (0.69)
10 June	20.57 (69.02)/ 18.66 (65.59)	19.42 (66.96)/ 18.66 (65.59)	1.15 (2.06)/ 0 (0)
20 June	20.57 (69.02)/ 18.28 (64.91)	20.19 (68.33)/ 18.28 (64.91)	0.38 (0.69)/ 0 (0)
30 June	20.57 (69.02)/ 19.04 (66.28)	19.81 (67.65)/ 18.66 (65.59)	0.76 (1.37)/ 0.38 (0.69)
9 July	19.42 (66.96)/ 17.9 (64.22)	18.66 (65.59)/ 17.14 (62.85)	0.76 (1.38)/ 0.76 (1.37)
19 July	23.63 (74.53)/ 21.71 (71.08)	22.86 (73.15)/ 21.71 (71.08)	0.77 (1.38) 0 (0)
29 July	20.57 (69.02)/ 19.42 (66.96)	20.59 (69.02)/ 18.66 (65.59)	0 (0)/ 0.76 (1.37)
8 August	22.09 (71.77)/ 20.57 (69.02)	22.09 (71.77)/ 20.57 (69.02)	0 (0)/ 0 (0)
18 August	21.33 (70.39)/ 20.57 (69.02)	21.33 (70.39)/ 20.57 (69.02)	0 (0)/ 0 (0)
28 August	21.71 (71.08)/ 20.95 (69.71)	21.71 (71.08)/ 20.95 (69.71)	0 (0)/ 0 (0)
7 September	22.48 (72.46)/ 20.57 (69.02)	22.09 (71.77)/ 20.57 (69.02)	0.38 (0.69)/ 0 (0)
17 September	19.42 (66.96)/ 19.04 (66.28)	19.42 (66.96)/ 19.04 (66.28)	0 (0)/ 0 (0)
27 September	18.66 (65.59)/ 17.52 (63.54)	18.66 (65.59)/ 17.52 (63.54)	0 (0)/ 0 (0)
2 October	17.9 (64.22)/16.38 (61.48)	17.52 (63.54)/16.38 (61.48)	0.38 (0.68)/0 (0)

Table 7. 2003 Maximum and Minimum Water Temperatures from Continuous Data Loggers at 0.5 feet and 4.5 feet from the Bottom (Near Surface) in the Water Column Upstream of the Railroad Trestle, Reach 3 of Soquel Lagoon.

Depth Above Bottom>>>>	Max/Min Temp °C(°F)/ °C(°F) **4.5 ft**	Max/Min Temp °C(°F)/ °C(°F) **0.5 ft**	Daily Temp. Difference of Max/ Min Temp. for 4.5 and 0.5 ft from Bottom **°C(°F) / °C(°F)**
1 June	18.66 (65.59)/ 16.38 (61.48)	18.66 (65.59)/ 16.38 (61.48)	0 (0)/ 0 (0)
10 June	16.76 (62.17)/ 15.62 (60.11)	16.76 (62.17)/ 15.62 (60.11)	0 (0)/ 0 (0)
20 June	19.81 (67.65)/ 16.76 (62.17)	18.66 (65.59)/ 16.76 (62.17)	1.15 (2.06)/ 0 (0)
30 June	20.95 (69.71)/ 18.66 (65.59)	20.57 (69.02)/ 18.66 (65.59)	0.38 (0.69)/ 0 (0)
9 July	20.95 (69.71)/ 18.28 (64.91)	20.19 (68.33)/ 18.28 (64.91)	0.76 (1.38)/ 0 (0)
19 July	19.81 (67.65)/ 19.04 (66.28)	19.42 (66.96)/ 18.66 (65.59)	0.39 (0.69) 0.38 (0.69)
29 July	20.95 (69.71)/ 19.42 (66.96)	20.95 (69.71)/ 19.42 (66.96)	0 (0)/ 0 (0)
8 August	23.24 (73.84)/ 20.95 (69.71)	22.09 (71.77)/ 20.57 (69.02)	1.15 (2.07)/ 0 (0)
18 August	21.71 (71.08)/ 19.81 (67.65)	20.95 (69.71)/ 19.81 (67.65)	0.76 (1.37)/ 0 (0)
28 August	21.71 (71.08)/ 20.19 (68.33)	20.95 (69.71)/ 19.81 (67.25)	0.76 (1.37)/ 0.38 (0.69)
7 September	20.95 (69.71)/ 19.04 (66.28)	20.19 (68.33)/ 18.66 (65.59)	0.76 (1.38)/ 0.38 (0.69)
17 September	20.95 (69.71)/ 19.04 (66.28)	19.81 (67.65)/ 18.66 (65.59)	1.14 (2.06)/ 0.38 (0.69)
27 September	18.66 (65.59)/ 17.90 (64.22)	18.28 (64.91)/ 17.52 (63.54)	0.38 (0.68)/ 0.38 (0.68)
4 October	18.66 (65.59)/17.14 (62.85)	18.28 (64.91)/17.14 (62.85)	0.38 (0.68)/0 (0)

Table 8. 2002 Maximum and Minimum Water Temperatures at One Foot Intervals Through the Water Column Upstream of the Railroad Trestle, Reach 3 of Soquel Lagoon.

Depth Above Bottom>>>>	Max/Min Temp °C(°F)/ °C(°F) **5.5 ft**	Max/Min Temp °C(°F)/ °C(°F) **4.5 ft**	Max/Min Temp °C(°F)/ °C(°F) **3.5 ft**	Max/Min Temp °C(°F)/ °C(°F) **2.5 ft**	Max/Min Temp °C(°F) /°C(°F) **1.5 ft**	Max/Min Temp °C(°F)/ °C(°F) **0.5 ft**	Temp. Diff. of Max/ Min Temp. for 5.5 and 0.5 ft from Bottom **°C(°F) / °C(°F)**
3 July					20.57 (69.71)/ 19.04 (66.28)	20.19 (68.33)/ 19.04 (66.28)	
10 July	22.48 (72.46)/ 20.19 (68.33)	22.48 (72.46)/ 20.19 (68.33)	22.48 (72.46)/ 20.19 (68.33)	22.09 (71.77)/ 20.19 (68.33)	22.68 (73.15)/ 20.19 (68.33)	22.09 (71.77)/ 20.19 (68.33)	0.39 (0.69)/ 0 (0)
20 July	19.42 (66.96)/ 18.28 (64.91)	19.42 (66.96)/ 18.28 (64.91)	19.42 (66.96)/ 18.28 (64.91)	19.42 (66.96)/ 18.28 (64.91)	19.42 (66.96)/ 17.9 (64.22)	19.42 (66.96)/ 17.9 (64.22)	0 (0)/ 0.38 (0.69)
30 July	21.33 (70.39)/ 19.42 (66.96)	21.33 (70.39)/ 19.42 (66.96)	21.33 (70.39)/ 19.42 (66.96)	21.33 (70.39)/ 19.42 (66.96)	20.95 (69.71)/ 19.42 (66.96)	20.95 (69.71)/ 19.42 (66.96)	0.38 (0.68)/ 0 (0)
9 August	21.71 (71.08)/ 19.42 (66.96)	21.71 (71.08)/ 19.42 (66.96)	21.71 (71.08)/ 19.42 (66.96)	21.33 (70.39)/ 19.42 (66.96)	20.95 (69.71)/ 19.42 (66.96)	20.95 (69.71)/ 19.42 (66.96)	0.76 (1.37)/ 0 (0)
19 August	19.42 (66.96)/ 18.28 (64.91)	19.42 (66.96)/ 18.28 (64.91)	19.42 (66.96)/ 18.28 (64.91)	19.42 (66.96)/ 17.9 (64.22)	18.66 (65.59)/ 17.9 (64.22)	18.66 (65.59)/ 17.9 (64.22)	0.76 (1.37)/ 0.38 (0.69)
29 August	19.04 (66.28)/ 18.28 (64.91)	19.04 (66.28)/ 18.28 (64.91)	19.04 (66.28)/ 18.28 (64.91)	18.66 (65.59)/ 18.28 (64.91)	18.28 (64.91)/ 17.9 (64.22)	18.28 (64.91)/ 17.9 (64.22)	0.76 (1.37)/ 0.38 (0.69)
8 September	20.19 (68.33)/ 18.28 (64.91)	19.81 (67.65)/ 18.28 (64.91)	19.81 (67.65)/ 18.28 (64.91)	19.81 (67.65)/ 18.28 (64.91)	19.42 (66.91)/ 18.28 (64.91)	19.42 (66.91)/ 18.28 (64.91)	0.77 (1.42)/ 0 (0)
18 September	20.19 (68.33)/ 18.28 (64.91)	19.81 (67.65)/ 18.28 (64.91)	19.42 (66.96)/ 18.28 (64.91)	19.42 (66.96)/ 18.28 (64.91)	19.04 (66.28)/ 17.9 (64.22)	19.04 (66.28)/ 17.9 (64.22)	1.15 (2.05)/ 0.38 (0.69)
28 September	18.28 (64.91)/ 16.76 (62.17)	18.28 (64.91)/ 16.76 (62.17)	17.52 (63.54)/ 16.76 (62.17)	17.52 (63.54)/ 16.76 (62.17)	17.14 (62.85)/ 16.76 (62.17)	17.14 (62.85)/ 16.76 (62.17)	1.14 (2.06)/ 0 (0)
5 October	17.9 (64.22)/16.0 (60.8)	17.52 (63.54)/16.0 (60.8)	17.14 (62.86)/16.0 (60.8)	16.76 (62.17)/16.0 (60.8)	16.76 (62.17)/15.62 (60.11)	16.76 (62.17)/15.62 (60.11)	1.14 (2.05)/0.38 (0.69)

Creek conditions in 1999-2005 had been much cooler than in 1998, despite the much higher baseflow in 1998. In 1998, there was a 20-day period in which water temperature rose above 21° C (69.8° F) for several hours each day in the stream above the lagoon, with a maximum of approximately 23.5° C (74.3° F) on 3 August 1998 (**Figure 6c**). Daily maxima were still approaching 21°C on 4 September 1998. Considerable riparian vegetation had been removed by El Niño stormflows the previous winter. Despite the warm stream temperatures, lagoon water temperatures in 1998 were relatively cool compared to other years (**Alley 2003**).

Aquatic Vegetation. Filamentous algae was first noted on 1 July 2005 during our second two-week monitoring, 3.0 weeks after sandbar closure (**Appendix A**); compared to 27 June 2004, 4.5 weeks after sandbar closure in 2004 (**Alley 2004**); and compared to 7 July 2003, 6 weeks after sandbar closure in 2003 (**Alley 2003**). Pondweed was first noted on 10 September 2005, 13 weeks after sandbar closure (although it may have gone unnoticed earlier due to its initial scarcity); compared to 6 August 2004, 10 weeks after sandbar closure; compared to 4 August 2003, 10.5 weeks after sandbar closure in 2003. As in 2004, in 2005 the pondweed became most abundant in September and continued into October. In 2005, however, the pondweed seemed to be visible primarily in Reach 1 downstream of the Stockton Bridge. In 2000-2003, pondweed became prominent earlier in mid- to late August and remained so into late October. Pondweed was not noticed until 14 August in 2000 and not until 20 August in 1999. The year, 2003, was unusual in that two species of pondweed were detected, one with ovate leaves and one with filamentous leaves. Pondweed was less abundant in 2005 than 2004.

In 2005, surface algae occurred relatively early (Reach 3) in 2005, 4.5 weeks after sandbar closure. In 2004, surface algae occurred relatively early, too, 4 weeks after sandbar closure (**Table 9**). Surface algae became more extensive in 2005 in Reach 3 than in 2004. Surface algae in 2005 varied between 0 and 20% coverage of Reach 3, with very little in the lower 2 reaches (maximum was 2%). The most extensive surface algae in 2005 was observed on 25 September when it was 2% in Reaches 1 and 2 and 20% in Reach 3.

At the mouth of Noble Gulch, surface algae in 2005 ranged from 0 to 2% through 10 September. Then on 25 September it covered 60% of the surface within 50 feet of the mouth (**Table 9**). However, it went back down to 2-3% coverage through October and was absent in November. The heavy appearance of surface algae coincided with a period of considerable gray water input from Noble Gulch that presumably contributed nutrients to stimulate plant growth. In 2004, surface algae ranged from 5 to 15% through the summer, with it collecting on and around the submerged fence placed at the mouth to corral water hyacinths that had been placed there. In 2003, surface algae at the Gulch reached 20% by late October. In 2002 the most surface algae coverage was 5% of the surface in Reaches 2 and 3 just before the Begonia Festival on 1 September and in those Reaches and at Noble Gulch in mid-September. Surface algae never really developed in 2001, with only 1-2% coverage appearing in September after the Begonia Festival. In 2000 the most coverage was 15% in Reach 3 in mid-August. In 1999, surface algae had reached a maximum during the two July monitorings, with as much as 25% of certain reaches being covered.

Algae mats on the lagoon bottom increased in thickness steadily through September in all three reaches, with their thickness increasing in an upstream direction in late August and September (**Table 9**). Algae concentration was recorded at a maximum on 25 September. Then, average algae thickness on the bottom was 2 feet in Reaches 1 and 2 and 3 feet in Reach 3, with bottom coverage of near 100%. Surface coverage

Table 9. Visually Estimated Algae Coverage and Thickness in the 2005 Lagoon.

Date	Reach 1			Reach 2			Reach 3			Mouth of Noble Gulch		
Month-Day	Ave. Bottom Thickness	% Bottom Cover	% Surf. Cover	Ave. Bottom Thickness	% Bottom Cover	% Surf. Cover	Ave. Bottom Thickness	% Bottom Cover	% Surf. Cover	Ave. Bottom Thickness	% Bottom Cover	% Surf. Cover
6-19	0	0	0	0	0	0	0	0	0	0	0	0
7-01	0.33	80	0	0.33	100	0	0.7	100	0	0.25	100	0
7-15	-	-	0	0.5	100	0	0.5	100	5	0.5	90	3
7-29	1.0	80	0	1.0	90	0	0.5	80	10	0.4	60	<1
8-14	-	-	0	-	85	0	-	60	0	2.0	95	0
8-27	1.0	35	0	1.0	95	0	1.5	100	0	4.0	100	0
9-10	-	-	0	1.5	100	<1	2.5	99	<1	2.0	60	2
9-25	**2.0**	**100**	**2**	**2.0**	**100**	**2**	**3.0**	**99**	**20**	**3.0**	**60**	**60**
10-8	-	-	0	-	-	<1	-	-	<1	3.0	100	20
10-18	-	-	0	-	-	10	-	-	15	0.5	50	3
11-03	-	-	0	-	-	0	-	-	0	-	-	0
11-17	1.5	100	0	0.3	70	0	-	-	0	0.15	60	0

<u>Dissolved Oxygen.</u> Critical oxygen levels are lowest in the early morning after oxygen has been depleted by cell respiration and before plant photosynthesis can produce much oxygen. This was the time that oxygen levels were most importantly measured and rated. In 2005, oxygen levels for steelhead were either "fair" or "good" *near the bottom at dawn* at all stations during monitorings (**Table 3, Figure 9a; Appendix A**). Therefore, oxygen concentration stayed above 5 mg/l at all other stations throughout the summer within 0.25 m of the bottom near dawn. Of the early morning monitorings, Station 1 at the flume was rated "good" (greater than 7 mg/l) 100% of the time. Station 2 at Stockton Avenue Bridge was rated "good" 67% and "fair" (between 5 and 7 mg/l) 33% of the time. Station 3 near the railroad trestle was rated "good" 67% of the time and "fair" 33% of the time. Station 4 at the mouth of Noble Gulch was rated "good" 67% of the time and "fair" 33% of the time. In 2005, as in 2003 and 2004, morning oxygen concentrations near the bottom were usually least near Noble Gulch (Station 4), particularly from mid-July to early October in 2005 (**Figure 9g; Appendix A**). The lower oxygen at Noble Gulch was perhaps due to the higher density of algae and pondweed in the vicinity and more cell respiration through the night to depress oxygen levels. While the trestle location (Station 3) had the next lowest oxygen concentration in 2003 and 2004, concentrations at the Stockton Avenue Bridge were sometimes lower than at the trestle in 2005. The flume station generally had the highest oxygen concentration of the 4 lagoon locations (85% of the monitorings) and higher concentrations than the stream station on 5 of 13 monitorings near dawn (38%). On 6 of the 13 monitorings (46%), the stream site had the higher oxygen concentrations than any of the lagoon stations near dawn. Station 3 under the trestle is subject to pigeon droppings that encourage algae production and decomposition that lead to greater oxygen depletion at night. In 2002, oxygen was rated "fair" or "good" near the bottom (**Figure 8**). In 2001 they had been rated "good" near the bottom on all monitorings except at the railroad trestle in October (**Figure 7**).

As in 2003 and 2004, during the two-week monitorings in 2005, oxygen levels were usually higher in the afternoon than in the morning at all stations within 0.25 m of the bottom throughout the lagoon season (**Figures 9h-k; Appendix A**). Exceptions to this trend occurred on the very overcast and cloudy 1 July at the flume and late in the season with a lower sun angle and more lagoon shading on 17 November at the Stockton Avenue station.

Salinity. Only salinities less than 0.5 parts per thousand were detected after sandbar construction in 2005 (**Appendix A**). Therefore, all stations were rated "good" throughout the lagoon period (**Table 3**).

Conductivity. Conductivity remained low throughout 2005, remaining in the 500-700 umhos the entire summer/fall (**Appendix A**). Stream conductivity was always slightly lower than in the lagoon. The highest lagoon conductivity in 2005 was 674 umhos after the Begonia Festival on 4 September. The highest conductivity detected in the creek in 2005 was 623 umhos on the morning of 18 October, which was lower than any lagoon readings that day.

Stream In-Flow to the Lagoon. The lagoon water quality is generally best when more summer baseflow occurs. When tidal overwash occurs or saltwater back-flushes into the lagoon, with more summer baseflow that passes through the lagoon, the more quickly that saltwater is flushed out of the lagoon to reduce lagoon heating. The year 2001 was most affected by tidal overwash in the last 6 years. With proper flume management and the new grated flume ceiling for 2004, it should be easier to maintain lagoon depth and prevent fluctuations in lagoon level when the summer begins with high baseflow. An improvement in the early summer was seen in 2004 (**Figure 2a**). To maximize summer baseflow, water percolation into the aquifer must be maximized and surface runoff must be minimized during the rainy season. 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.

Habitat conditions in the 2005 lagoon followed a winter with numerous storm events, with the highest baseflow since the El Niño winter of 1997-98, which had been substantially more than any other of the last 15 years of monitoring (**Table 10**). The early summer inflow was slightly less than in 1995 and 1996. Stream inflow to the lagoon on 1 June was fourth highest in the last 15 years and sixth highest on 1 October. This was in contrast to a comparatively low stream inflow in 2004, which had the twelfth highest streamflow on 1 June and 1 October. August streamflow in 2005 was similar to those in 1995, 1996, 1999 and 2000. Streamflow just above the lagoon was measured at 2.93 cfs on 8 October 2005 at Nob Hill, compared to 1.33 cubic feet per second (cfs) on 1 October 2004, 1.92 cfs there in 2003, 1.28 cfs near the Grange in 2002 and

1.58 cfs in 2001 near the Grange. Lagoon water temperature and stream inflow were cooler in 2005 than 2004, as were regional summer air temperatures. The 2005 summer lagoon was approximately the same depth as in 2004 at the Stockton Avenue Bridge and upstream of the trestle. In 2004, the lagoon was 2 feet deeper under the Stockton Avenue Bridge and 1 foot deeper upstream of the railroad trestle compared to 2003. This deepening returned lagoon depth to 2002 levels in these locations. There was no tidal overwash in 2005, though some saline water remained in the deeper lagoon area near the trestle for at least 10 days after sandbar closure.

Water quality worsens at the end of the dry season in most years, when stream inflow is at a minimum. Shortly after sandbar closure in 2005, streamflow into the lagoon was visually estimated in June at 15 cfs, compared to 4- 4.5 cfs (2004) (**Table 3**), 10-12 cfs (2003), 8 cfs (2000), 8-10 cfs (1999) and 31.2 cfs (1998) (measured with flowmeter in 1998) (**Alley 1999-2004**). Data were lacking 2001 and 2002 in June. At the end of the dry season, inflow to the lagoon at Nob Hill was 1.33 cubic feet per second (cfs)(measured by flowmeter) on 1 October 2004 compared to 1.91 cfs (2003), 1.28 cfs (2002), 1.58 cfs (2001), 2.32 cfs (2000) and 3.7 cfs (1999) at the Soquel Village Grange (0.6 miles upstream of lagoon) in late September and October. In 1998, the Coastal Watershed Council measured streamflow at Nob Hill to be 6.91 cfs in mid-September. The lowest visually estimated summer baseflows in 1995, 1996 and 1997 had been 2.5 cfs, 2.25 cfs and 1 cfs, respectively (**Alley 1996-1998**). In 1994, lagoon in-flow declined below 1 cfs by late July and to an estimated 0.05 cfs by late September, even though the visually estimated baseflow in June had been similar to 2004 at 3.5- 4 cfs (**Alley 1995**).

Drain Line Test for Restaurants Contiguous with Soquel Creek Lagoon. The restaurants contiguous with the Soquel Creek Lagoon that had accessible plumbing systems were tested for leaks and deficiencies in plumbing connections and repaired as necessary. Confirmation is contained in **Appendix B**.

Begonia Festival Observations and Water Quality Findings. The City's fishery biologist was present during and after the Begonia Festival. The day of the Festival, 4 September, was fogless and warm. The lagoon depth was maintained at maximum levels of 2.48. There were 5 floats in the nautical parade and 21 other boats in water. None of the floats were propelled by wading this year. The lagoon bottom was left undisturbed. Float 1 was propelled by surfboarders. 2 kayaks propelled float 2. 3 rowers in 1 canoe propelled float 3. Float 4 was propelled by electric motor. Float 5 was propelled by electric motor with a back-up motor for steering if needed. Air temperature of 15.5 °C at 1005 hr and 19.8°C at 1416 hr. Secchi depth was to the bottom before and after the Begonia Festival. Fewer begonia petals were on the water after the festival than the previous year, although children on floats were throwing flowers overboard as was done the previous year. They were instructed to stop, and they did so. Water samples were taken for hydrogen sulfide testing in Reaches 1 and 2 immediately before and immediately after the float procession. Results indicated that there was less than milligram per liter (parts per million) total sulfide before and afterwards (**Appendix C**). The concentrations of sulfide were actually slightly higher prior to the nautical parade. There was no odor of hydrogen sulfide, and no fish mortality was observed.

It was noted that oxygen concentrations were lower in the morning of 4 September prior to the Begonia Festival and afterwards at Stations 2 and 3 than those measured during monitorings preceding (27 August) and afterwards (10 September) (**Figures 9i-j**). This dip in oxygen prior to the nautical procession did not appear related to the festival. It was likely related to lower than usual oxygen production the previous day. The lower oxygen levels than usual measured immediately after the Begonia Festival may have been caused by slight turbidity (secchi depth to the bottom) and the fact that the measurements were taken about 1 hour earlier in the afternoon than typical monitorings. Later in the afternoon, oxygen levels would increase with additional photosynthesis. There were no waders with the floats to cause turbidity in 2005. However, with 21 other boats in the water, there were other sources of water turbulence leading to slight turbidity. It was noted that at Station 4 in early morning on 4 September that oxygen was higher than on either 27 August or 10 September, though the afternoon oxygen was less (**Figure 9k**). Despite the oxygen reductions on 4 September measured before and after the nautical procession, oxygen levels in the morning were rated "fair" for steelhead at 2 stations and "good" at one station. Oxygen levels in the afternoon were rated "good" at all 3 measured stations. At 2 of the 3 sites in the afternoon the water was supersaturated with oxygen.

Water quality measurements and observations on 10 September detected no oxygen depletion resulting from decomposing begonias or trampled aquatic vegetation. With no floats propelled by waders, there was no evidence of the Begonia Festival by this next lagoon monitoring.

Table 10. Streamflow Recorded at the USGS Stream Gage in Soquel Village, Approximately One Mile Upstream of the Lagoon and Estimated from the Graphical Representation.

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

Discussion of Options to Improve Water Quality

All storm drains leading to the lagoon should ideally be re-directed away from the lagoon in summer. Included in these is the culvert draining Noble Gulch. Significant quantities of gray water and oily slicks have consistently emptied into the lagoon from Noble Gulch until 2001, and now again in 2005 (**Alley 1995; 1996b; 1997-2000**). Gray water plumes were observed in 2004 on only 1 of 11, 2-week monitorings. However, in 2005, gray water plumes and sometimes oil slicks were observed on 7 of 13, 2-week monitorings. The gray water problem occurred particularly in late September and October in 2005 and was correlated with the highest surface algae estimates. On 25 September, a nearby resident said that there was gray water visible every morning. He had called Santa Cruz County Public Health about the problem. Ed Morrison at the City of Capitola reported that the City had looked into the problem but had not identified the source of the gray water. Its source was centered very close to the lagoon, however. As further history of the problem, in 2001 and 2002, no gray water was observed during monitorings, but in 2003, the water was murky on 2 of 12 monitorings. In 2000, gray water plumes were observed on 5 of the 7 monitorings.

Stimulation of algal growth has annually occurred at the mouth of Noble Gulch, with consistently greater growth there compared to elsewhere in the lagoon in most years except 2001. Increased algal growth indicates elevated nutrient inputs probably associated with bacteria. Oxygen depletion noted at dawn has been consistently greater at the mouth of Noble Gulch in 2002-2005 and other years, with usually lower oxygen readings at that station (**Figures 8, 9a and 9d**). Even so, oxygen concentrations at the mouth of Noble Gulch at dawn in 2005 were in the "good" range (> 7 mg/l) 8 times and "fair" 5 times (**Table 3; Figure 9g**). In 2004, the oxygen concentrations had been rated "good" 6 times and "fair" 6 times (**Figure 9d**). Oxygen was in the "good" range throughout 2001 (**Figure 7**) and 2002 (**Figure 8**). At the mouth of Noble Gulch in 2003, the oxygen rating in the morning was "good" 6 times and "fair" 6 times (**Figure 9a**). Usually, when cloudy water enters the lagoon from Noble Gulch, the water is clear upstream in Noble Gulch at the park beyond Bay Street. This indicates that pollutants enter Noble Gulch from the lower village near Soquel Creek. There are ducks living at the mobile home park up that drainage that could be removed to reduce nutrient influxes and coliform bacterial inputs. A flashboard dam could be constructed in Noble Gulch at Bay Street to impound water to be pumped out for irrigation purposes, provided that lagoon depth is being adequately maintained. Coliform counts greater than 200/ 100 ml are considered a hazard to human health.

By minimizing the stream inflow from Noble Gulch, nutrients and bacteria entering the lagoon would be reduced. Algae production may be reduced. Another drain into the lagoon is situated under the railroad trestle, where slight oxygen depletion has been detected in recent years. This drain could be capped if summer runoff was re-directed into the sewer.

The gulls are a primary source of pollution, both for bio-stimulating nutrients and bacteria. They forage through the human refuge left on the beach. They bathe in the lagoon. They roost on the buildings surrounding the lagoon. Reducing the gull population at Soquel Creek Lagoon would be a major step in reducing pollution. It is likely that the gull population is artificially high because of the artificial food source and artificial roosting areas. If these were reduced, then the gull population would probably decline, and pollution would be reduced at Soquel Lagoon. Better refuge disposal is needed. More of the refuge cans on the beach had domed, gull-proof lids in 2005, but some had flat lids that could not cover cans when they were over-filled. The gulls have excellent access to these overfilled cans and commonly drag refuge out of cans lacking lids. More refuse containers with heavier dome lids that are gull-proof and user-friendly to beach-goers may reduce gull numbers. Regarding roosting, there are methods available to make buildings' roofs inhospitable to gulls. Gull sweeps are an effective option. On the 17 November monitoring, parallel wires were in position on some of the restaurant roofs. Consequently, only 1 gull and no pigeons were observed roosting there. However, on 1 December the wires appeared to have been removed.

Another source of bird pollution is the rock dove (pigeon) population that circulates between the wharf and the railroad trestle over the lagoon. As stated in the original management plan, the trestle could be screened so that roosting areas were eliminated and bird pollution reduced.

Regarding urban runoff, installation and maintenance of silt and grease traps on storm drains is critical to reducing pollution by petrochemicals. All existing and new drainage systems from new development and parking lots should include installation of effective traps and percolation basins to increase percolation of storm runoff.

A large Arundo (giant reed) invasion had occurred below Highway 1. These invasive plants reduce stream shading by eliminating riparian trees, may restrict fish feeding with their overhanging and reduce wildlife habitat by reducing plant species diversity. The Friends of Soquel Creek and the Santa Cruz County RCD removed Arundo upstream of Highway 1 in 2004. In summer 2005, workers who were removing non-native vegetation from the riparian corridor cut the Arundo immediately downstream of Highway 1 and near the Nob Hill Sewage lift station. However, it had re-sprouted in October. Another patch of Arundo was observed during the sandbar construction monitoring adjacent to the lagoon behind a residence on River View Drive. It also needs to be removed.

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

1. Replace all of the flat-lid refuse cans on and around the beach with ones having domed, gull-proof lids. Use enough refuse containers to satisfy the demand for refuse disposal.

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

3. Re-install the 12-inch high wooden baffle inside the flume prior to directing water through the flume, if it was destroyed during the previous winter.

4. Do not allow the pedal boat operator to dictate lagoon level.

5. Maximize lagoon depth throughout the dry season, while maintaining passage through the flume for adult steelhead until June 1 and for steelhead smolts until July 1. If the lagoon level begins to drop below the notch for steelhead smolts on one side of the flume because of the hole for adult steelhead after June 1, close the underwater portal for adults. If there is plenty of flow to maintain lagoon depth with the adult portal open, leave it open throughout the summer. If adult steelhead are seen in the lagoon after June 1 and the adult portal has been closed, then open the portal for a week to allow out-migration.

6. After July 1, leave the flume exit closed once it closes, unless flooding is eminent. Install visquine on the outside of the flashboards to prevent leakage into the flume. Maximize the number of boards in the flume entrance to maximize lagoon depth.

7. Secure the flume boards to prevent their lifting by vandals to drain the lagoon.

8. If the lagoon bottom becomes invisible due to turbidity for more than one day after the rains that do not breach the sandbar, immediately lower the lagoon level to the point where the bottom is visible. This will allow algal growth despite the high turbidity. Plant photosynthesis will produce oxygen and prevent anoxic conditions. A previous recommendation in the original Management Plan (**1990**) should be emphasized to prevent fish mortality; parking lots and streets draining into the lagoon should be cleaned thoroughly before the first fall rains.

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

10. Do not reduce the lagoon level for the Begonia Festival

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

12. "Gull Sweeps" sold by West Marine Products should be installed on Esplanade roofs to test their effectiveness in deterring gulls. According to the catalogue, "Powered by the slightest breeze, the Gull Sweep's motion will deter the most determined bird." These were successfully used on San Diego restaurants (**Y. Sherman, pers. communication**).

13. Regarding the Begonia Festival, we recommend that float propulsion by surfboard paddling or rowboat or electric outboard motor continue to be encouraged rather than pulling and pushing by waders. If wading is allowed, set a limit of 3 waders per float. Allow float passage in one direction only, presumably downstream, before dismantling

near the Stockton Avenue Bridge. In the past, floats were taken down the lagoon and then back up before dismantling back at the bridge.

14. If wading during the Begonia Festival is requested, continue to perform more detailed water quality monitoring before and after the Begonia Festival to determine the effects of wading. Continue to measure hydrogen sulfide levels.

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

16. 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.

17. The City should seek funding and volunteers to remove invasive Arundo and other non-native plants in the riparian corridor between Highway 1 and the lagoon in order to protect native riparian vegetation, maximize stream shading, minimize water temperature of inflow water and protect aquatic and wildlife habitat.

FISH CENSUSING

Steelhead Plantings in Soquel Creek

No steelhead were planted in Soquel Creek in 2005, as was the case in 2003 and 2004. It appears that CDFG allowed planting only in streams where the juveniles' parents were captured in those streams (San Lorenzo River and Scott Creek). No adult steelhead were captured from Soquel Creek for the hatchery. Therefore, no juveniles were planted.

Results of Fish Sampling in Soquel Creek Lagoon

Even with a freshwater lagoon created by the City of Capitola, the water temperature sometimes approaches the upper tolerance limit of steelhead for 1-2 hours per day when morning fog is absent and stream inflow is warm. If sufficient saltwater were present in the lagoon, water temperatures could become lethal for steelhead. Although tidal overwash occurred in 2001 and 2004, it was prevented in 2005. In 2004, lagoon water temperature reached 24°C (75.2°F) on 20 July after tidal overwash on 19 July. However, the elevated condition lasted only 4 days with quick flume management. The shroud was installed on the flume inlet and the adult portal was opened to encourage draining of saltwater from the lagoon. However, due to 2 tidal overwashes in July 2001, daily water temperature fluctuated between approximately 23 and 26°C for 14 days near the bottom in Reaches 1-3. This likely forced juveniles higher in the water column or further upstream where water depth was less. This would increase vulnerability to predation.

Also, the increased temperature increased fish metabolic rate, possibly reducing growth rate in 2001.

Fall sampling for steelhead occurred on 2 and 9 October 2005, from just upstream of the Stockton Avenue Bridge, downstream. A bag-seine with dimensions 106-foot long by 6- feet high by 5/16-inch mesh was used. The seine was set perpendicular to shore, parallel to the Stockton Avenue Bridge and just upstream of it. Juvenile steelhead congregate in the shade under the bridge. The seine was pulled to the beach in front of Venetian Court. With this larger, coarser-meshed seine, no tidewater gobies were captured. A total of 294 juvenile unclipped steelhead were captured on the 2 days (compared to 447 in 2004, 204 in 2003 and 509 in 2002) ranging from 76 to 208 mm Standard Length (SL). A total of 212 juveniles from 5 effective seine hauls were marked on 2 October. On 9 October, 82 unmarked (unclipped) steelhead and 14 marked steelhead were captured from 5 effective seine hauls. The median size of steelhead captured on both days was 105-109 mm compared to just barely 115-119 mm in 2004, 110-114 mm in 2003, 105-109 mm SL in 2002 and 125-129 mm SL in 2001 (**Figures 10-14**). In 2000, the median size increment was 135-139 mm SL (**Figure 15**). In 1999 it had been 120-125 mm SL (**Figure 15**). In 1998, the most popular size increment was 115-119 mm SL (**Figure 16**). Comparison of size distributions and the median size in each of the last 7 years, young-of-the-year growth rate was similar in 2002-2005, with faster growth rates in 1998-2001. In 2005, the median size was determined for each sampling day separately. On 2 October the median was 105-109 mm SL, and on 9 October it was 110-114 mm SL, showing an increase consistent with growth over the week. Regrettably, we did not measure lengths of the marked fish on the second day to get a more accurate indication of growth. However, the methods followed were those used in previous years. We concluded from the size distributions of juveniles captured that juvenile steelhead grew less in the 2005 summer lagoon than in the 2004 lagoon, despite cooler water temperatures, lower metabolic requirements and less competition from a smaller juvenile population. This may be partially due to a 15-day shorter lagoon period prior to sampling in 2005 compared to 2004, with sandbar closure on 9 June and 26 May in respective years.

Nineteen steelhead captured on 2 October had been previously PIT-tagged by NOAA Fisheries biologists. Nine PIT-tagged individuals were captured on 9 October.

Our steelhead population estimate based on mark and recapture for fall 2005 was 1,454 juveniles +/- 347 compared to 3,869 juveniles +/- 1,009 in 2004, 849 juveniles +/- 198 in 2003, 1,042 juveniles +/- 84 in 2002 and 454 juveniles +/-27 in 2001 (**Table 11, Figure 18**) (methods in **Ricker 1971**). Other species captured with the 106-foot seine on the two days combined were 3 starry flounders, one prickly sculpin, one juvenile Sacramento sucker and abundant threespine sticklebacks.

Our lagoon population estimate in fall, 2005, indicated a reduction in the population compared to 2004 but was third highest in 13 years of estimates. We would expect fewer juveniles to use the lagoon in 2005 than 2004 because there were much higher adult passage flows in 2005, encouraging less spawning in the lower creek to seed the lagoon with young-of-the-year steelhead. Past calculations indicated that lagoon production represented nearly 1/3 of the smolt-sized steelhead production in the lower 7.2 miles of mainstem Soquel Creek in both 1999 and 2000. In 1993, the lagoon production estimate of nearly 2,800 fish represented 10% of the smolt production in the 16.6 miles of steelhead habitat in the mainstem, East and West Branches. The 2004 production estimate of 3,900 fish represented an estimated 47% of the smolt production for the 16.6 miles of habitat. Thus, the lagoon provides valuable habitat through proper management.

On 2 October 2005, a total of 4 seine hauls were made for tidewater gobies with a 30-foot x 4-foot x 1/8-inch mesh beach seine in lower Soquel Lagoon near the beach. This was adjacent to Venetian Court, around to the flume. The sheer drop off at the lagoon margin prevented more seining. This is the only location where a seine could be adequately beached to capture tidewater gobies. Threespine sticklebacks were abundant with no tidewater gobies captured. The last capture of tidewater gobies was one in fall, 1997. The low number captured in 1992-1997, and their absence since the El Niño stormflows in winter 1997-98, probably indicated a lack of backwater areas to be used as refuges during high winter stormflows. This species was plentiful in Soquel Lagoon during the last drought of the late 1980's and early 1990's. Tidewater gobies have been recently reported in adjacent lagoons (Moran Lake and Aptos) by Jerry Smith (**pers. communication**). They may re-populate Soquel Lagoon in the future from these sources.

Table 11. Estimates of Juvenile Steelhead Numbers in Soquel Creek Lagoon for the Years 1988 and 1992-2005.

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; 4 effective seine hauls.
2000-	875 +/-156 (standard error).185 fish were marked; 4 effective seine hauls.
2001-	454 +/- 27 (standard error). 186 fish were marked; 4 effective seine hauls.
2002-	1,042 +/-84 (standard error). 363 fish were marked; 4 effective seine hauls.
2003-	849 +/-198 (standard error). 109 fish were marked; 5 effective seine hauls.
2004-	3,869 +/- 1,009 (standard error). 281 fish were marked; 4 effective seine hauls.
2005-	1,454 +/- 347 (standard error). 212 fish were marked; 5 effective seine hauls and one with rope tangled around one pole.

In order to maintain good steelhead nursery habitat in Soquel Creek Lagoon, the sediment input from the watershed must be reduced. Stream shading must be increased to provide cooler stream inflow. The City must maintain the water level as high as possible throughout the summer until sandbar breaching, without large fluctuations. It is potentially easier to maintain good water quality and water depth when there is higher streamflow into the lagoon in summer (known as summer baseflow). However, prior to the placement of the ceiling grate on the flume inlet, the City Public Works Department had an easier time of maximizing water depth in years with intermediate streamflows, such as 1999-2002, rather than 1998, with the previous inlet design to the flume. 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 more difficult to maximize lagoon depth early in the lagoon season in 2005 with the higher streamflow than in 2004 (**Figure 2a**).

If the lagoon becomes too shallow, steelhead habitat in the upper lagoon is lost. This is another reason to keep the lagoon as deep as possible during summer. The flume's flashboards must be secured against vandal's intent on draining the lagoon and against tidal backpressure that may dislodge the boards.

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. Minimizing pollutant input from early fall storms is also important for reducing biological oxygen demand and avoiding fish kills.

Recommendations Regarding Fish Management

1. If the streamflow in Soquel Creek in the vicinity of Soquel Village approaches the point of losing surface flow, notify nurseries having surface diversions upstream and the Fish and Game Department of the streamflow conditions so that direct water diversion of surface flow may be reduced or discontinued until flow returns. Pumping by the Soquel Creek Water District from the Main Street well may also need to be curtailed. Complete loss of surface flow should be avoided.

2. Maximize lagoon depth by maximizing the number of flashboards in the flume inlet as streamflow declines and by sealing the boards with visquine and/or plywood, as was done in the past.

3. Secure the flume boards so that vandals cannot pry them up and drain the lagoon. This will prevent tidal surges through the flume from doing the same thing. Installation of a louver system on one side of the flume inlet would eliminate the need to deal with boards all summer. The design and installation of a louver system is recommended.

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

5. Do not remove flume boards for the Begonia Festival or prior to taking fall vacation time.

6. Remove flume boards as the first small storms begin in fall and replace the boards after the stormflow has subsided. The effort should be to minimize lagoon fluctuation until the sandbar actually breaches. Many forecasts for rain and storm intensities are incorrect in the early fall. It is harmful to steelhead to drop the lagoon level in anticipation of a storm that fails to develop and then fail re-install the flume board afterwards.

7. Maintain the lagoon in fall until streamflow has increased enough (20-25 cfs) to prevent stranding of spawning adult steelhead or coho salmon and to prevent osmotic stress to lagoon- inhabiting steelhead. If necessary, install a perimeter fence with 2"x 4" mesh with 6-foot panels around the flume entrance by October to prevent plugging of the flume's screen with aquatic vegetation during the first minor storms. The goal should be to maintain the lagoon until approximately Thanksgiving in late November, before allowing stormflow to breach the sandbar.

8. If sufficient turbidity occurs after the first storm of the season to prevent light from penetrating to the bottom of the intact lagoon for more than one day, reduce lagoon depth temporarily to insure that light reaches the bottom. This will prevent death of aquatic vegetation and increased biological oxygen demand, with the associated loss of oxygen production that would have occurred from photosynthesis. Thus, anoxic conditions will be prevented. When the lagoon clears up, re-establish the maximum lagoon depth.

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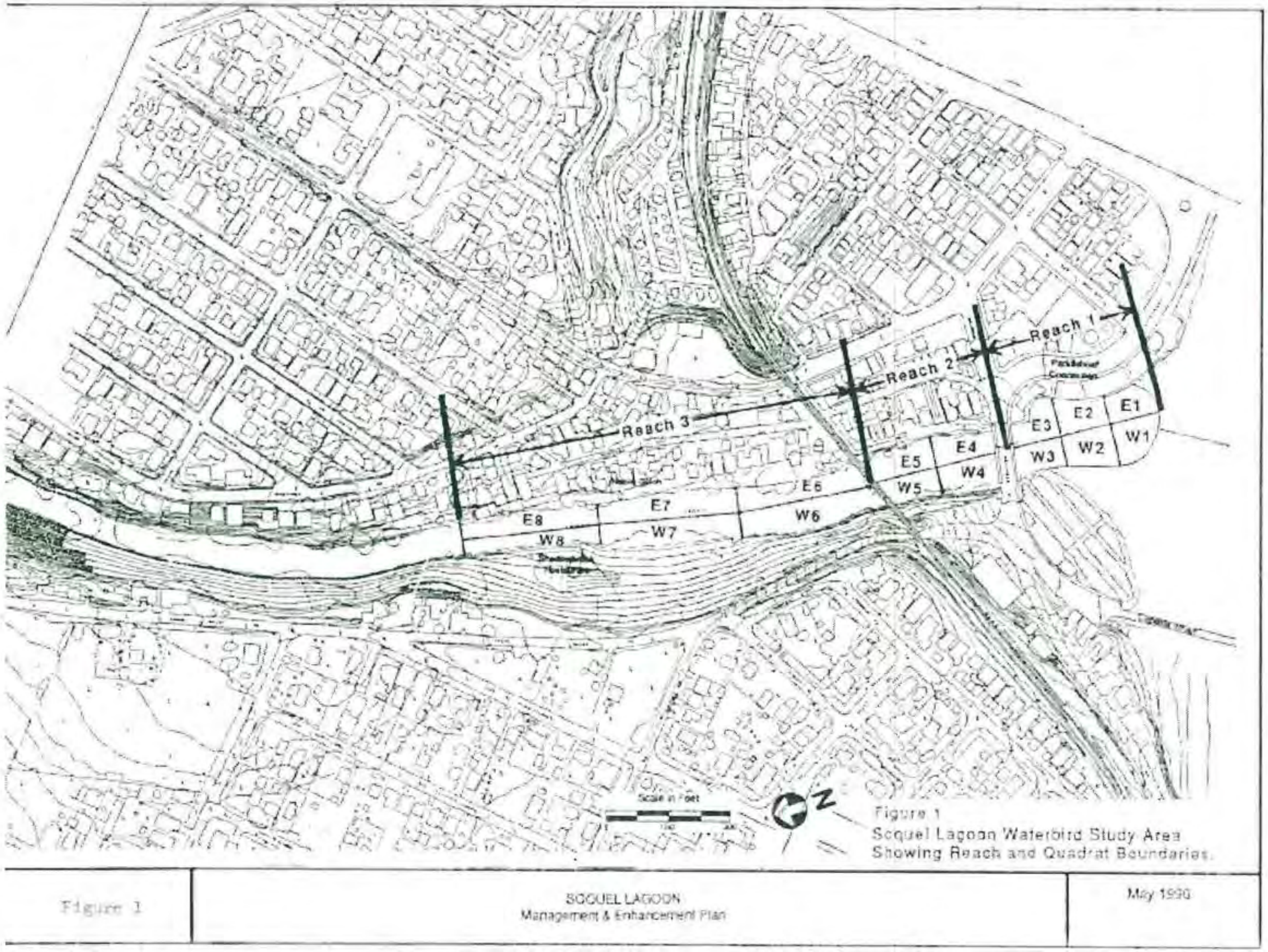
FIGURES


Reach 1
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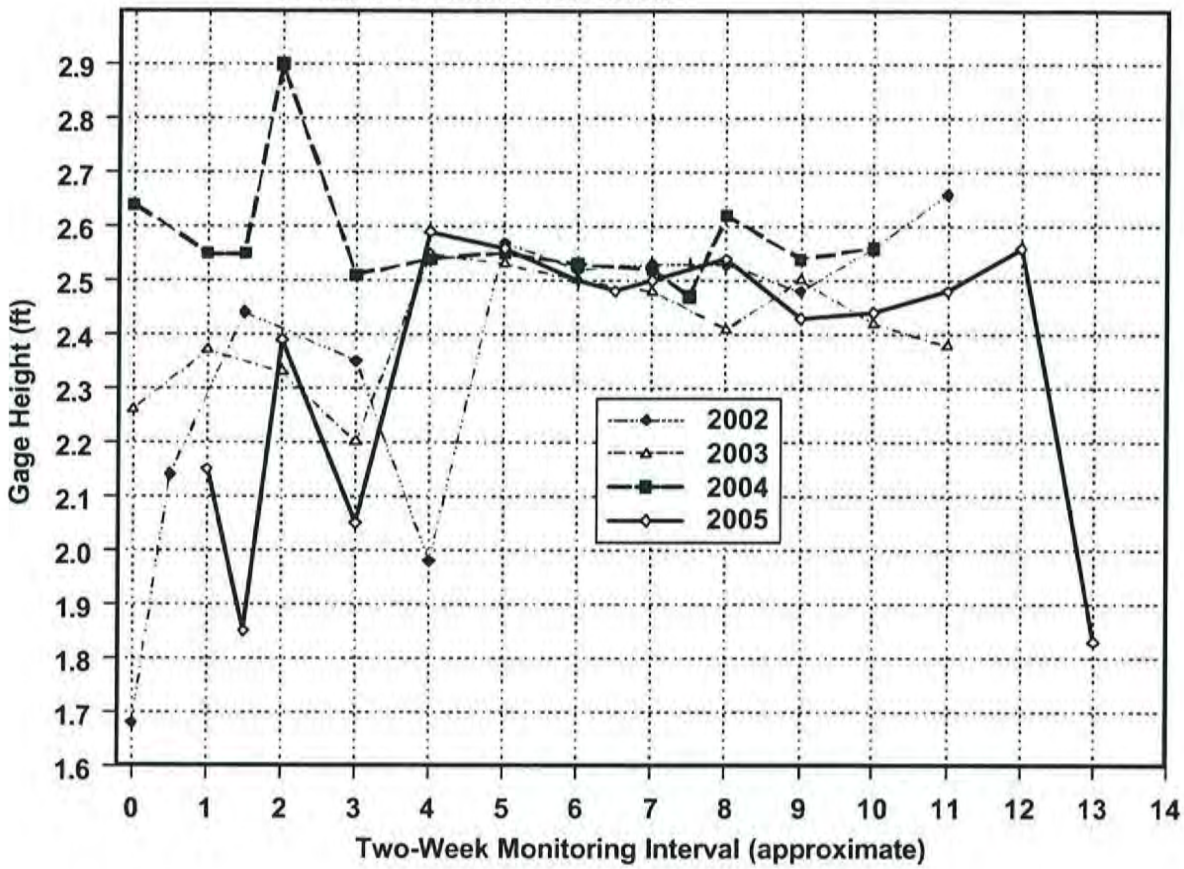
W8
Scale in Feet
Figure 1
Soquel Lagoon Waterbird Study Area
Showing Reach and Quadrat Boundaries.
Figure 1
SOQUEL LAGOON
Management & Enhancement Plan
May 1990

Figure 2a. Soquel Lagoon Gage Height at Stockton Avenue Bridge, From Approximately 25 May to 1 December, 2002 - 2005.



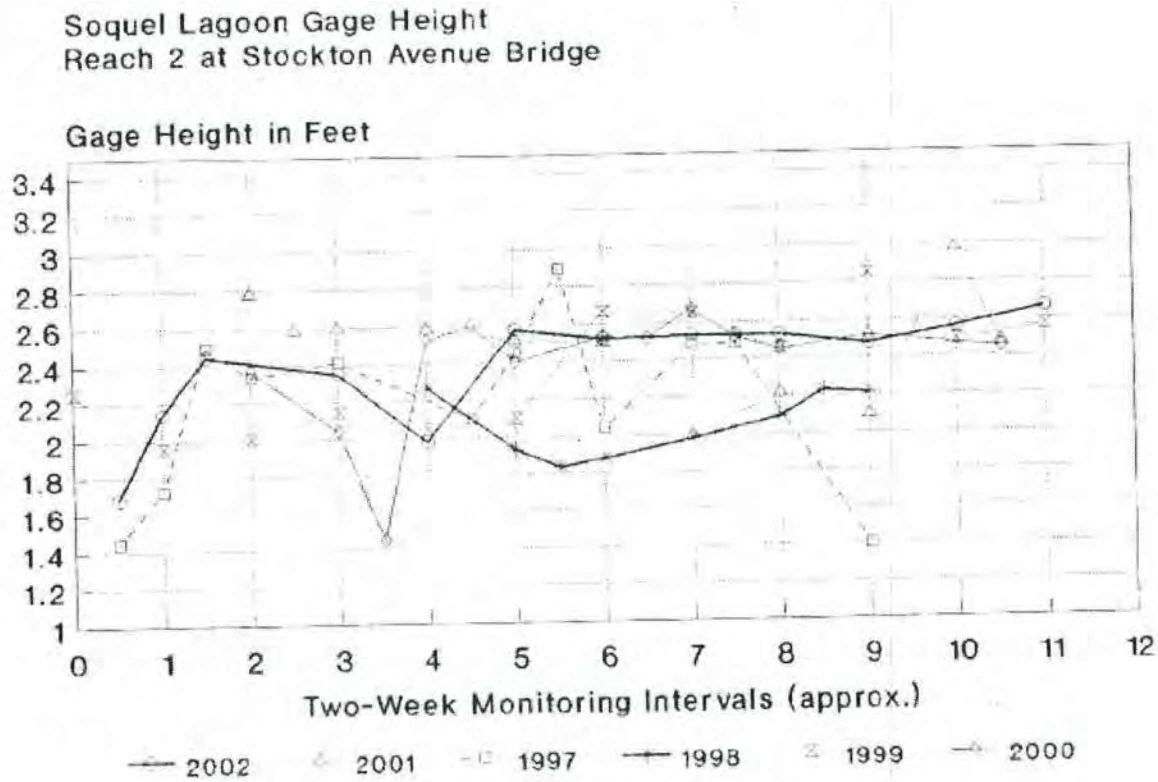


Figure 2b. Soquel Lagoon Gage Height
Near Stockton Avenue Bridge
Mid-May to Late October, 1997-2002.

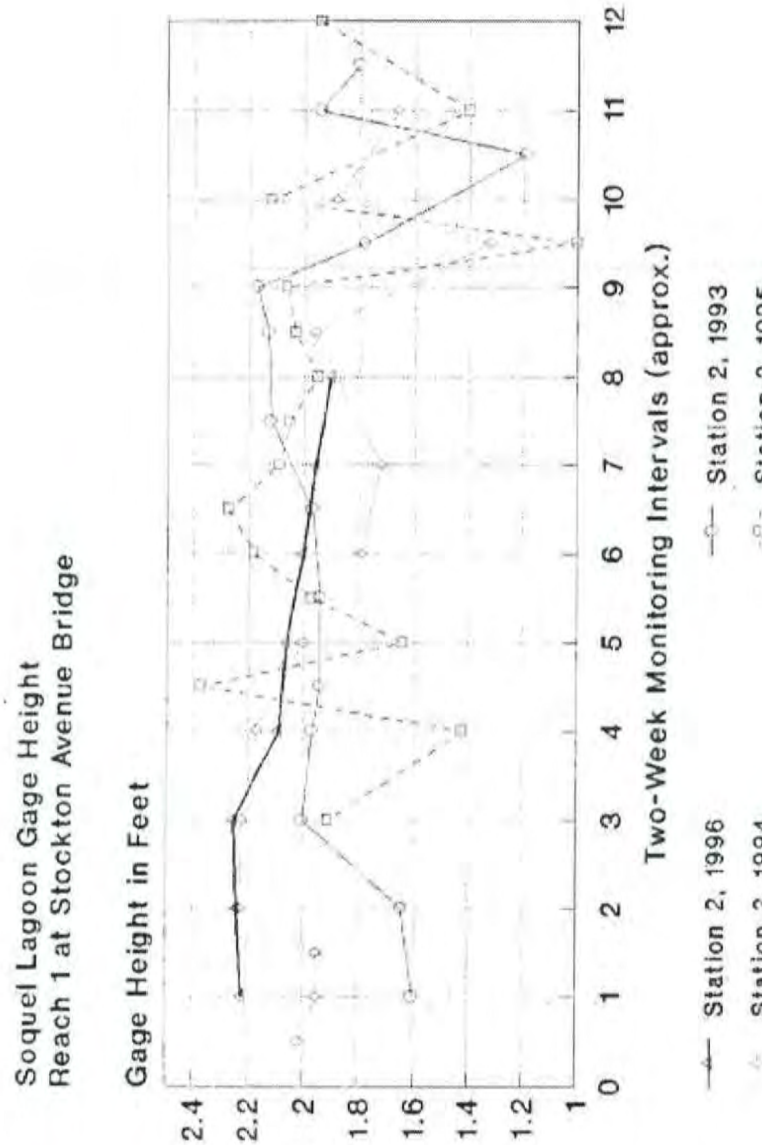


Figure 2c. Soquel Lagoon Gage Height
Near Stockton Avenue Bridge
Late May to Late October, 1993-96.

Figure 3a. 2004 and 2005 Soquel Lagoon Water Temperature at the Flume (Station 1) Near the Bottom at Dawn and in the Afternoon after 1500 hr From Approximately 13 June to 1 December.

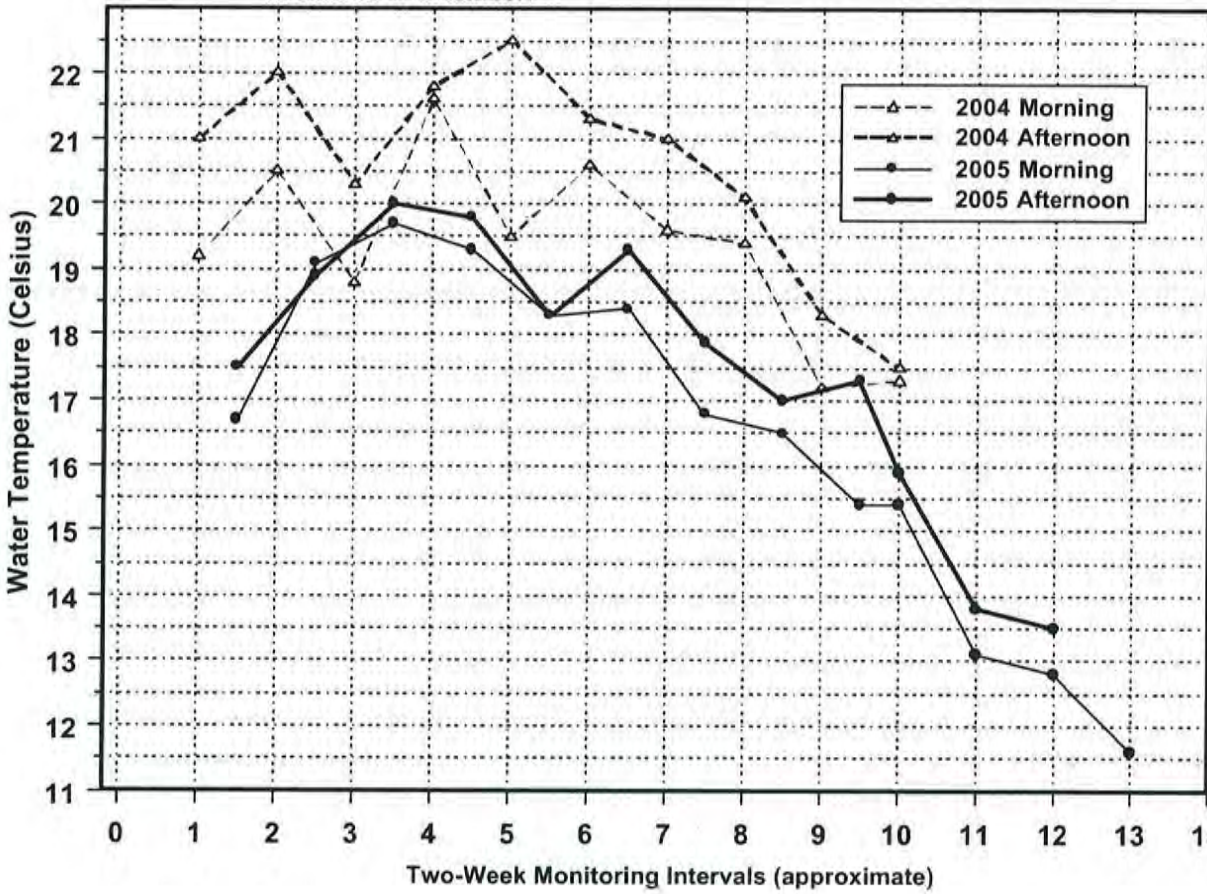


Figure 3b. 2004 and 2005 Soquel Lagoon Water Temperature at Stockton Avenue Bridge Near the Bottom at Dawn and in the Afternoon after 1500 hr From Approximately 13 June to 1 December.

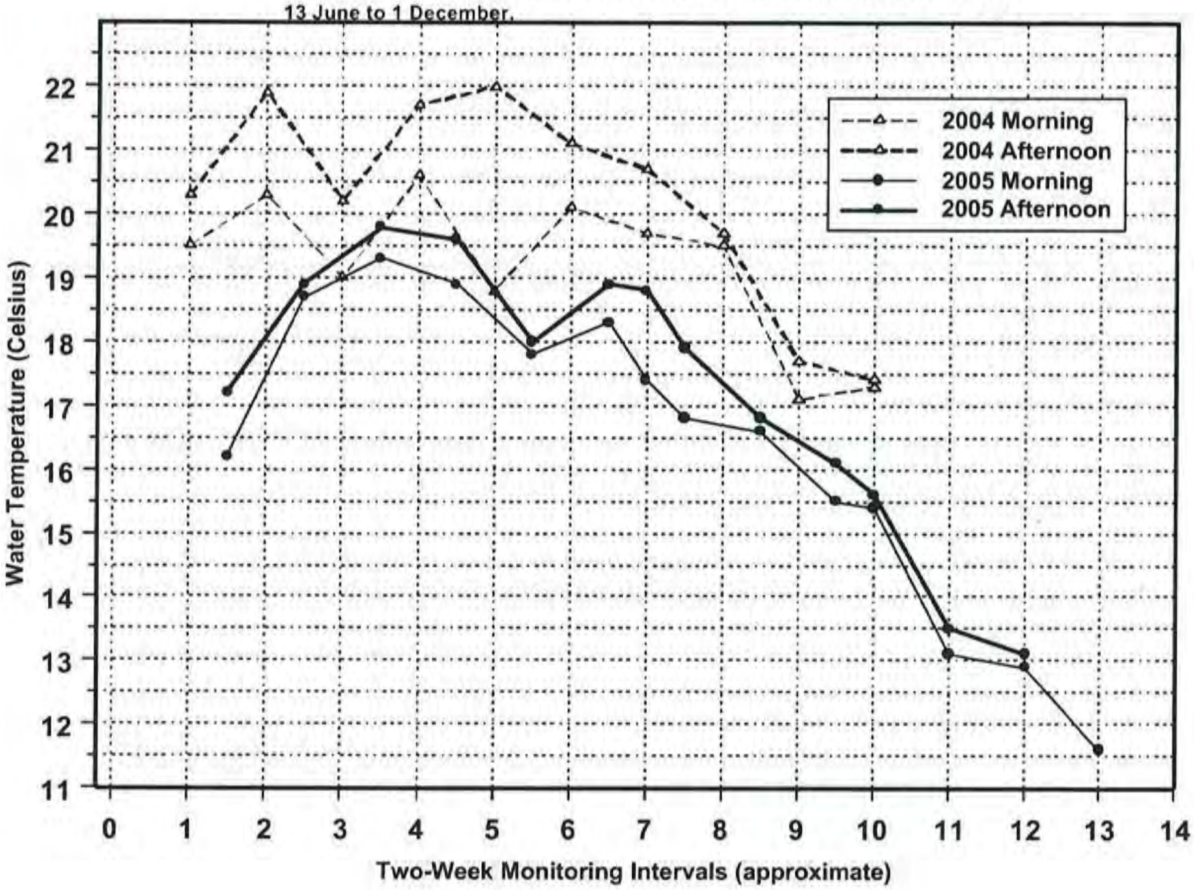


Figure 3c. 2004 and 2005 Soquel Lagoon Water Temperature at the Railroad Trestle Near the Bottom at Dawn and in the Afternoon after 1500 hr From Approximately 13 June to 1 December.

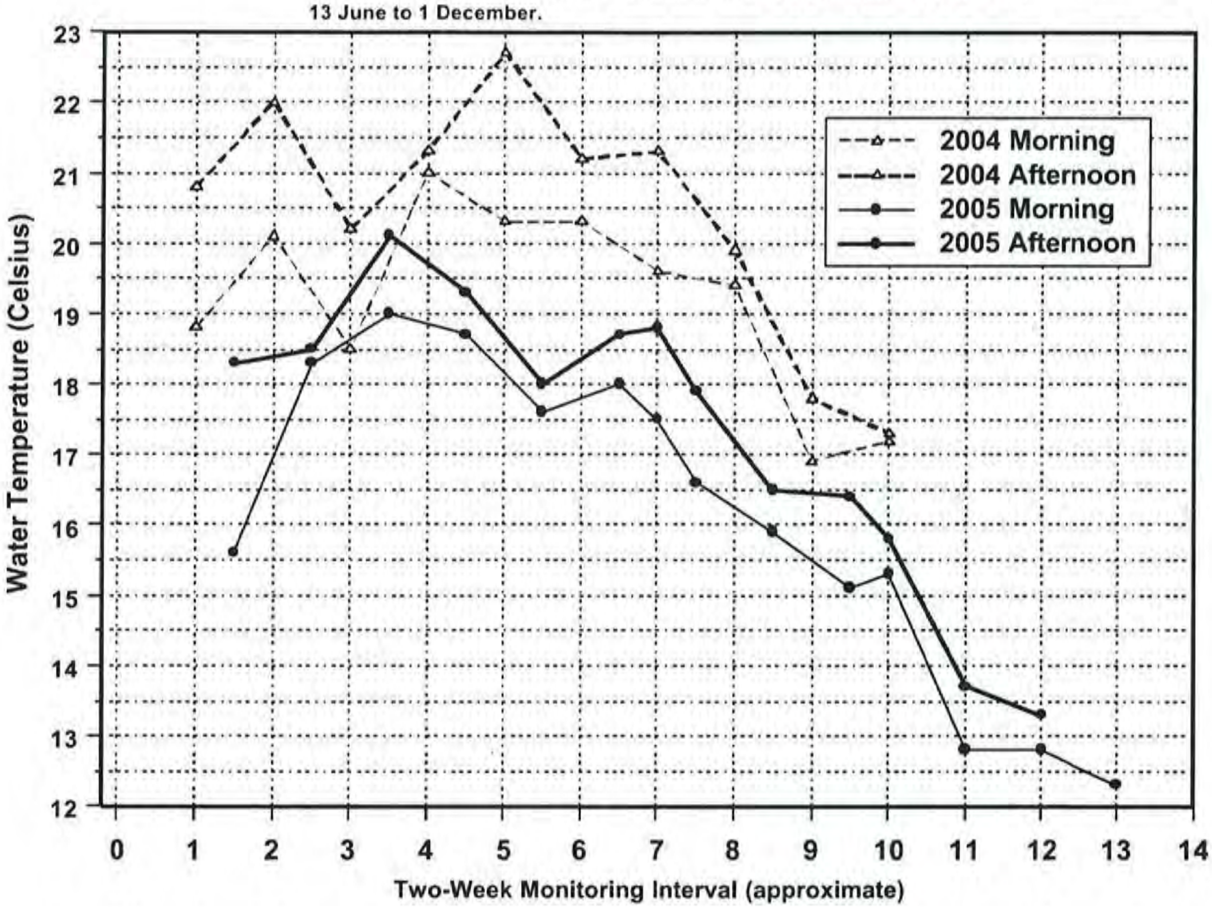


Figure 3d. 2003-2004 Soquel Lagoon Water Temperature at the Mouth of Noble Gulch Near the Bottom at Dawn and in the Afternoon after 1500 hr From Approximately 10 June to 1 November.

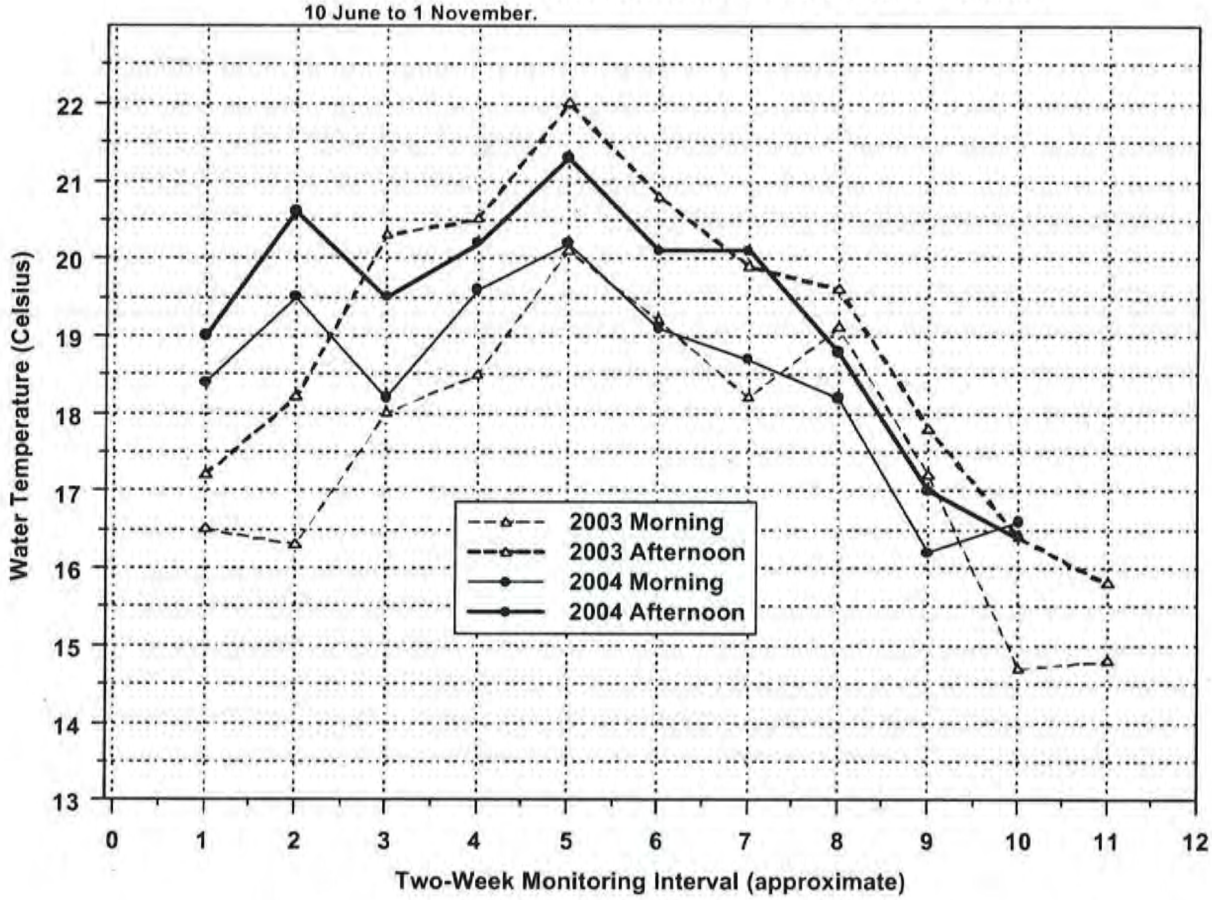


Figure 3e. 2004 and 2005 Soquel Creek Water Temperature at Nob Hill Above the Lagoon Measured Between 0800 hr and 0930 hr From Approximately 13 June to 1 December.

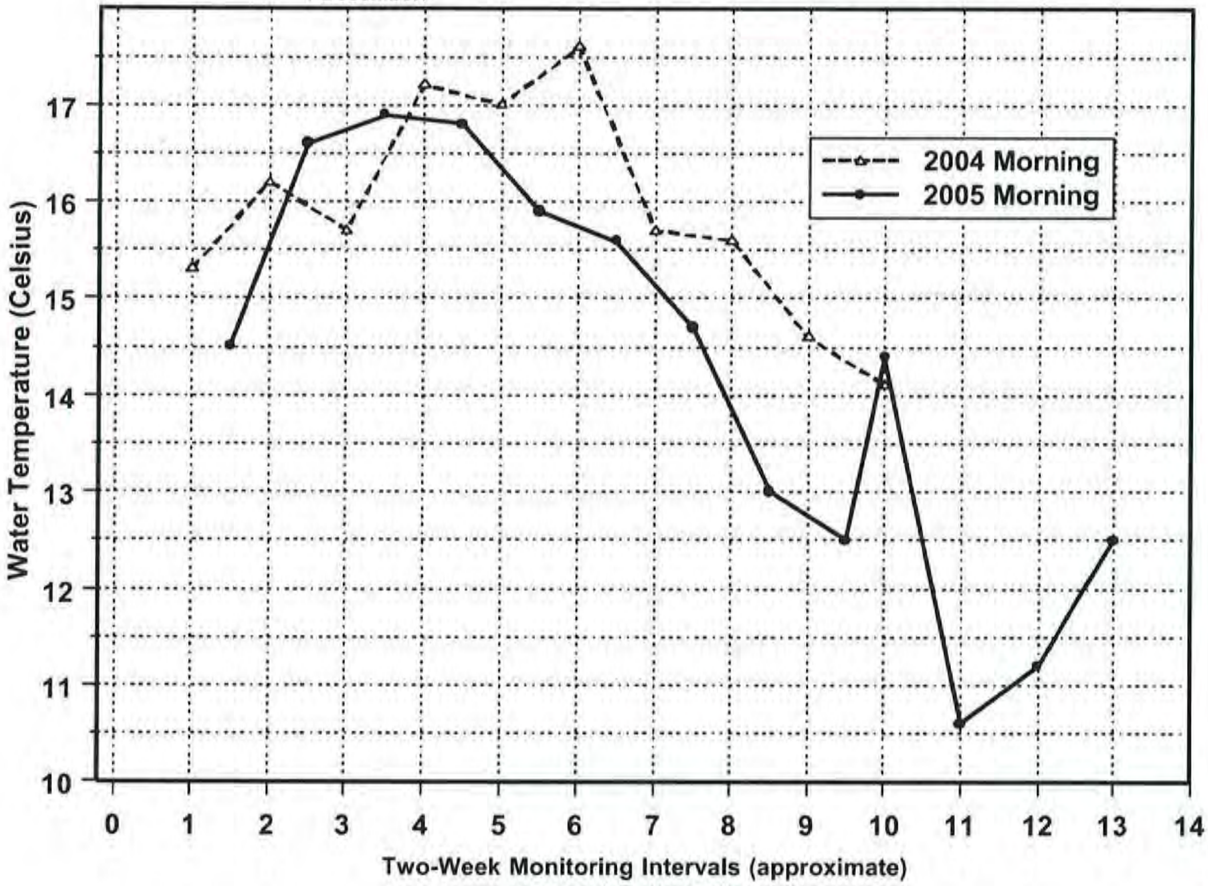


Figure 3f. Water Temperature at Four Lagoon Stations and in Soquel Creek Near the Bottom at Dawn from 19 June to 1 December 2005.

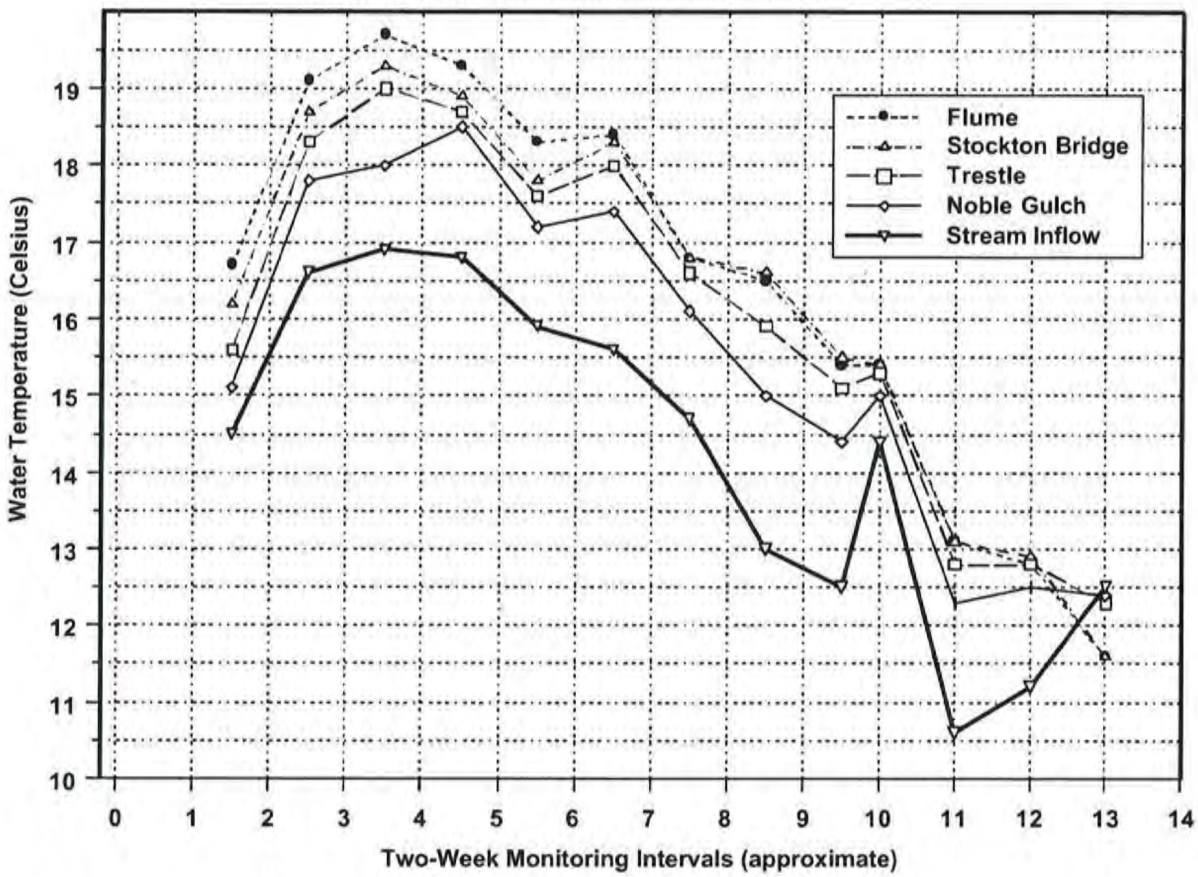


Figure 3g. Water Temperature at Four Lagoon Stations Near the Bottom Between 1500 and 1630 hr in the Afternoon from 19 June to 17 November 2005.

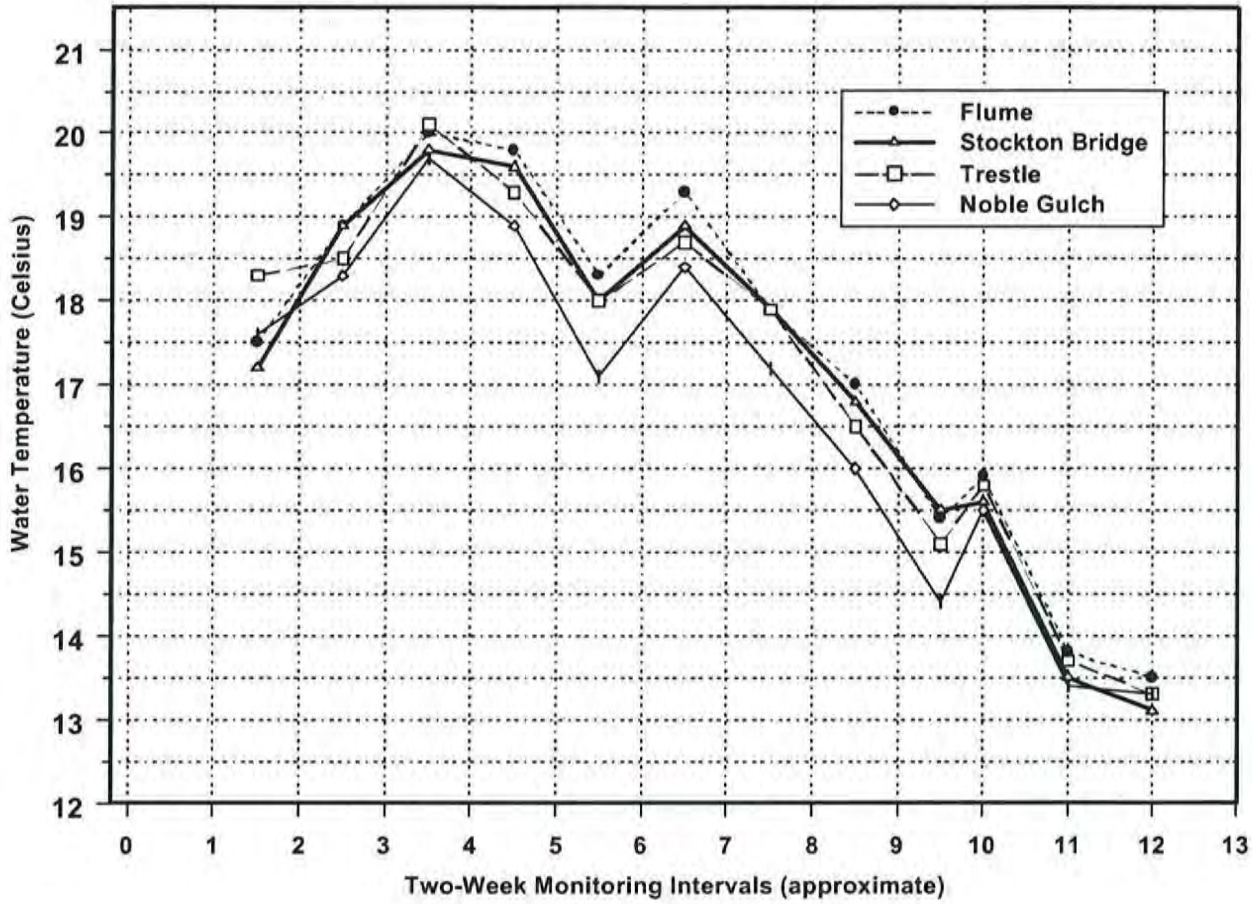
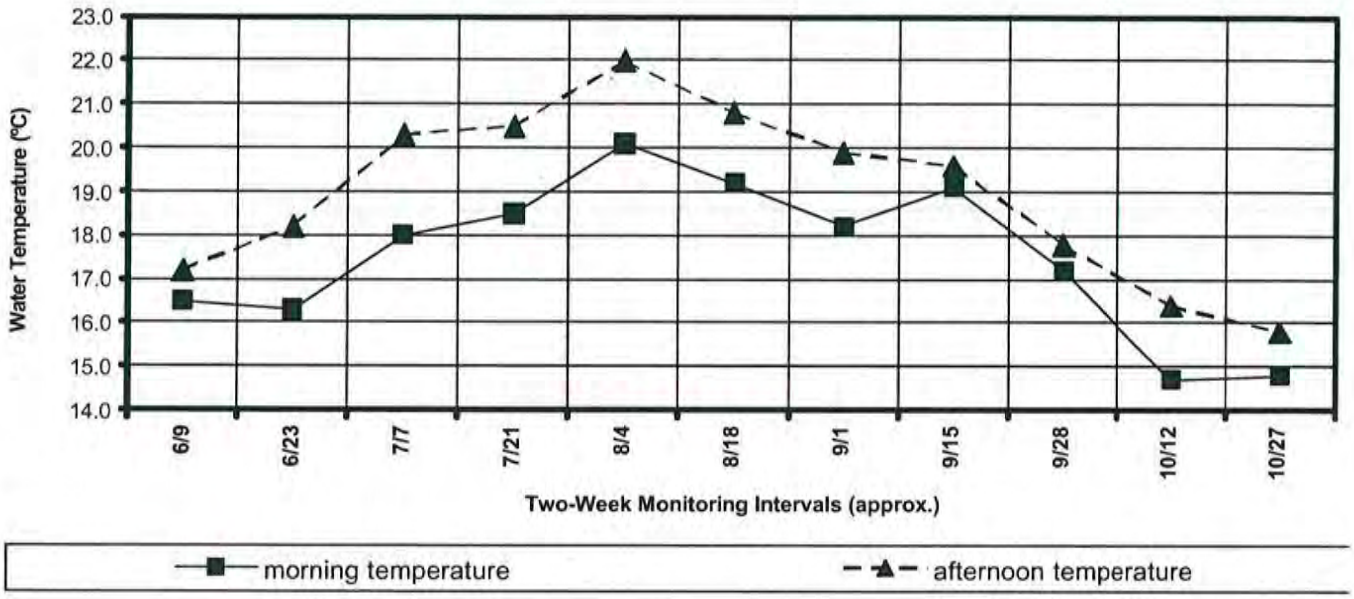


Figure 3h. Soquel Lagoon Water Temperature in the Morning and Afternoon, 9 June - 27 October 2003, Within 0.25 Meters of the Bottom Station 4, Mouth of Noble Gulch.



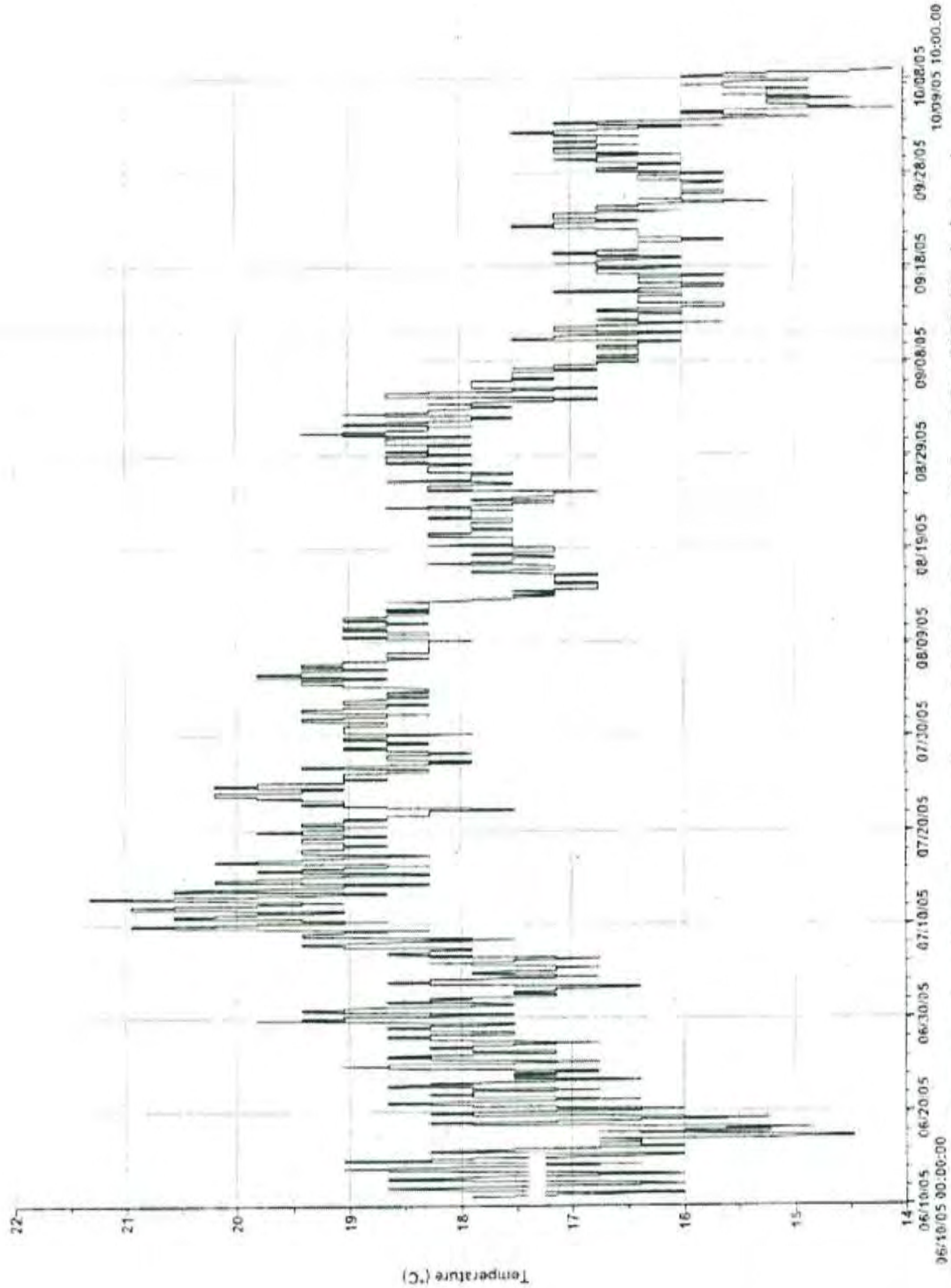


Figure 4a. Water Temp. (°C) Above Trestle 0.5 ft from Bottom, 10 Jun- 9 Oct 2005. 30-min Interval

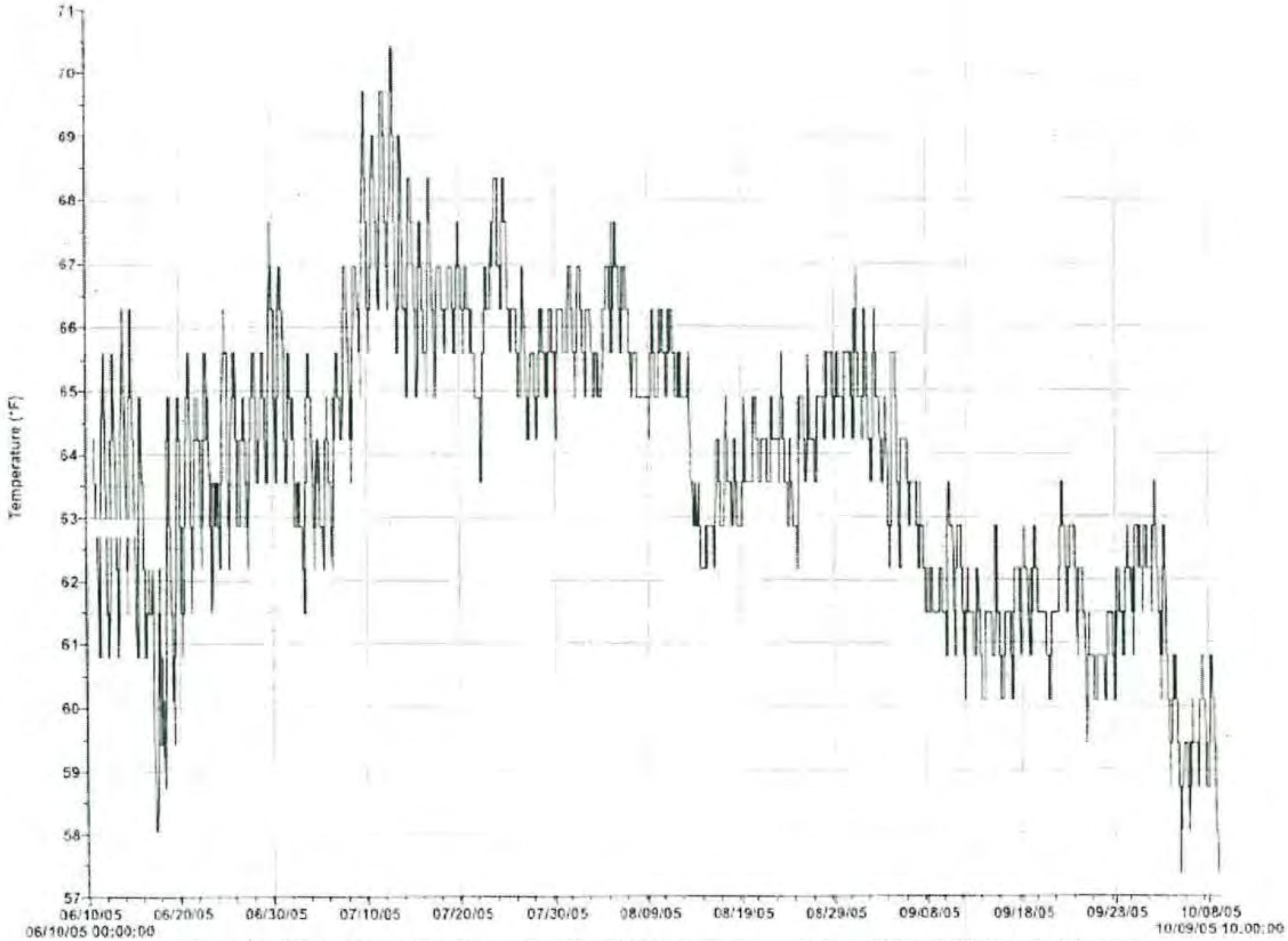


Figure 4b. Water Temp. (°F) Above Trestle 0.5 ft from Bottom, 10 Jun- 9 Oct 2005, 30-min Interval

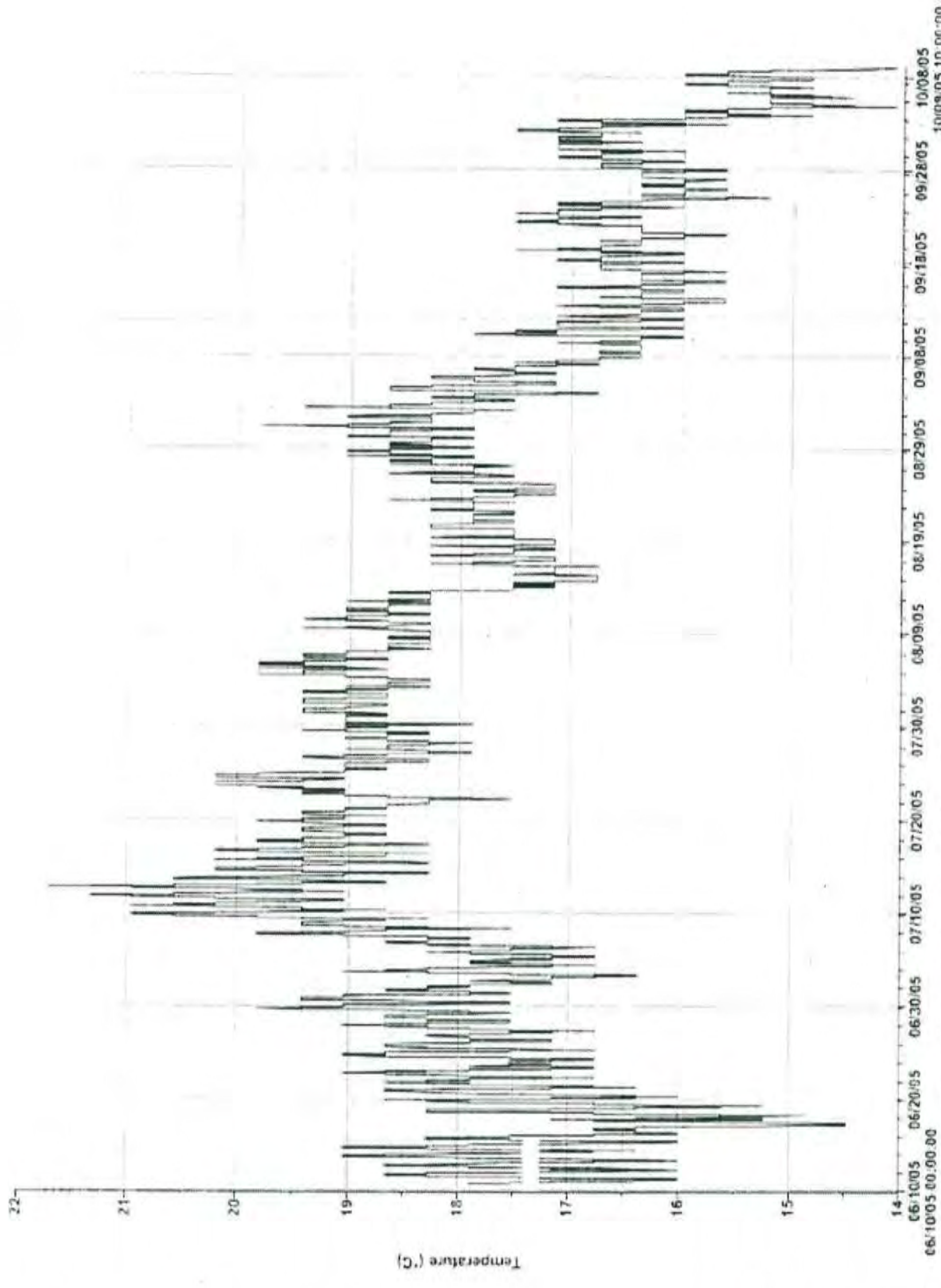


Figure 4c. Water Temp. (°C) Above Trestle 1.5 ft from Bottom, 10 Jun- 9 Oct 2005, 30-min Interval

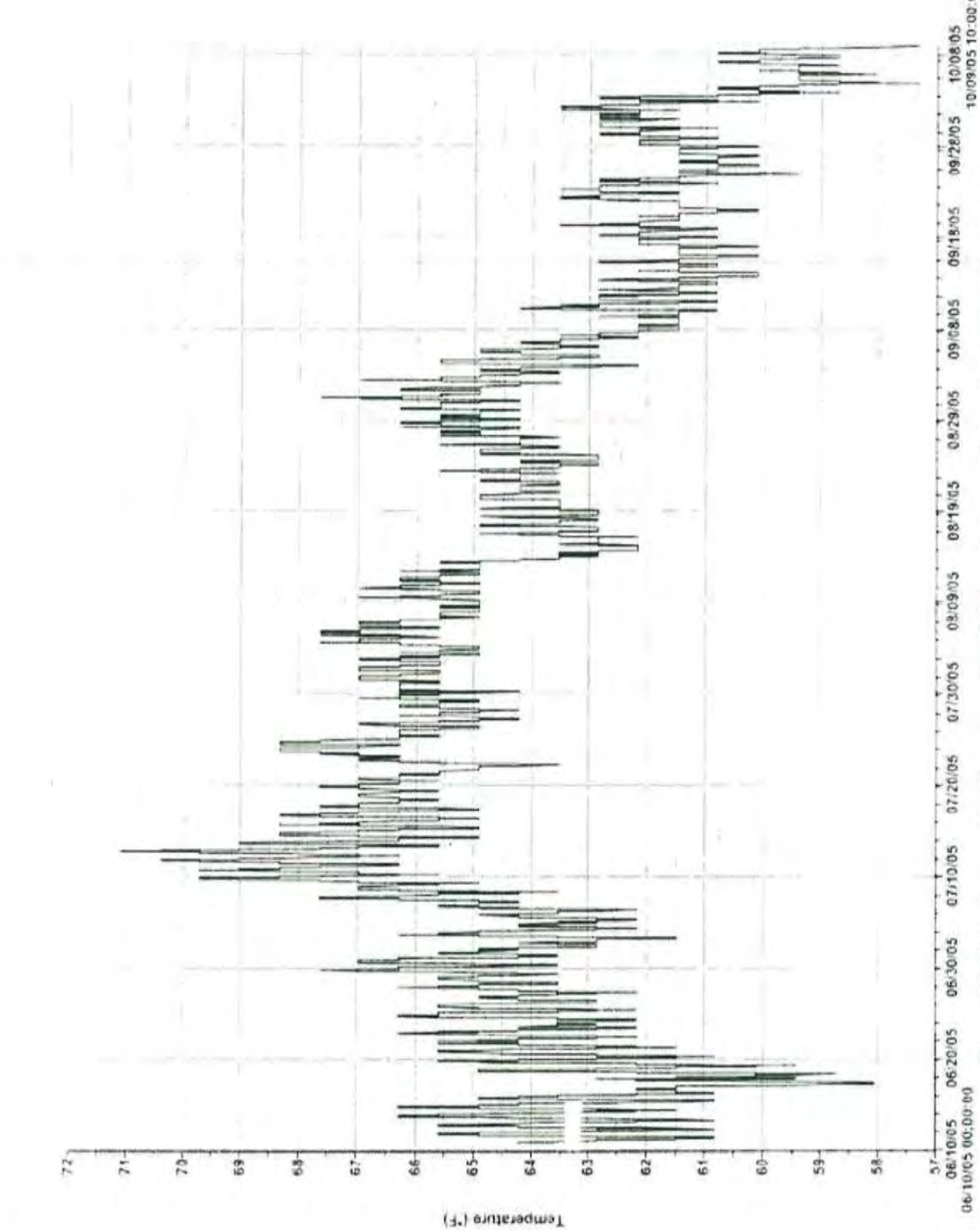


Figure 4d. Water Temp. (°F) Above Trestle 1.5 ft from Bottom, 10 Jun- 9 Oct 2005, 30-min Interval

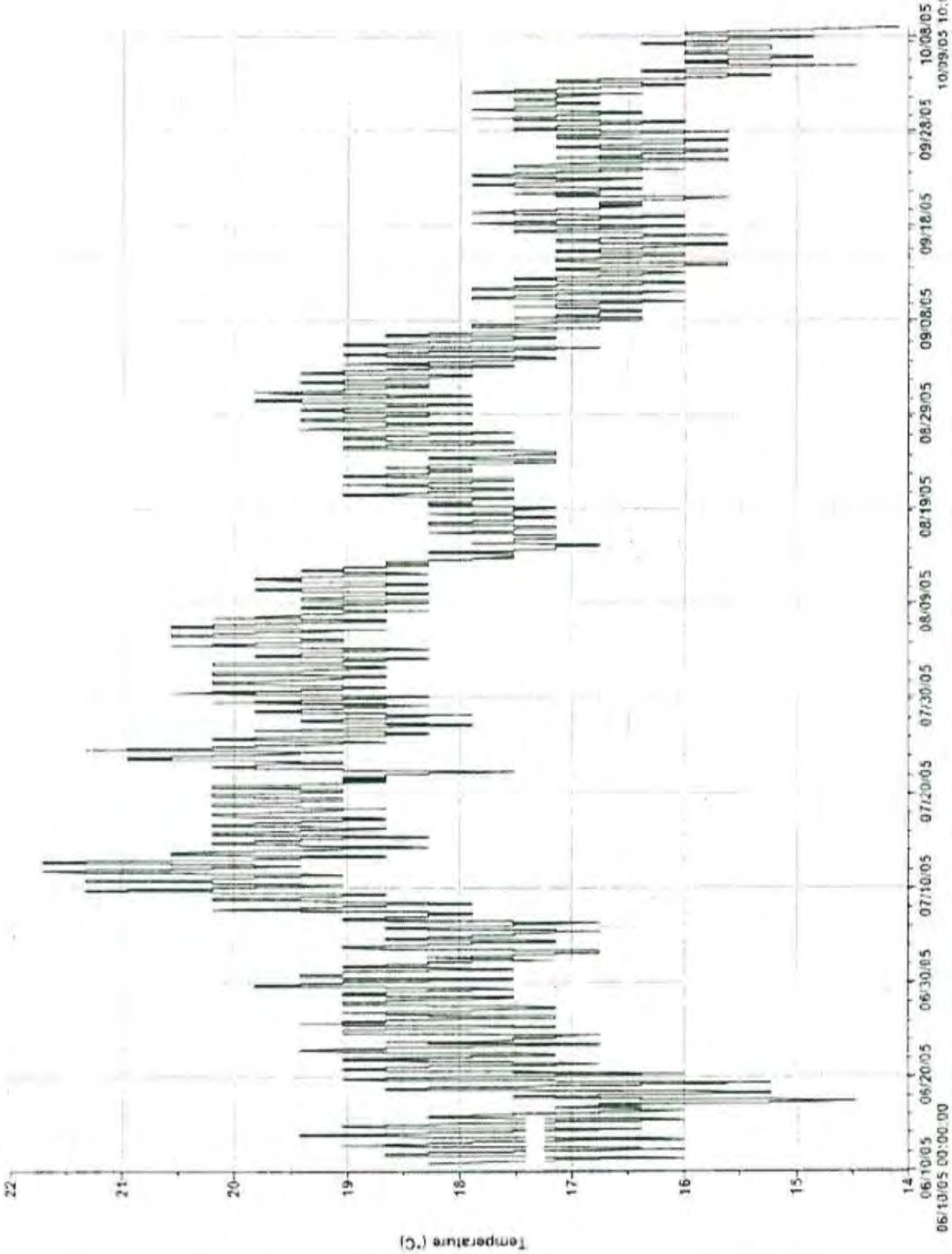


Figure 4e. Water Temp. (°C) Above Trestle 2.5 ft from Bottom, 10 Jun- 9 Oct 2005, 30-min Interval

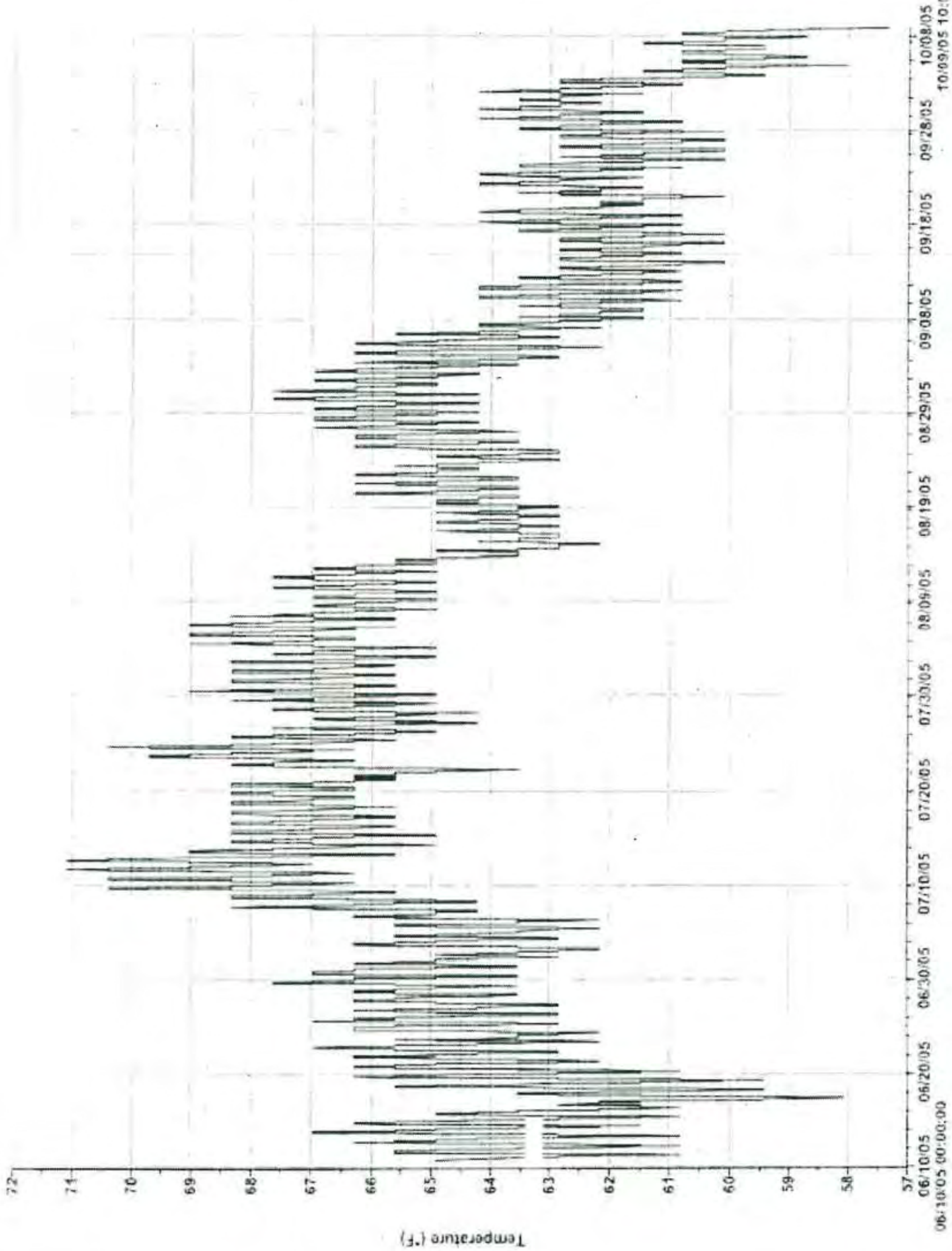


Figure 4f. Water Temp. (°F) Above Trestle 2.5 ft from Bottom, 10 Jun- 9 Oct 2005, 30-min Interval

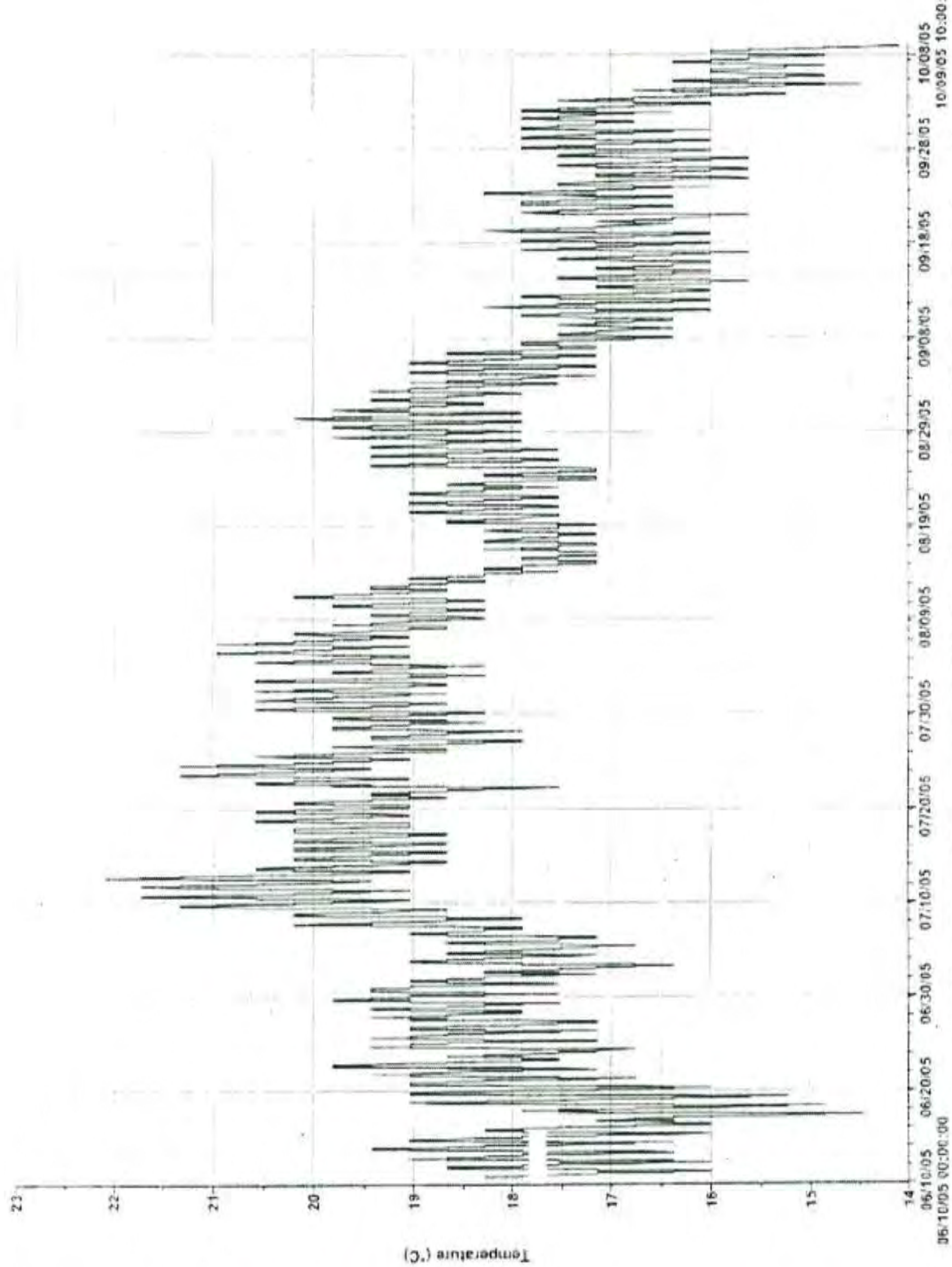


Figure 4g. Water Temp. (°C) Above Trestle 3.5 ft from Bottom, 10 Jun- 9 Oct 2005, 30-min Interval

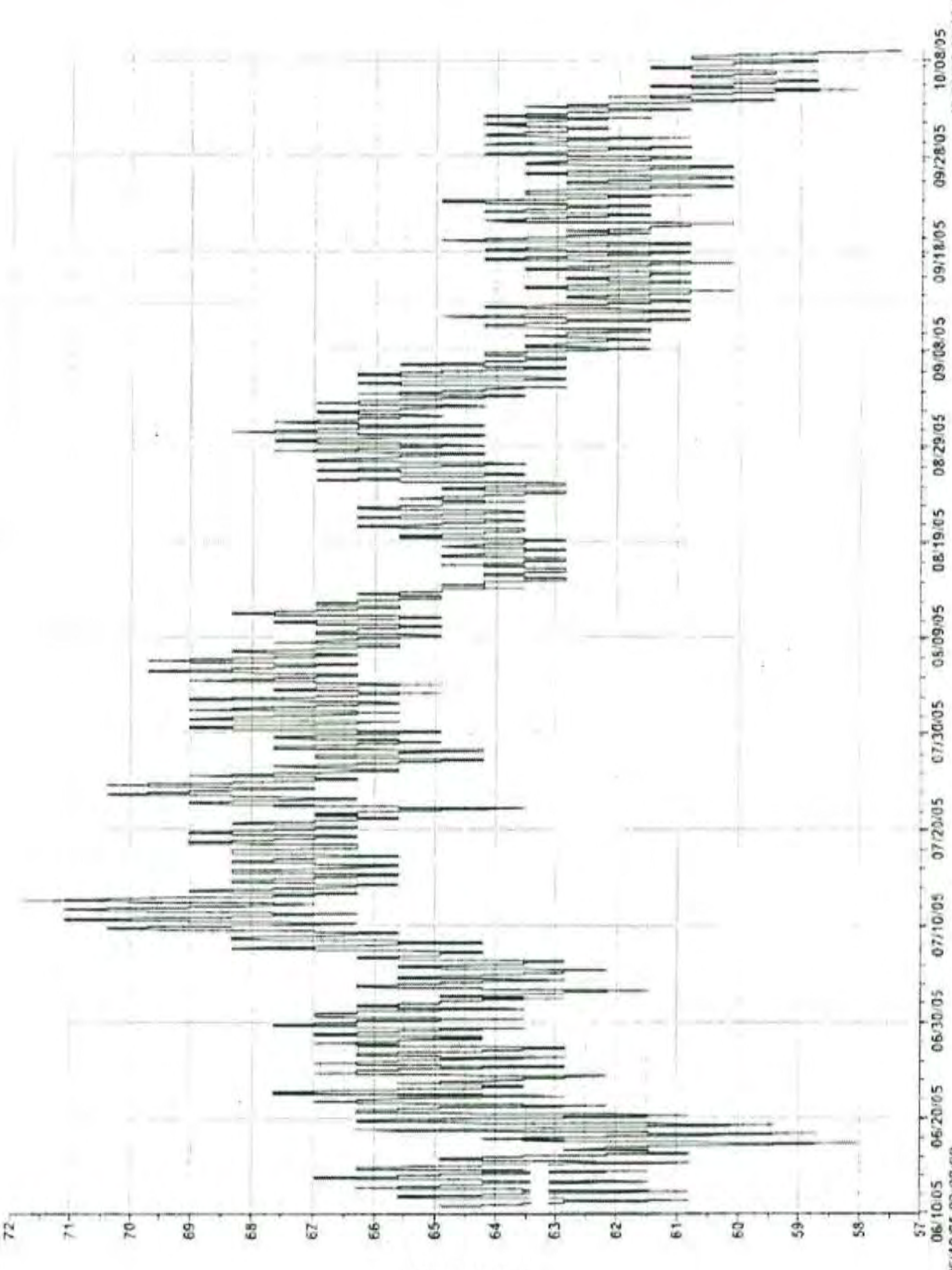


Figure 4h. Water Temp. (°F) Above Trestle 3.5 ft from Bottom, 10 Jun- 9 Oct 2005, 30-min Interval

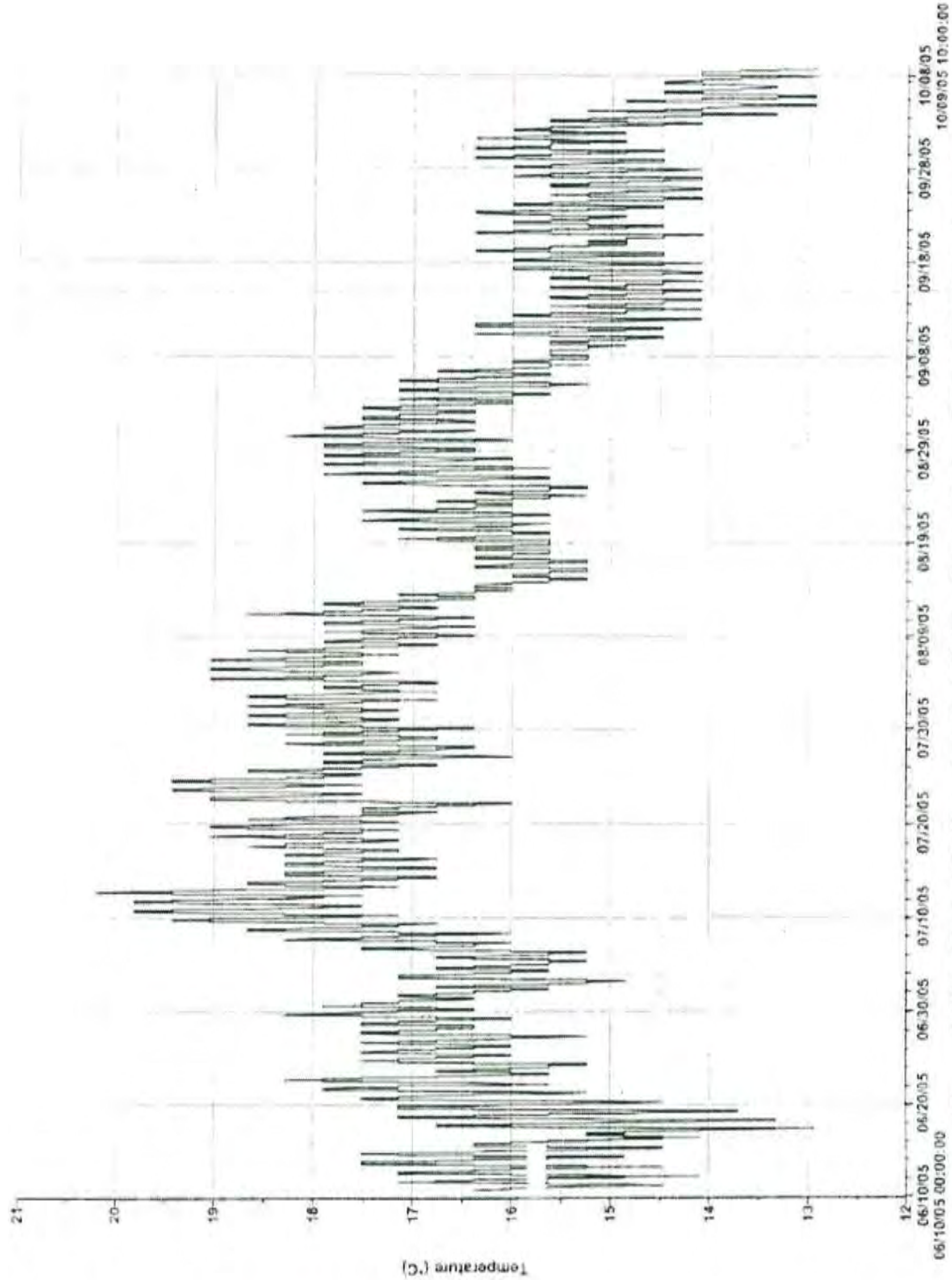


Figure 4i. Water Temp. (°C) Above Trestle 4.5 ft from Bottom, 10 Jun- 9 Oct 2005, 30-min Interval

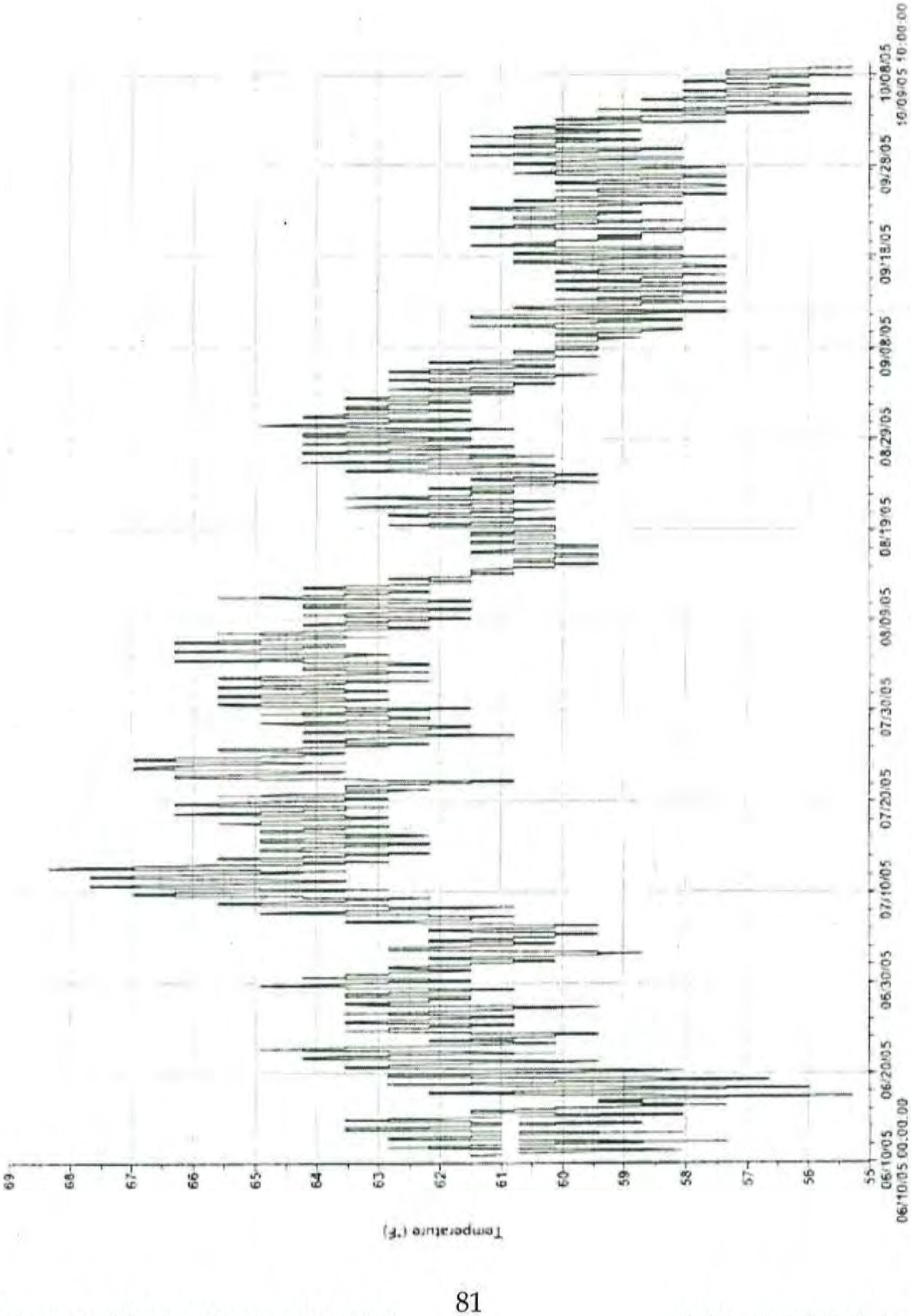


Figure 4j. Water Temp. (°F) Above Trestle 4.5 ft from Bottom, 10 Jun- 9 Oct 2005, 30-min Interval

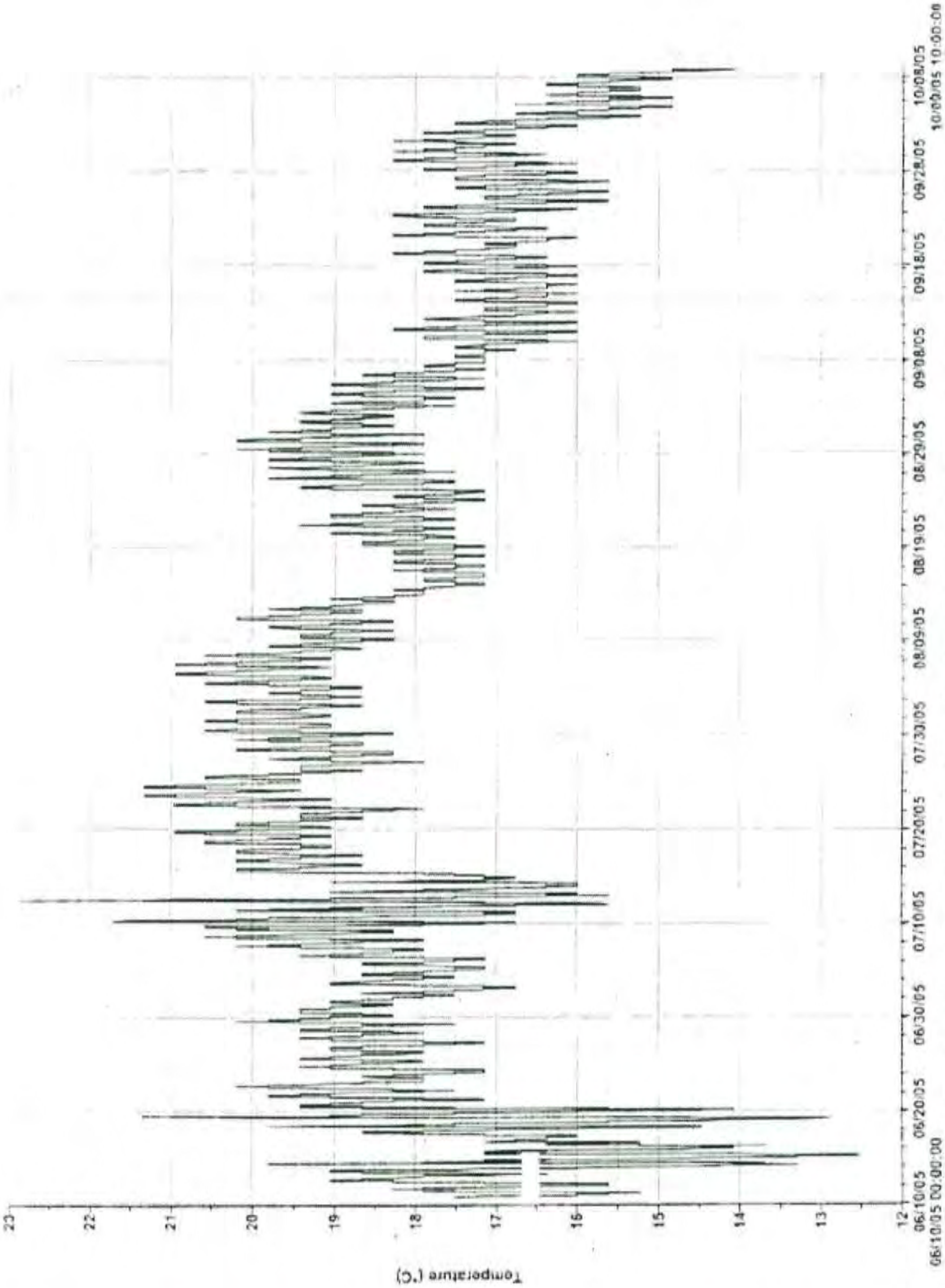


Figure 4k. Water Temp. (°C) Above Trestle 5.5 ft from Bottom, 10 Jun- 9 Oct 2005, 30-min Interval

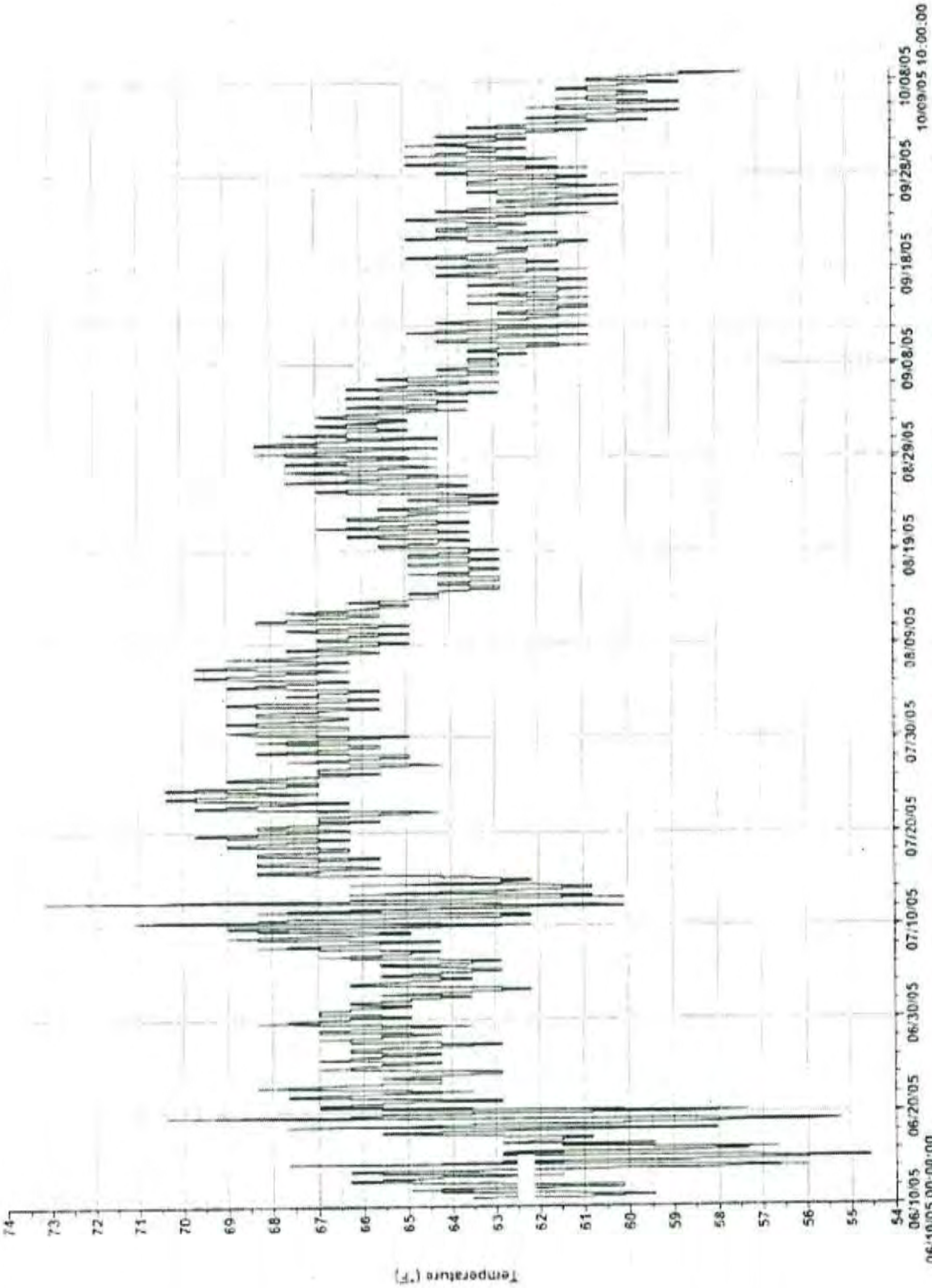


Figure 4l. Water Temp. (°F) Above Trestle 5.5 ft from Bottom, 10 Jun- 9 Oct 2005, 30-min Interval

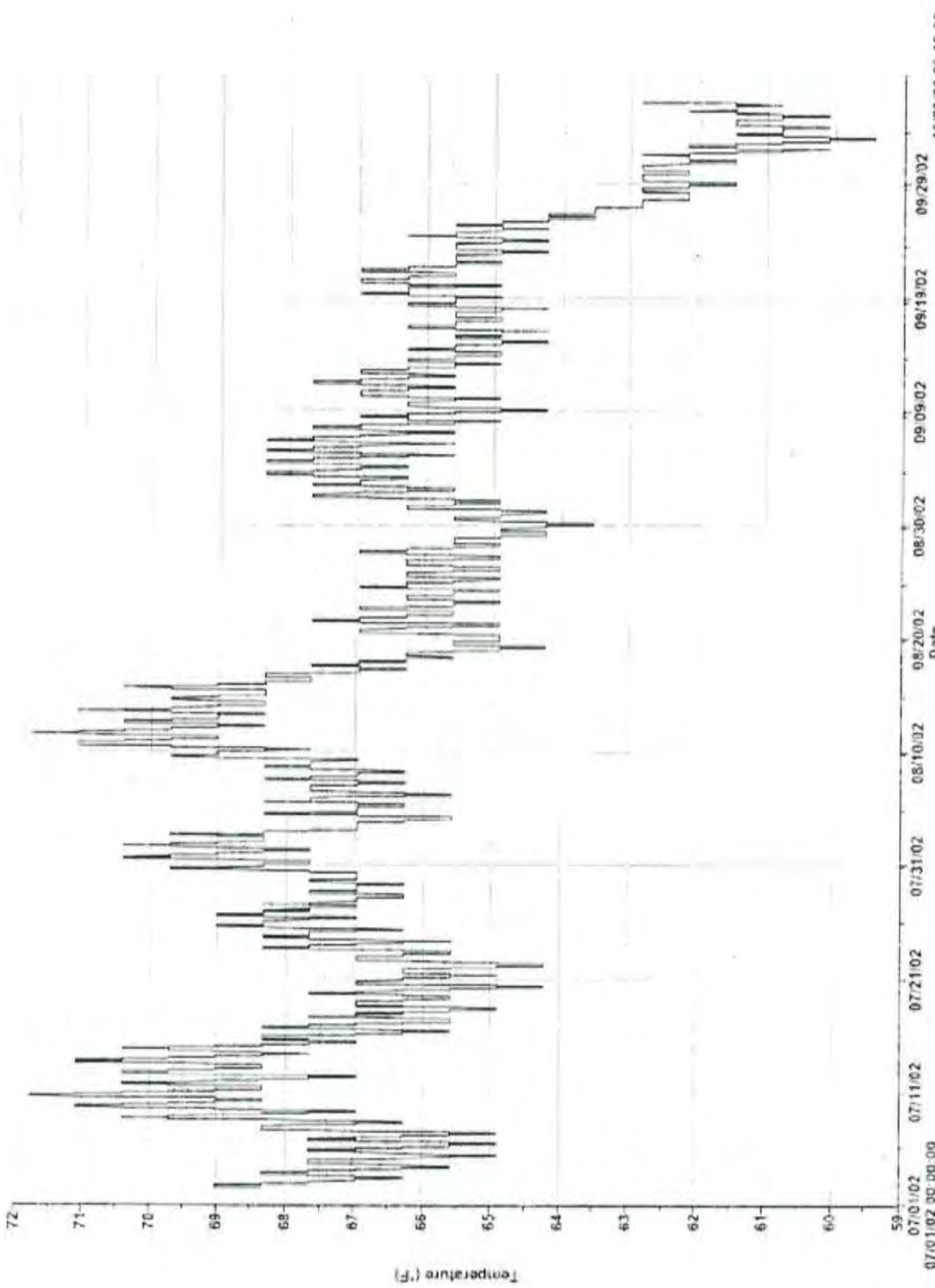


Figure 4m. Water Temp. (°F) Above Trestle 0.5 ft From Bottom, 9 Jul- 6 Oct 2002, 30-min Interval

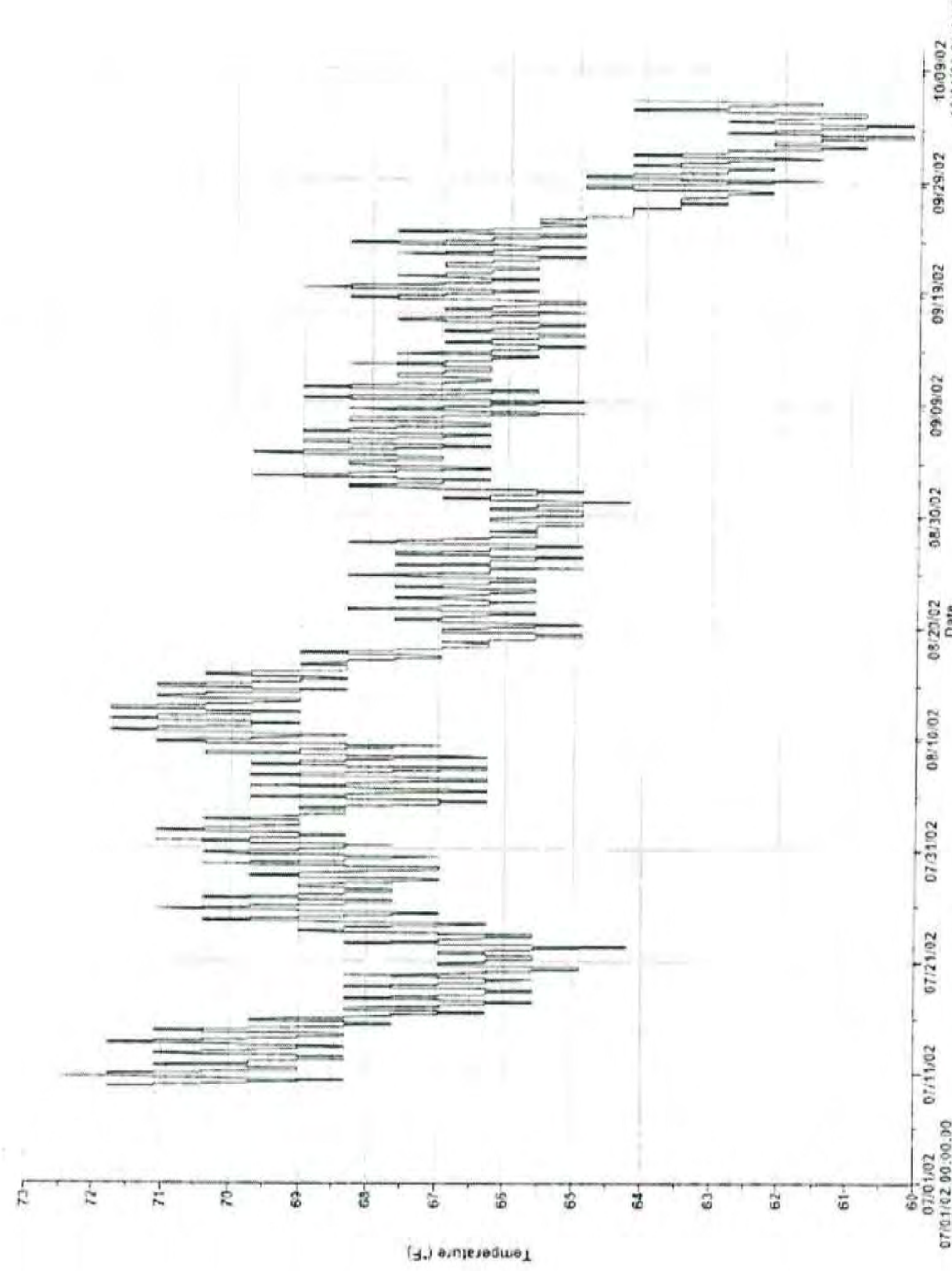


Figure 4n. Water Temp. (°F) Above Trestle 5.5 ft From Bottom. 9 Jul- 6 Oct 2002. 30-min Interval

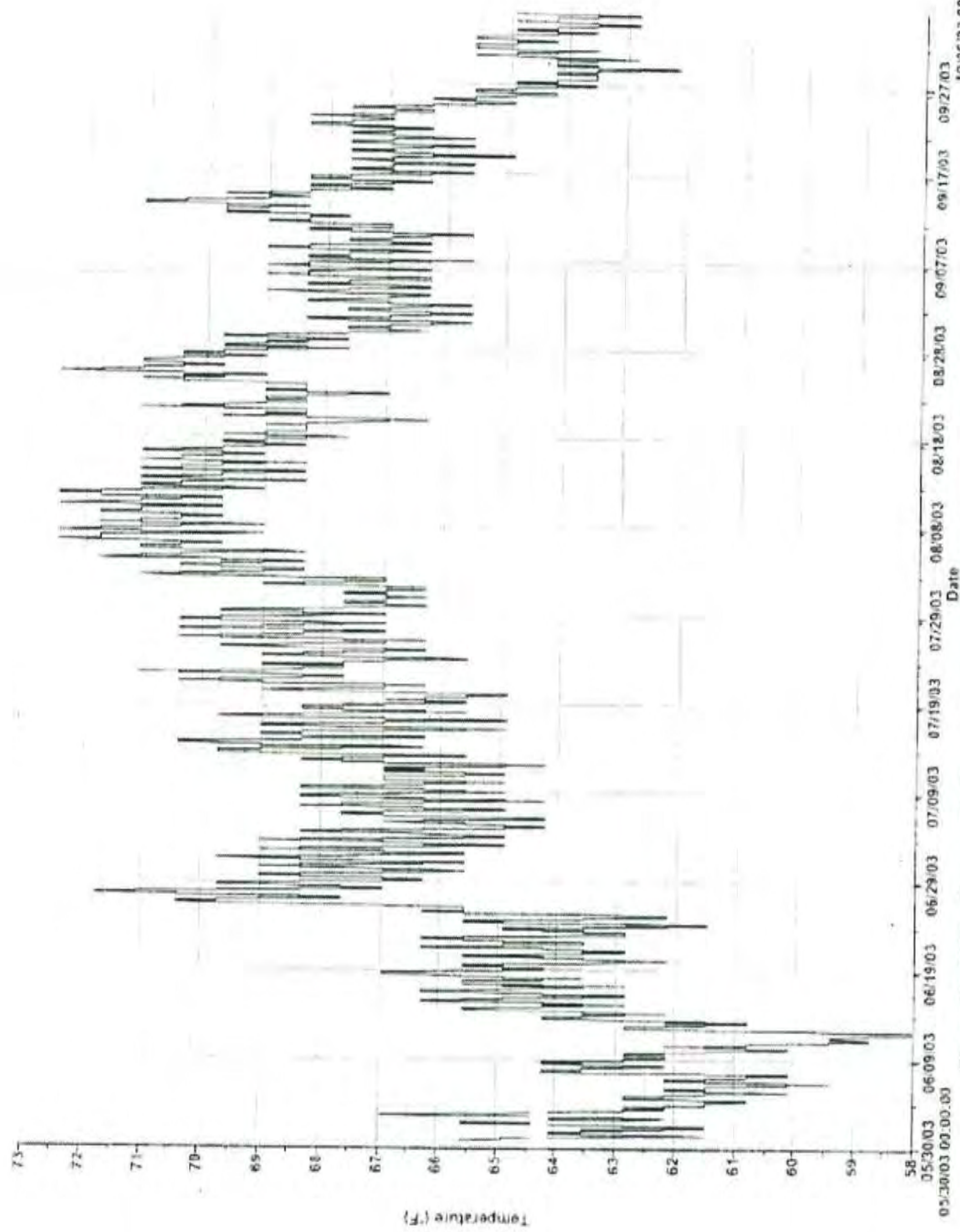


Figure 4o. Water Temp. (°F) Above Trestle 0.5 ft From Bottom, 30 May- 5 Oct 2003, 30-min Interval

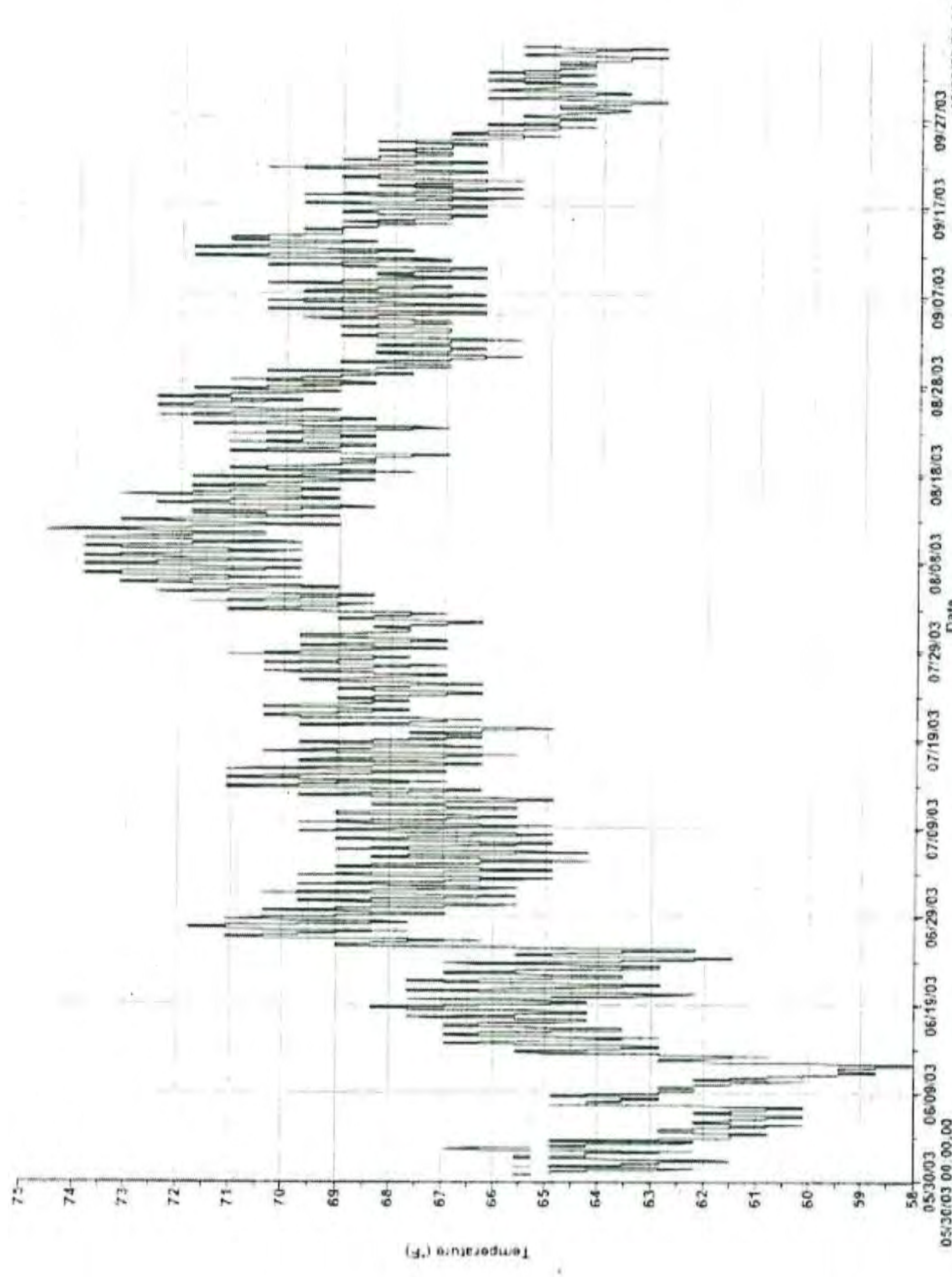


Figure 4p. Water Temp. (°F) Above Trestle 4.5 ft From Bottom, 30 May- 5 Oct 2003, 30-min Interval

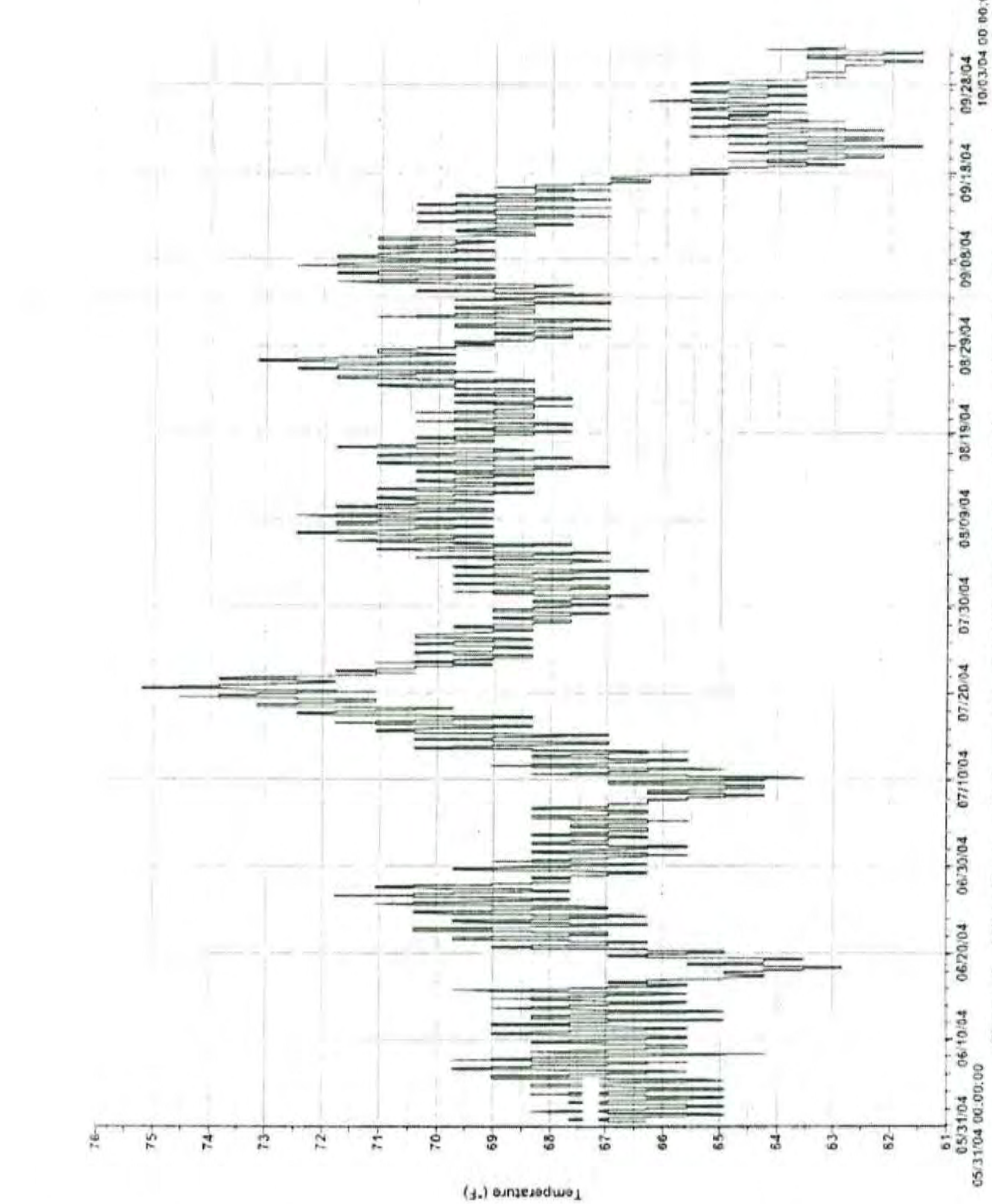


Figure 4. Water Temp. (°F) Above Trestle 0.5 ft from Bottom. 31 May- 3 Oct 2004, 30-min Interval

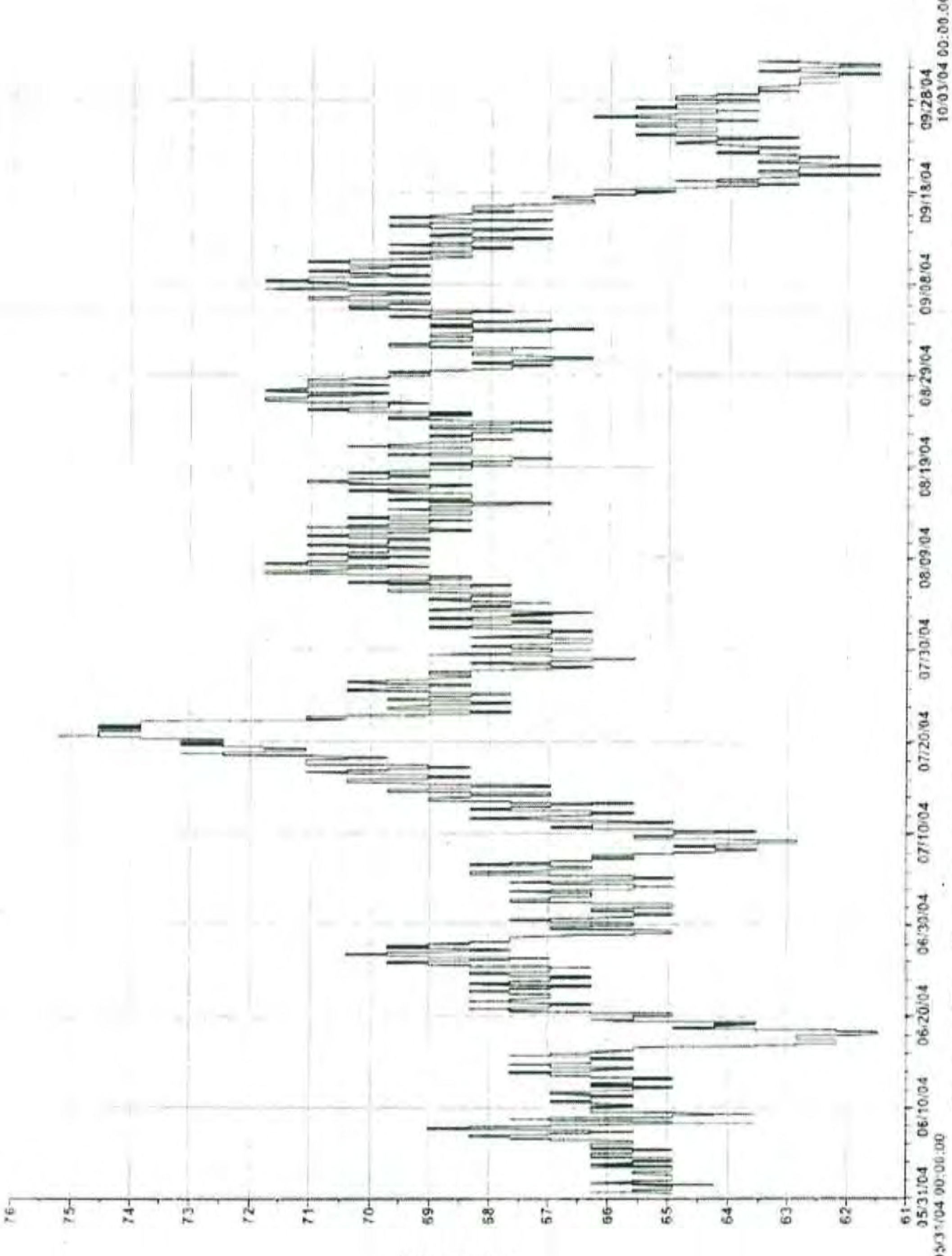


Figure 4r. Water Temp. (°F) Above Trestle 5.5 ft from Bottom, 31 May- 3 Oct 2004, 30-min Interval

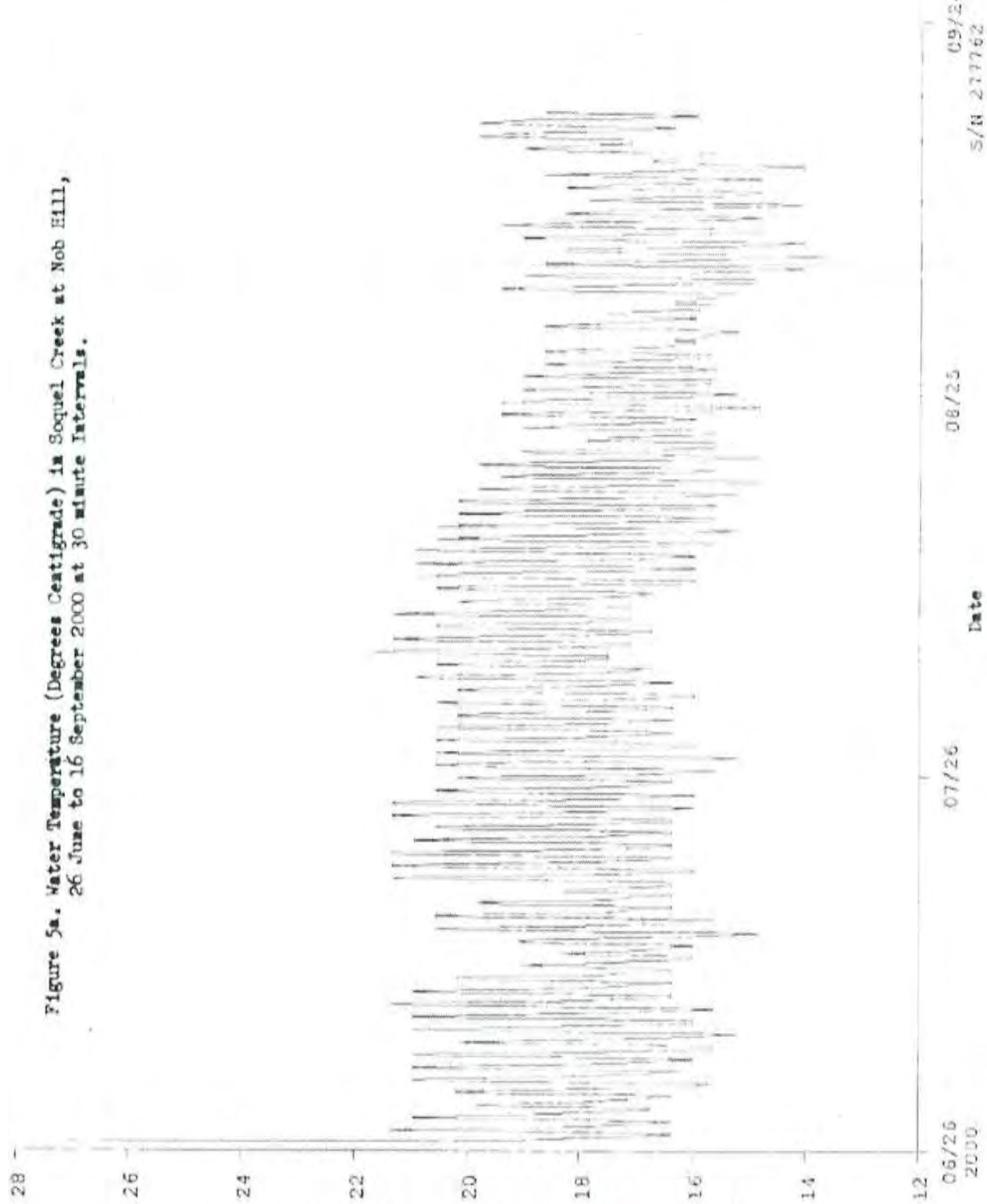


Figure 5a. Water Temperature (Degrees Centigrade) in Soquel Creek at Nob Hill, 26 June to 16 September 2000 at 30 minute Intervals.

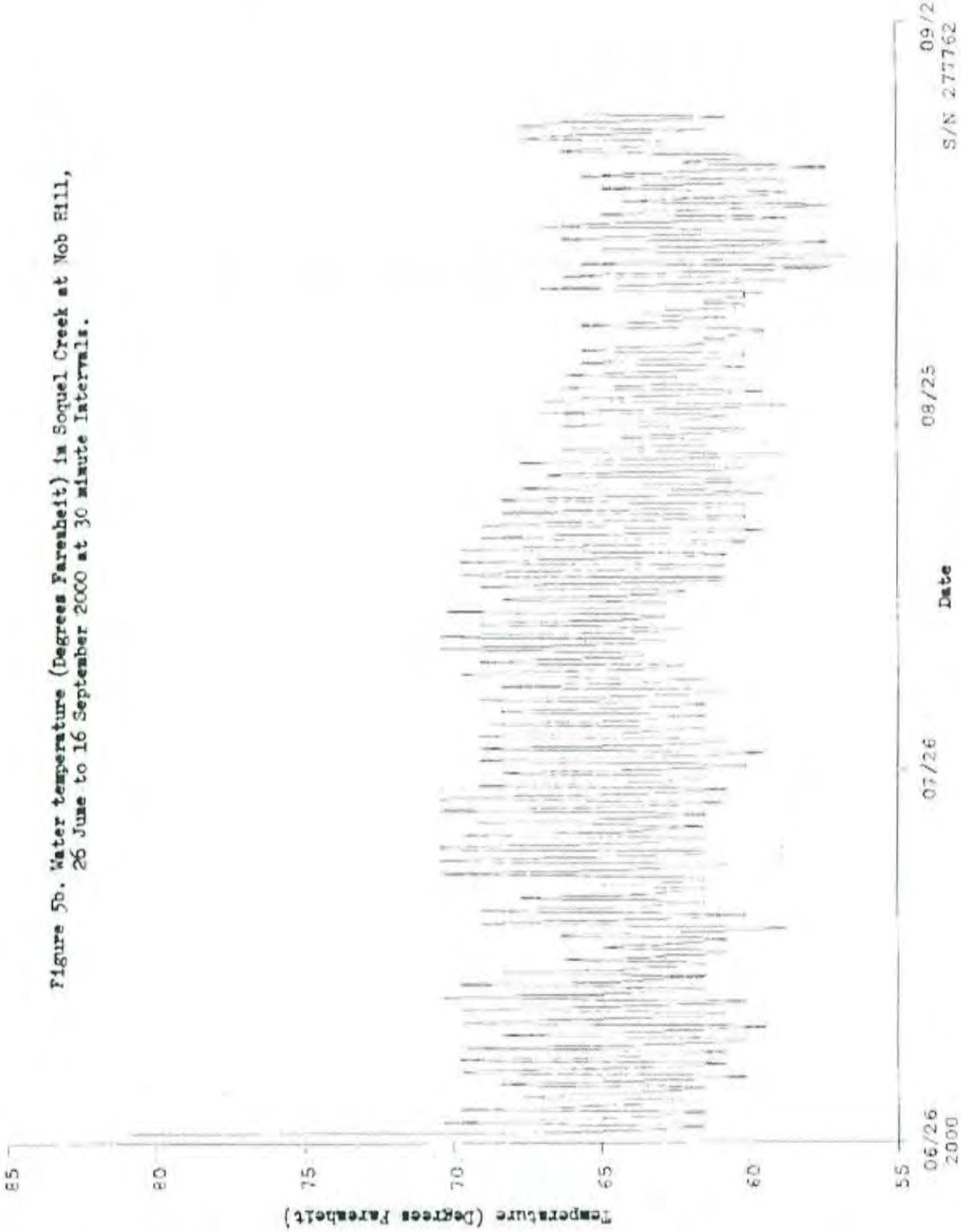
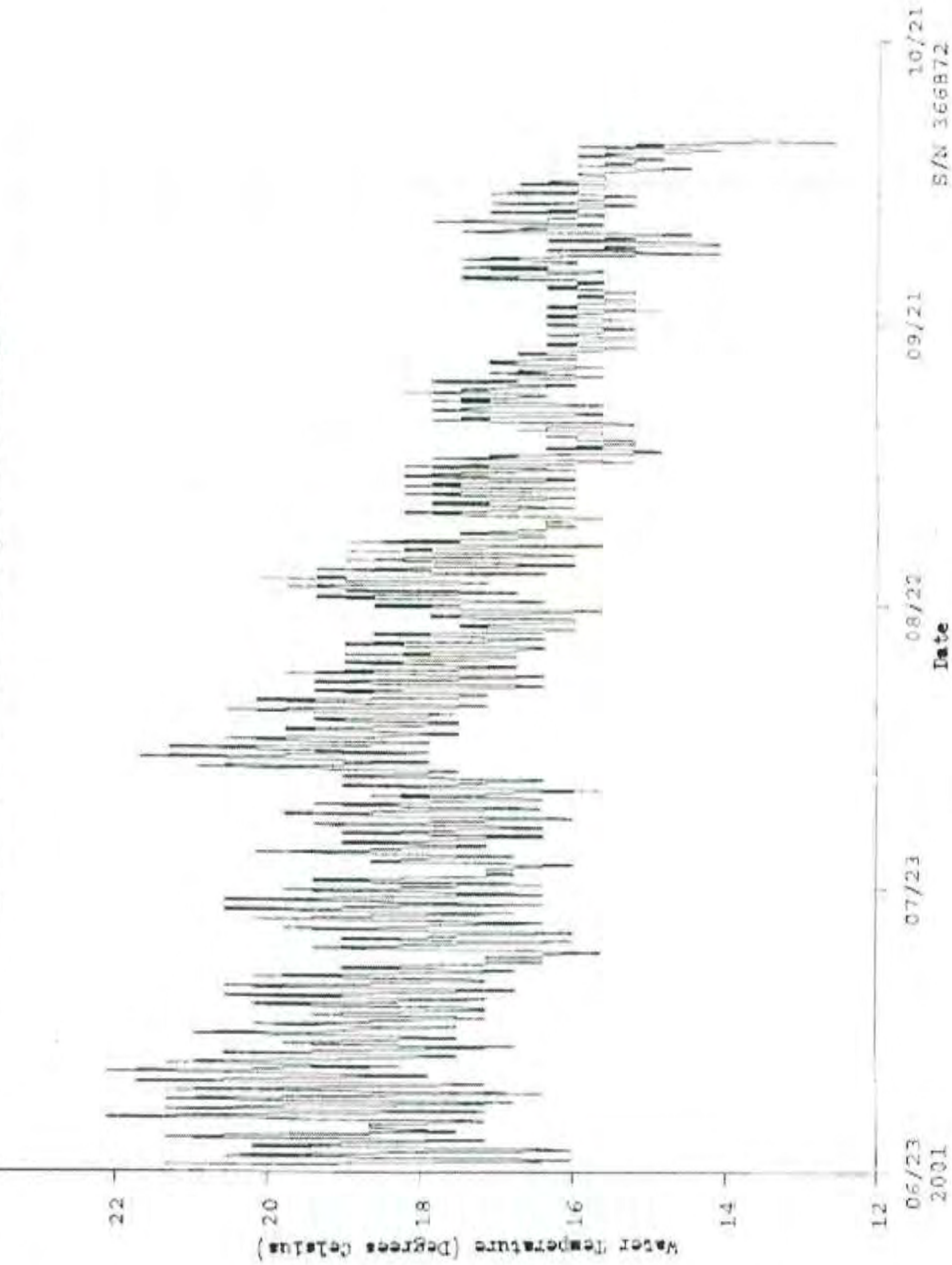


Figure 5b. Water temperature (Degrees Farenheit) in Soquel Creek at Nob Hill, 26 June to 16 September 2000 at 30 minute Intervals.

Figure 5c. Water Temperature (Degrees Celsius) in Soquel Creek at Nob Hill, 23 June to 10 October 2001 at 30-minute Intervals.



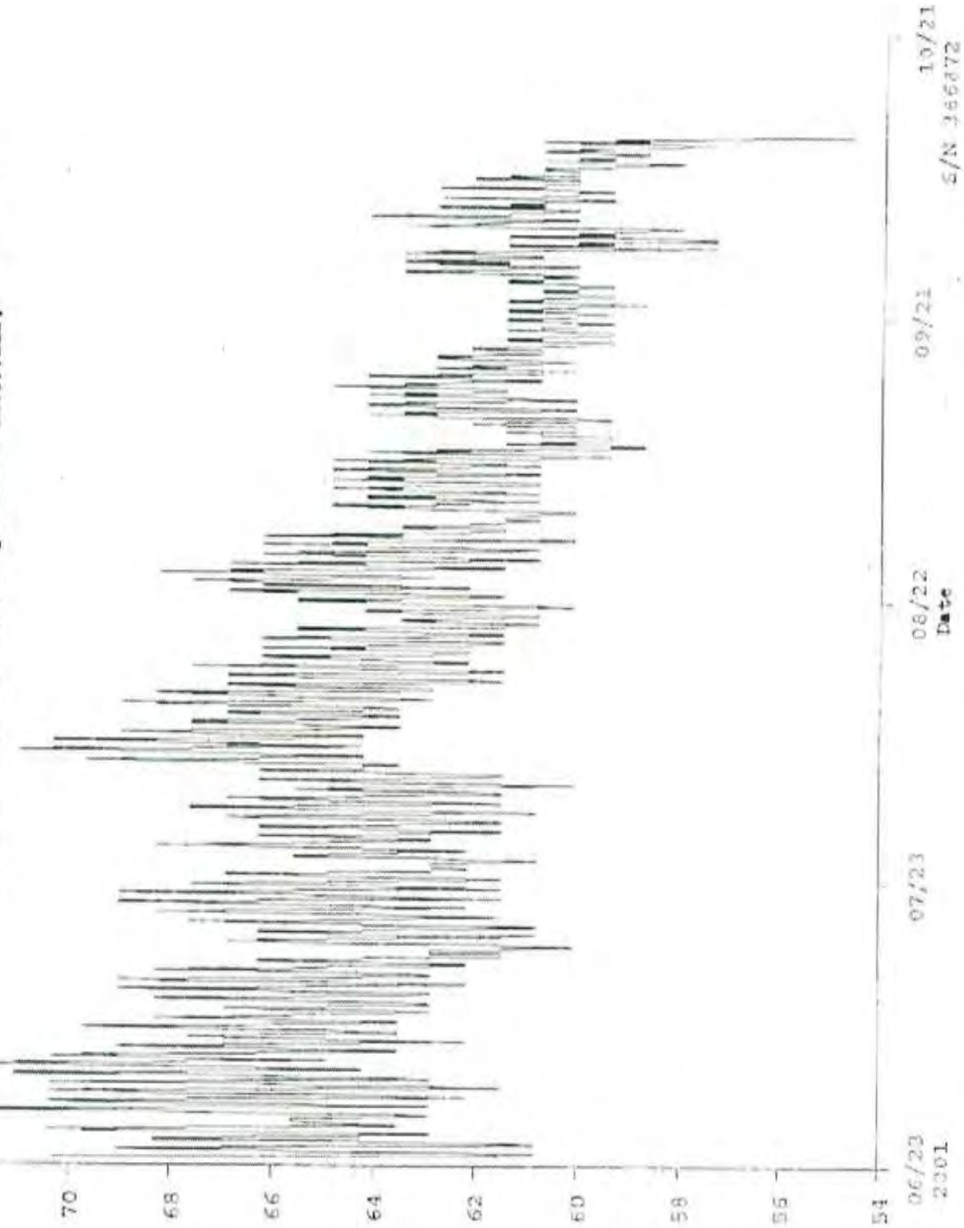


Figure 51. Water Temperature (Degrees Farenheit) in Soquel Creek at Nob Hill, 23 June to 10 October 2001 at 30-minute Intervals.

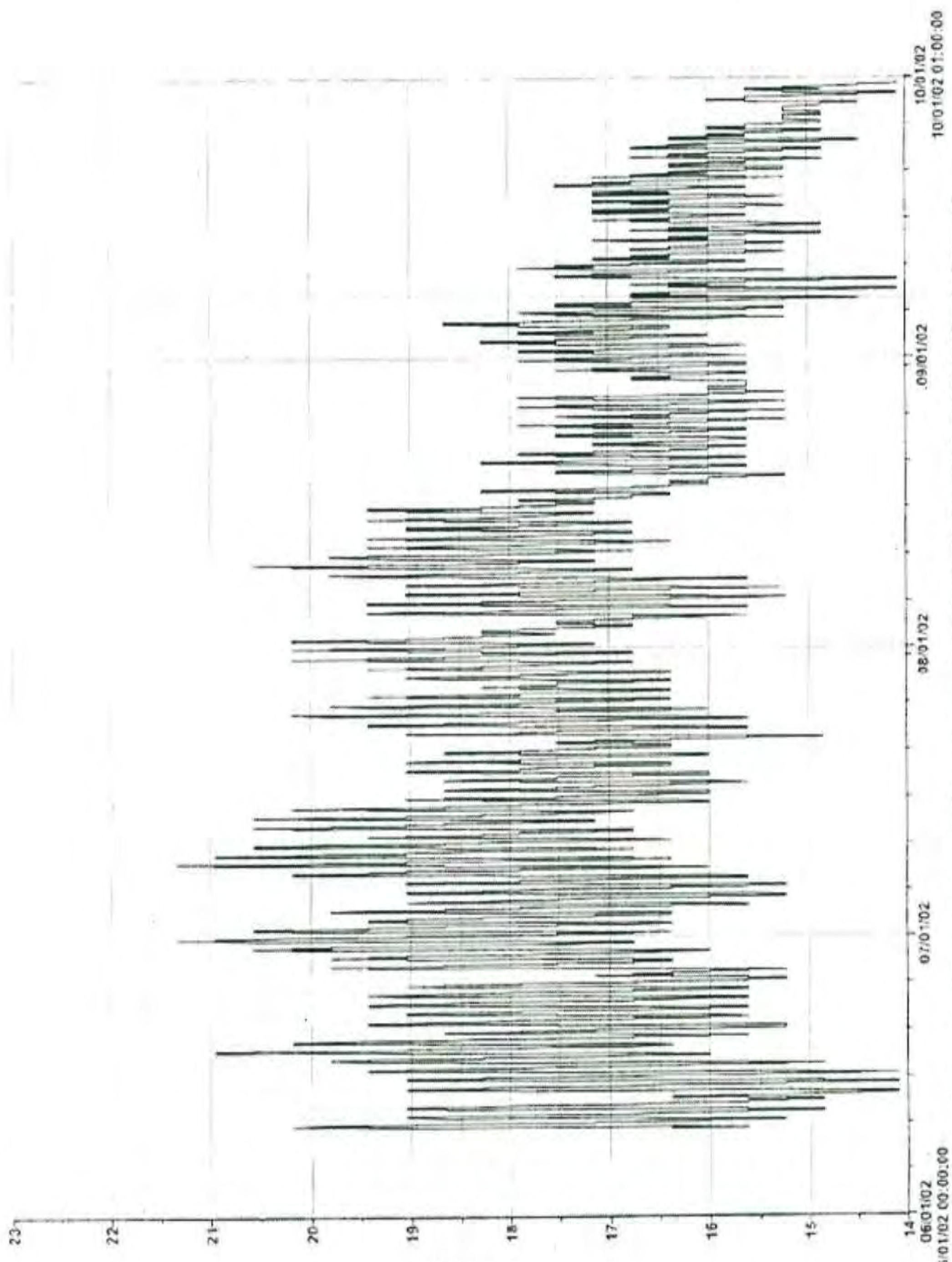


Figure 5e. Water Temp. (°C) Above Lagoon (Nob Hill), 10 Jun-30 Sep 2002, 30-min Interval

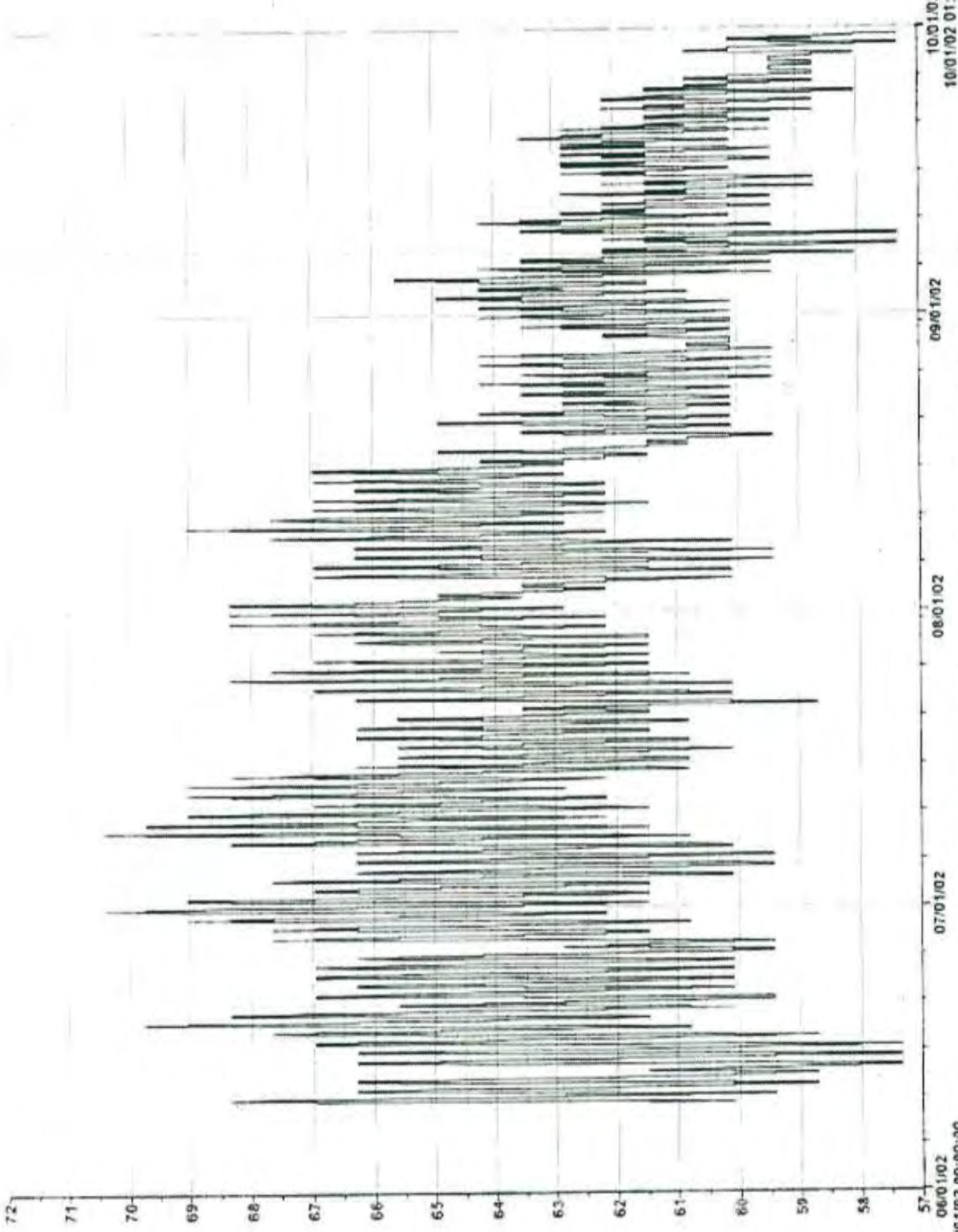


Figure 5f. Water Temp. (°F) Above Lagoon (Nob Hill), 10 Jun-30 Sep 2002, 30-min Interval

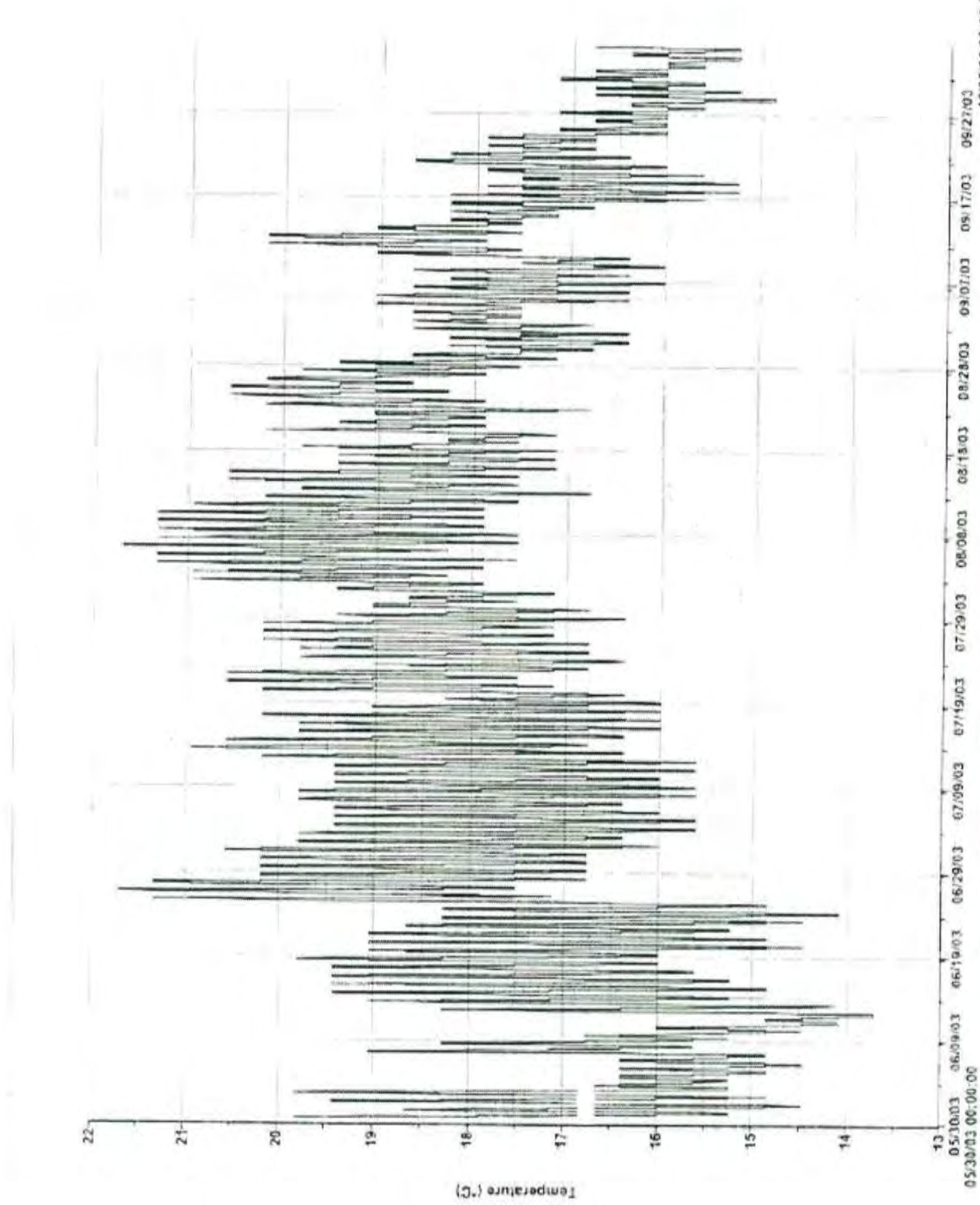


Figure 5g. Water Temp. (°C) Above Lagoon (Nob Hill), 30 May- 5 Oct 2003, 30 -min Interval

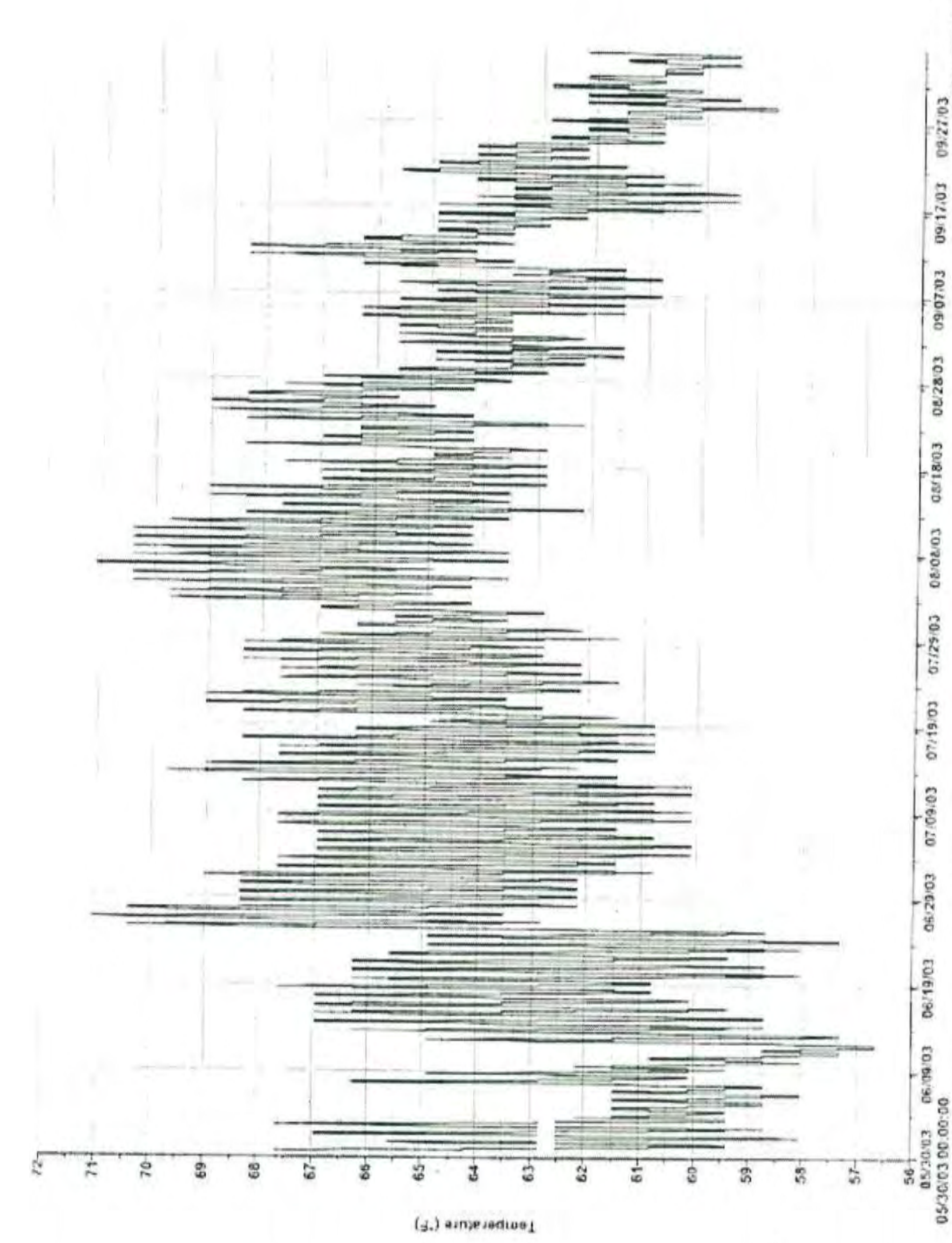


Figure 5h. Water Temp. (°F) Above Lagoon (Nob Hill), 30 May- 5 Oct 2003, 30-min Interval

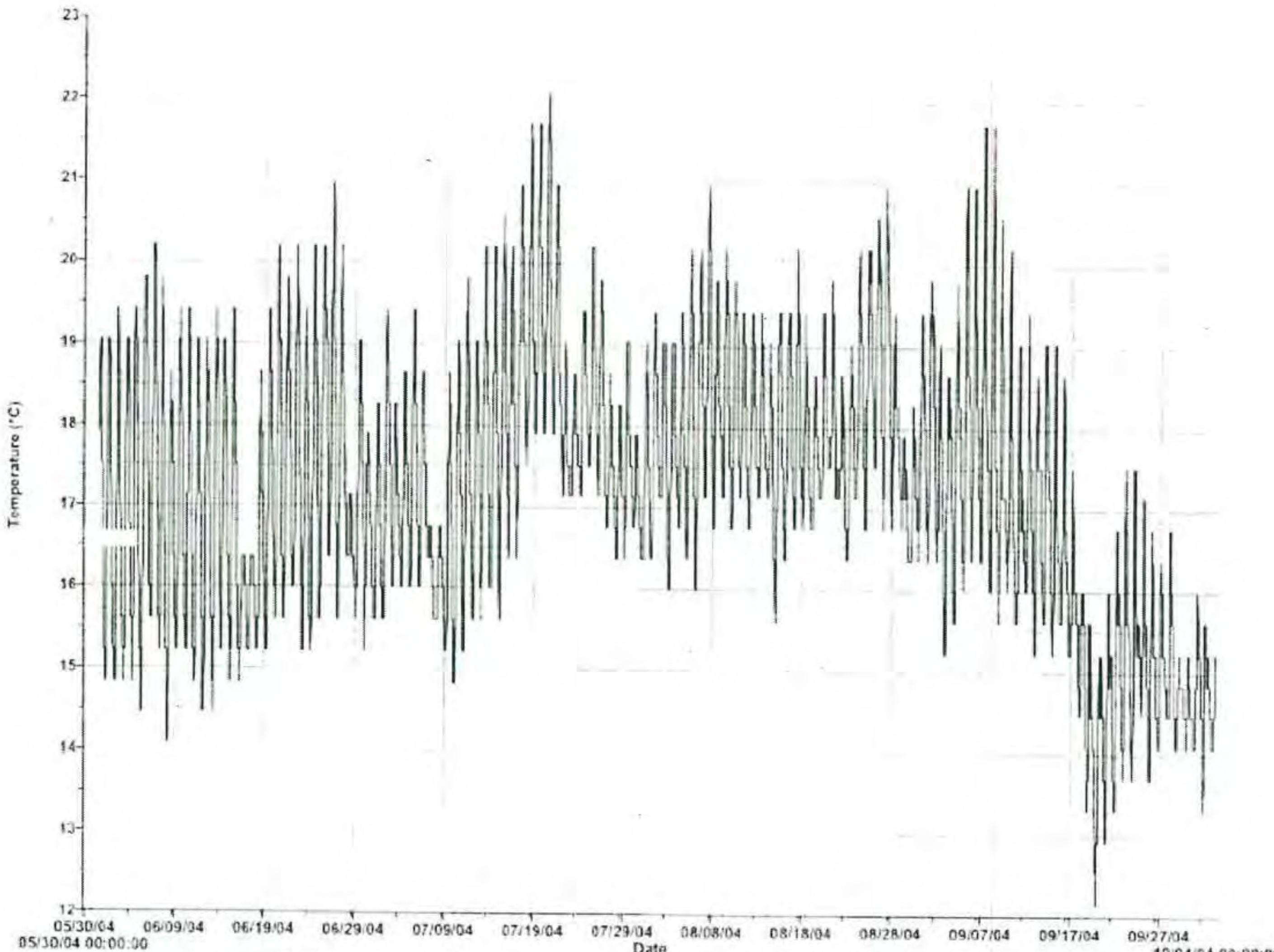


Figure 5i. Water Temp. (°C) Above Lagoon (Nob Hill), 31 May- 3 Oct 2004, 30-min Interval

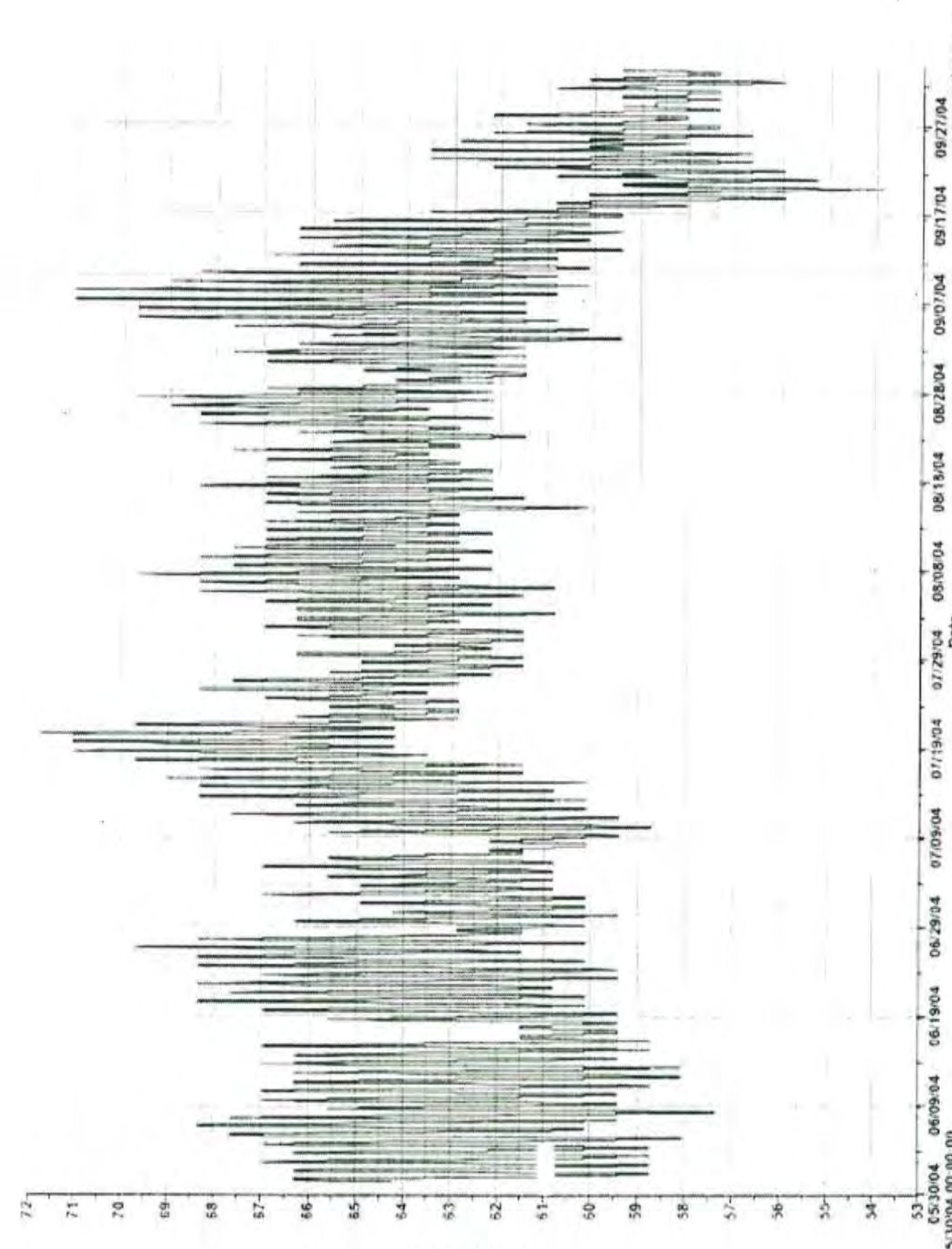


Figure 5j. Water Temp. (°F) Above Lagoon (Nob Hill), 31 May- 3 Oct 2004, 30-min Interval

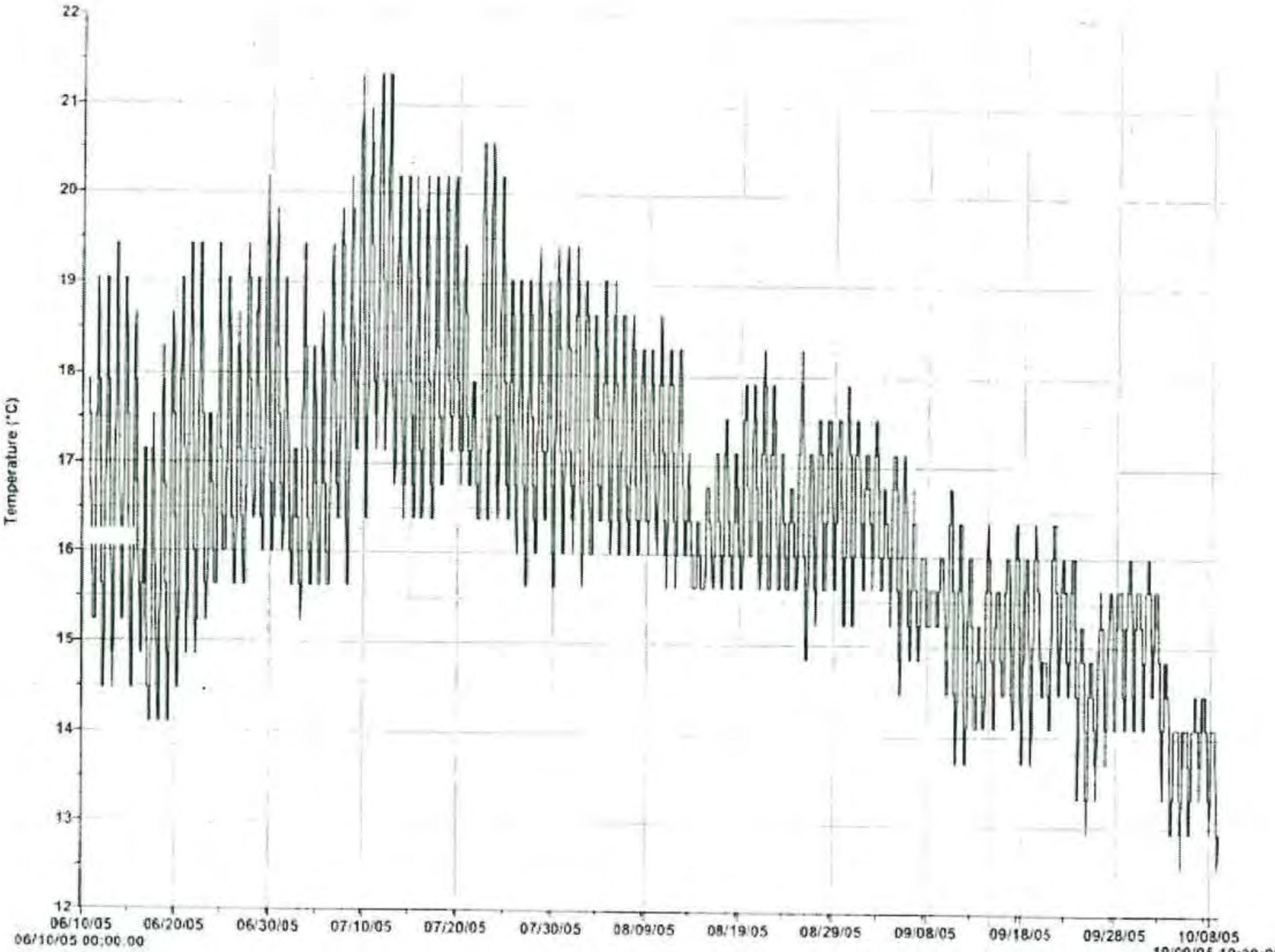


Figure 5k. Water Temp. (°C) Above Lagoon (Nob Hill), 10 June- 9 Oct 2005, 30-min Interval

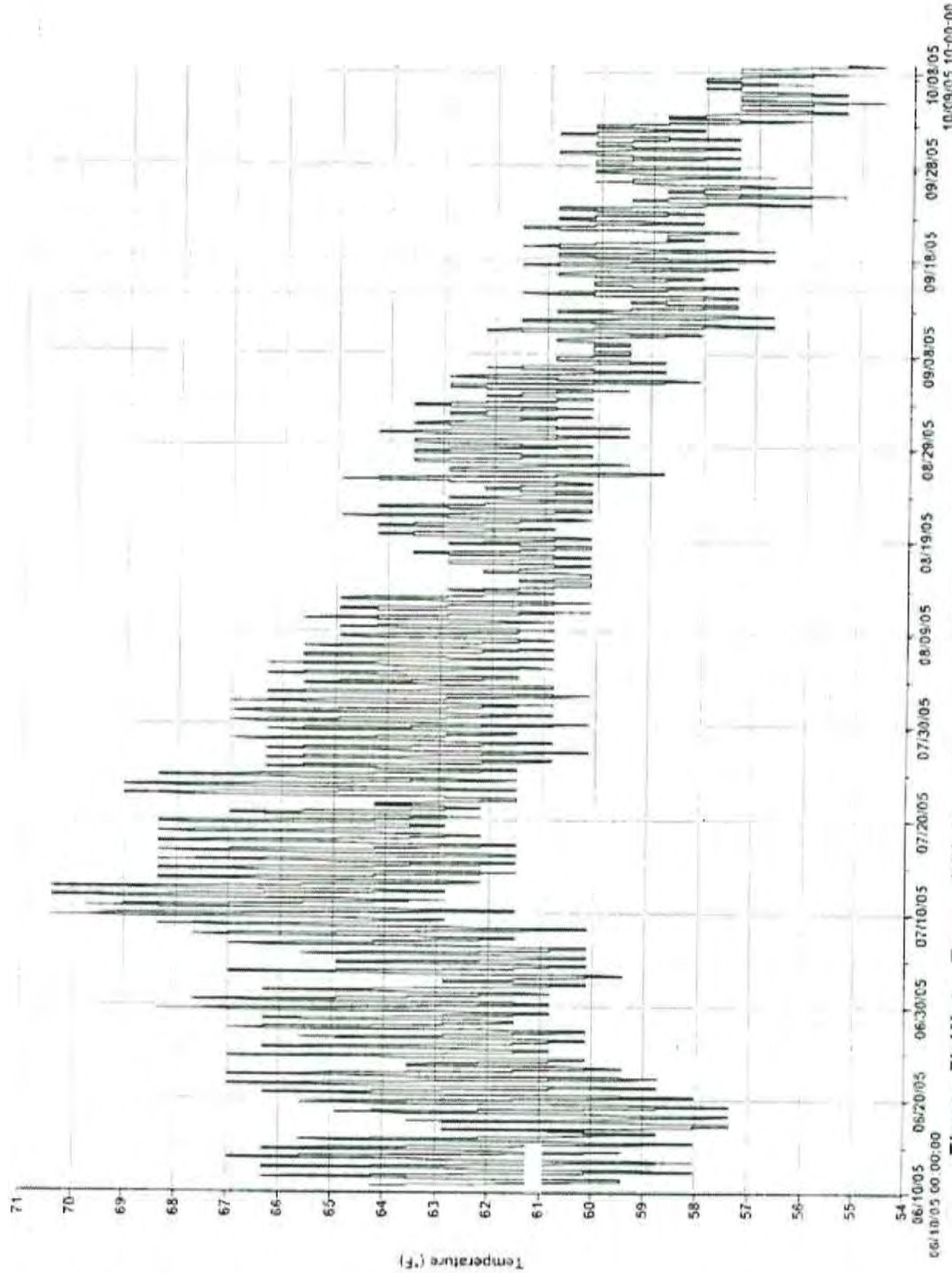


Figure 5I. Water Temp. (°F) Above Lagoon (Nob Hill), 10 June- 9 Oct 2005, 30-min Interval

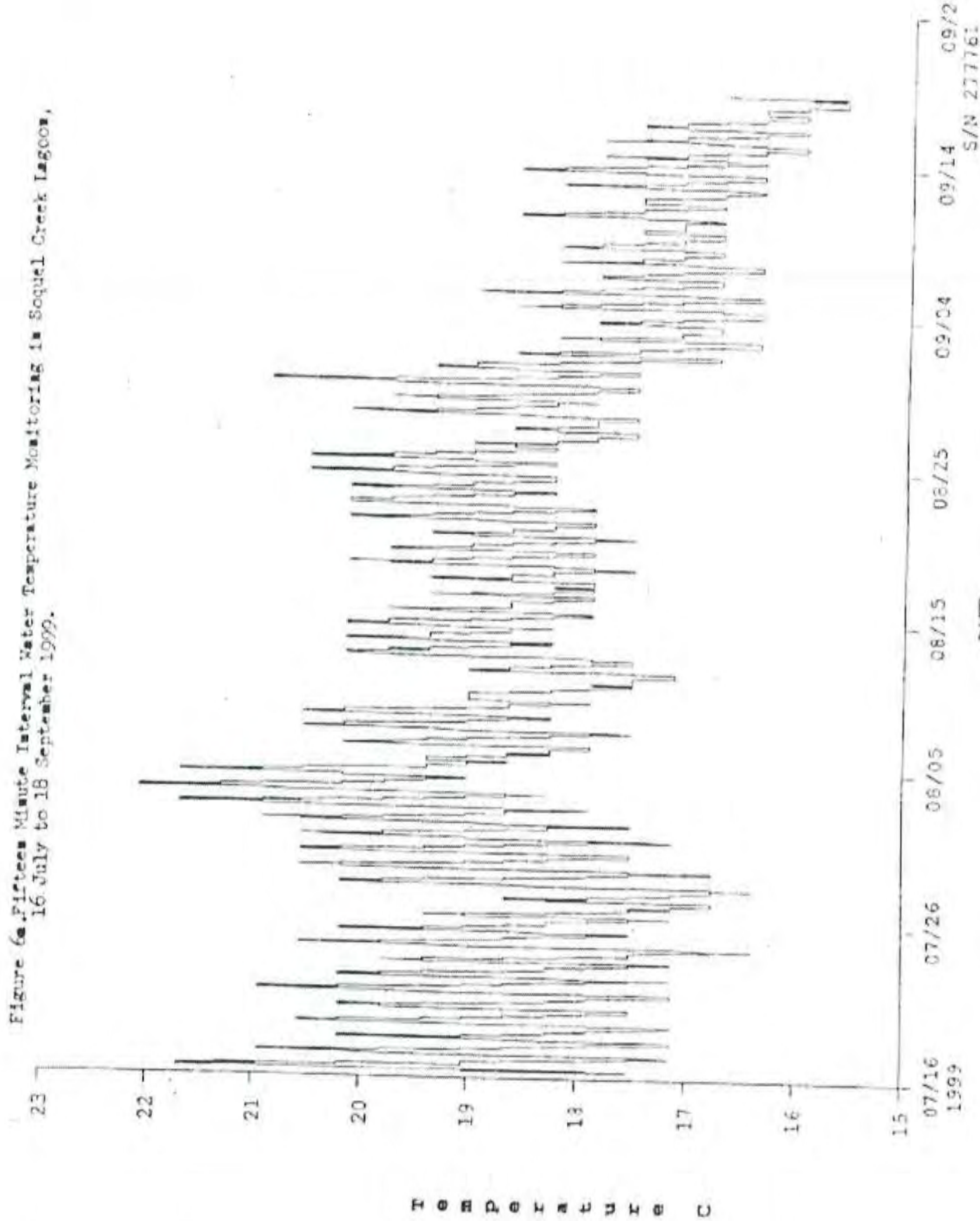


Figure 6a. Fifteen Minute Interval Water Temperature Monitoring in Soquel Creek Lagoon, 16 July to 18 September 1999.

Figure 6b. Fifteen Minute Interval Water Temperature Monitoring in Soquel Creek at Nob Hill, 16 July to 18 September 1999.

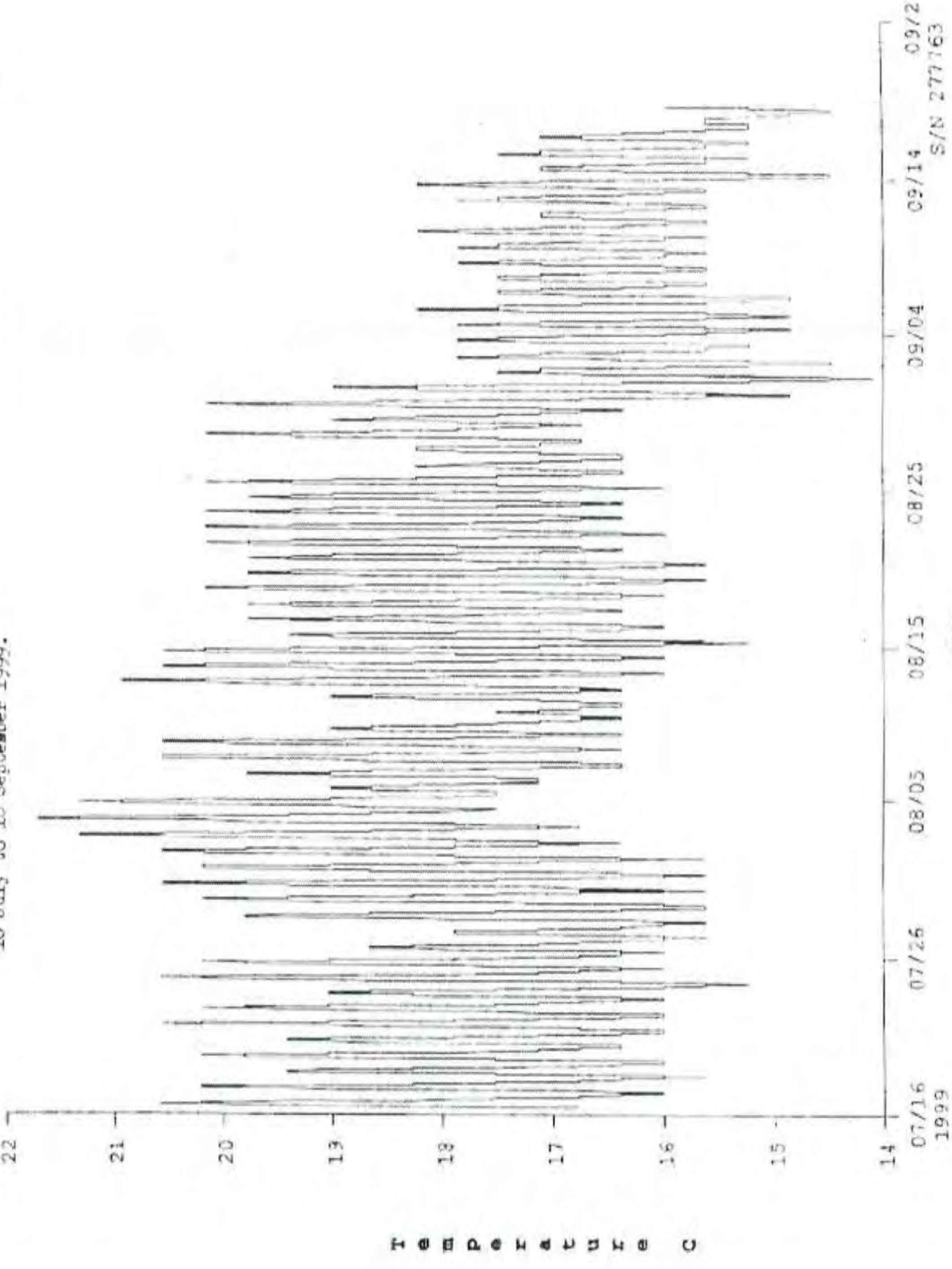


Figure 6c. Hourly Water Temperature Monitoring at Nob Hill on Soquel Creek, July 23 - September 4, 1998.

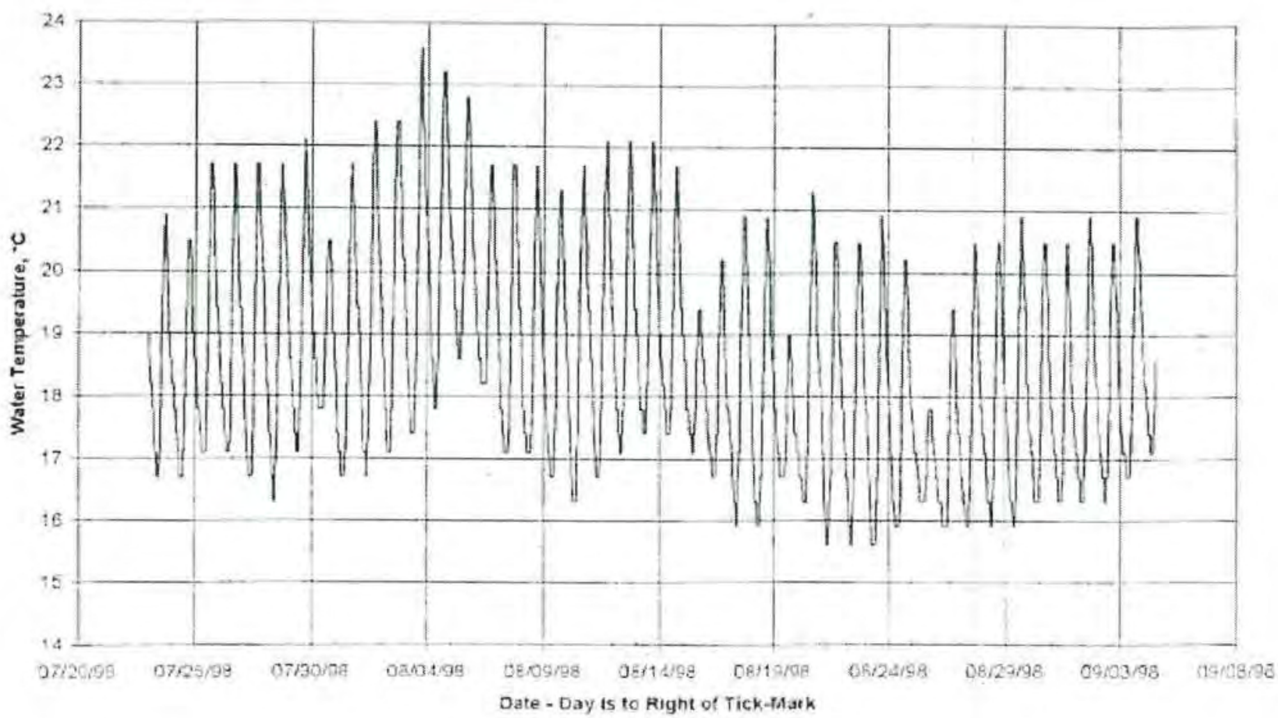


Figure 7. Soquel Lagoon Oxygen Concentration at Dawn, 29 June - 8 October 2001, Within 0.25 Meters of the Bottom at 4 Stations.

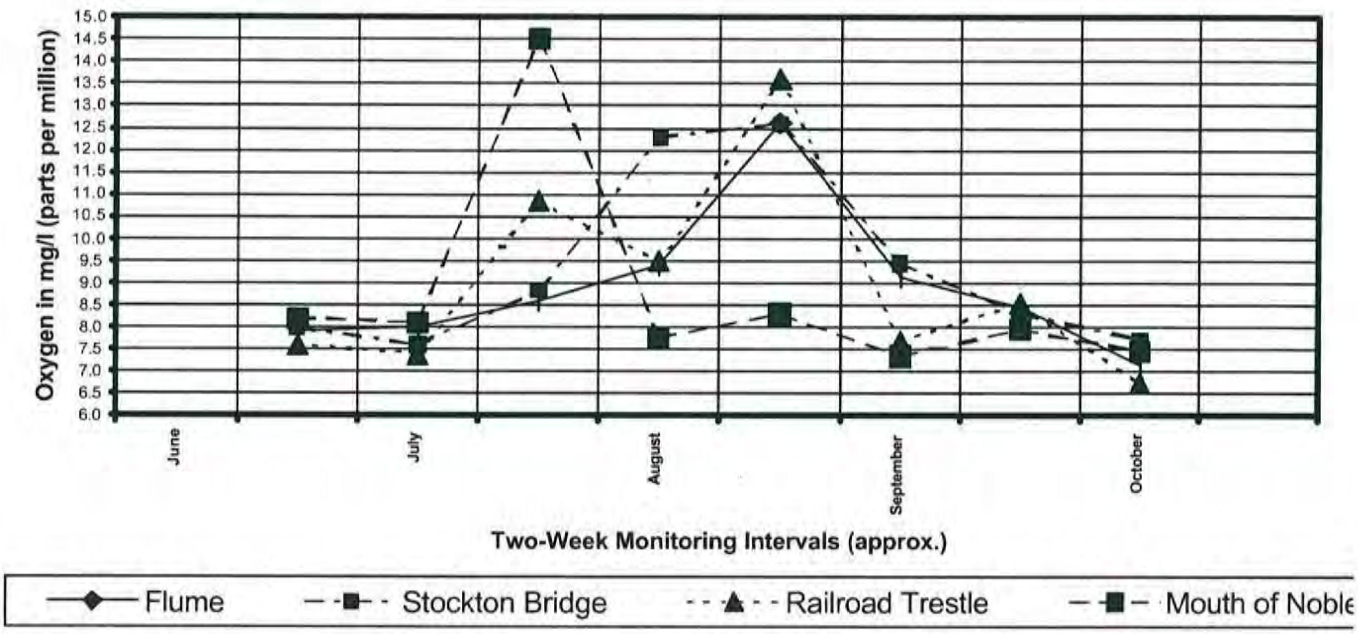


Figure 8. Soquel Lagoon Oxygen Concentration at Dawn, 10 June - 25 October 2002, Within 0.25 Meters of the Bottom at 4 Stations.

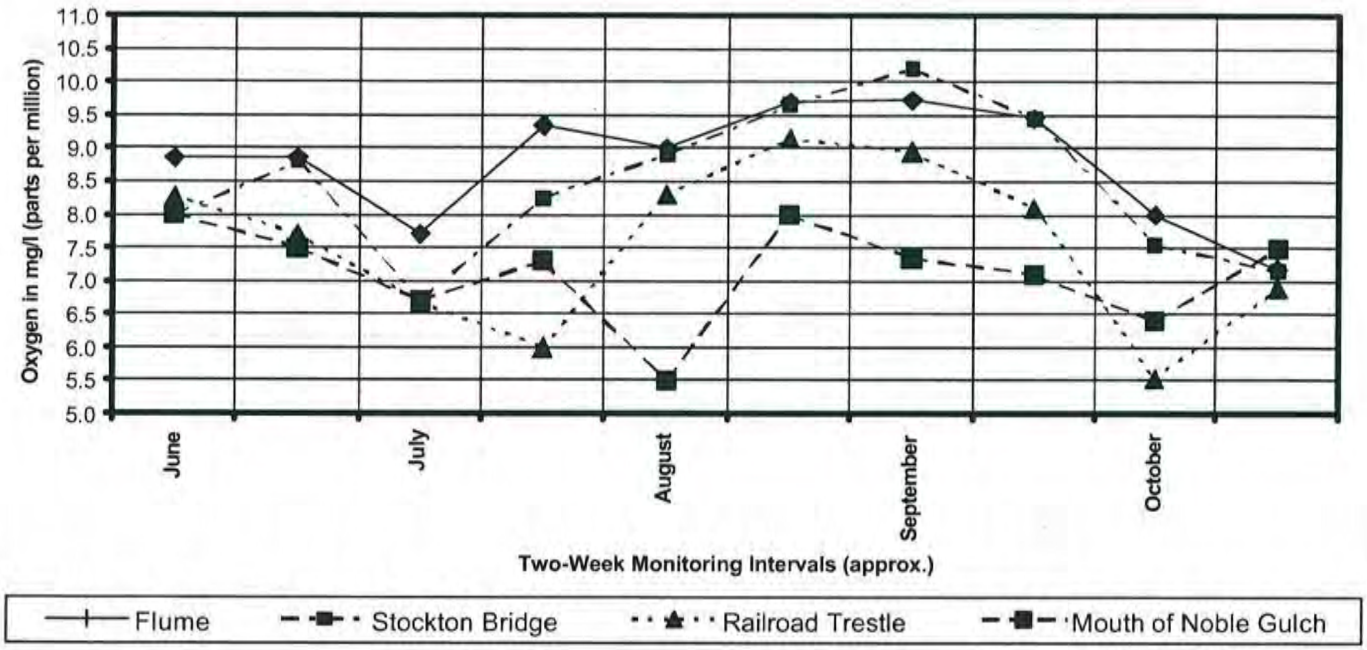


Figure 9a. Soquel Lagoon/Stream Oxygen Concentration at Dawn, 9 June - 27 October 2003, Within 0.25 Meters of the Bottom at 5 Stations.

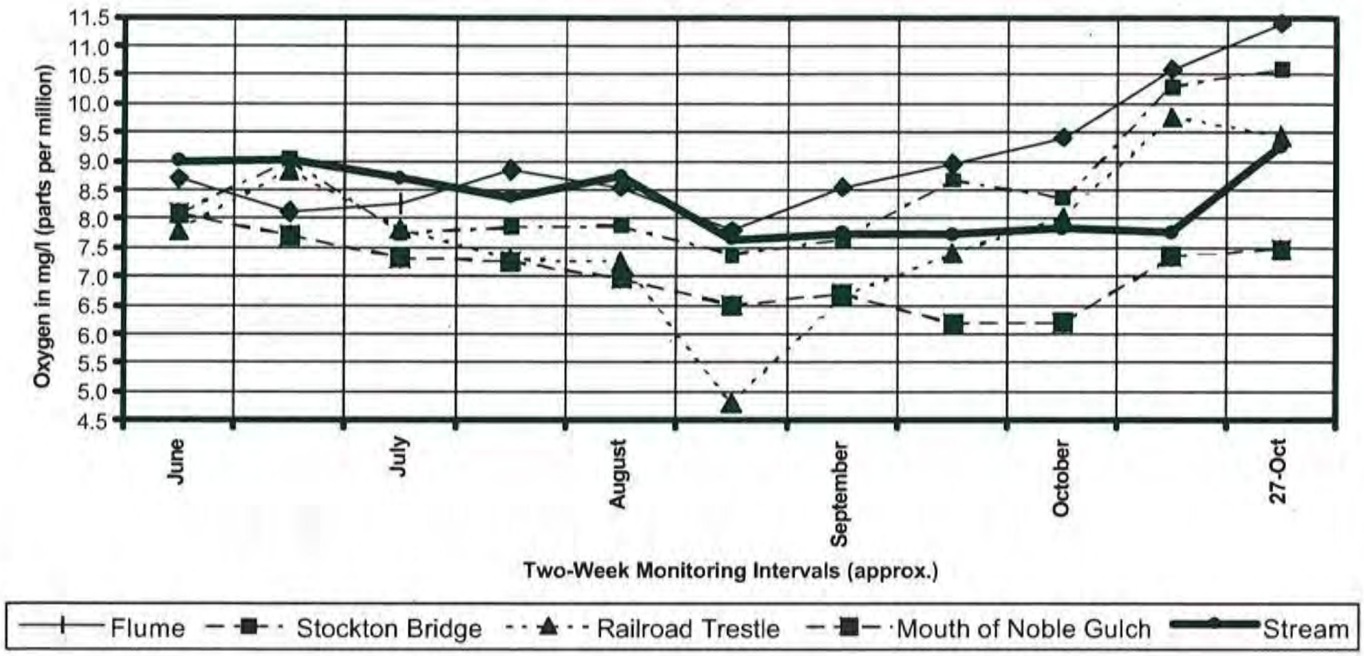


Figure 9b. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon, 9 June - 27 October 2003, Within 0.25 Meters of the Bottom Station 2, Stockton Avenue Bridge.

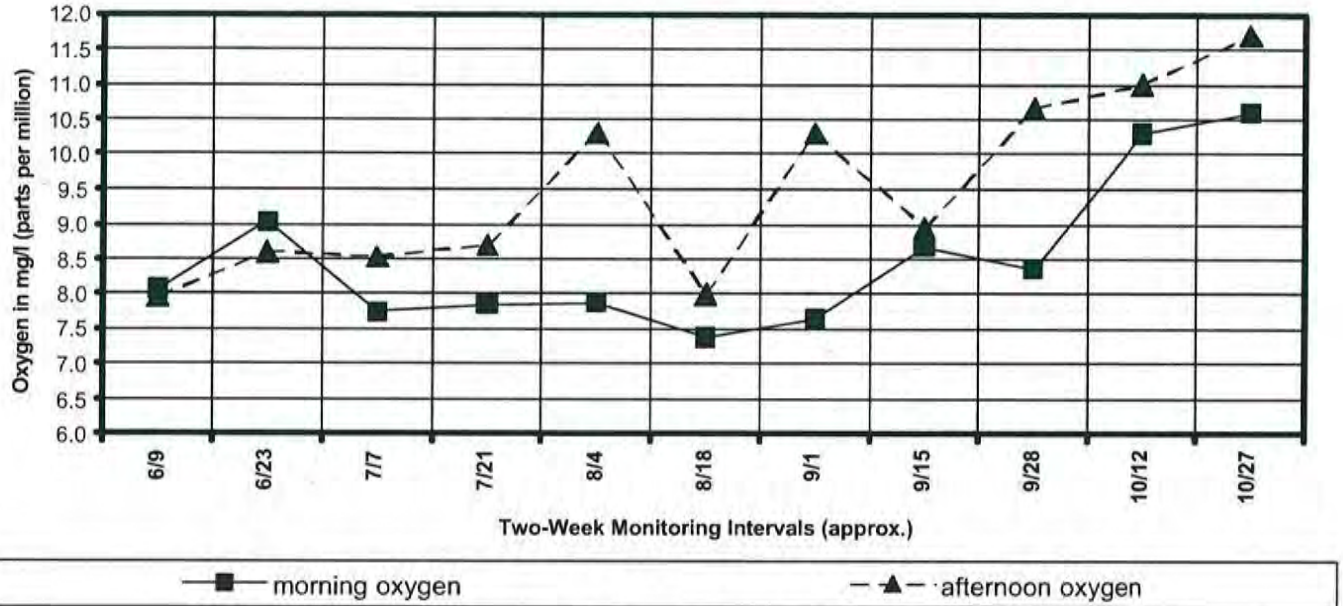


Figure 9c. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon, 9 June - 27 October 2003, Within 0.25 Meters of the Bottom Station 4, Mouth of Noble Gulch.

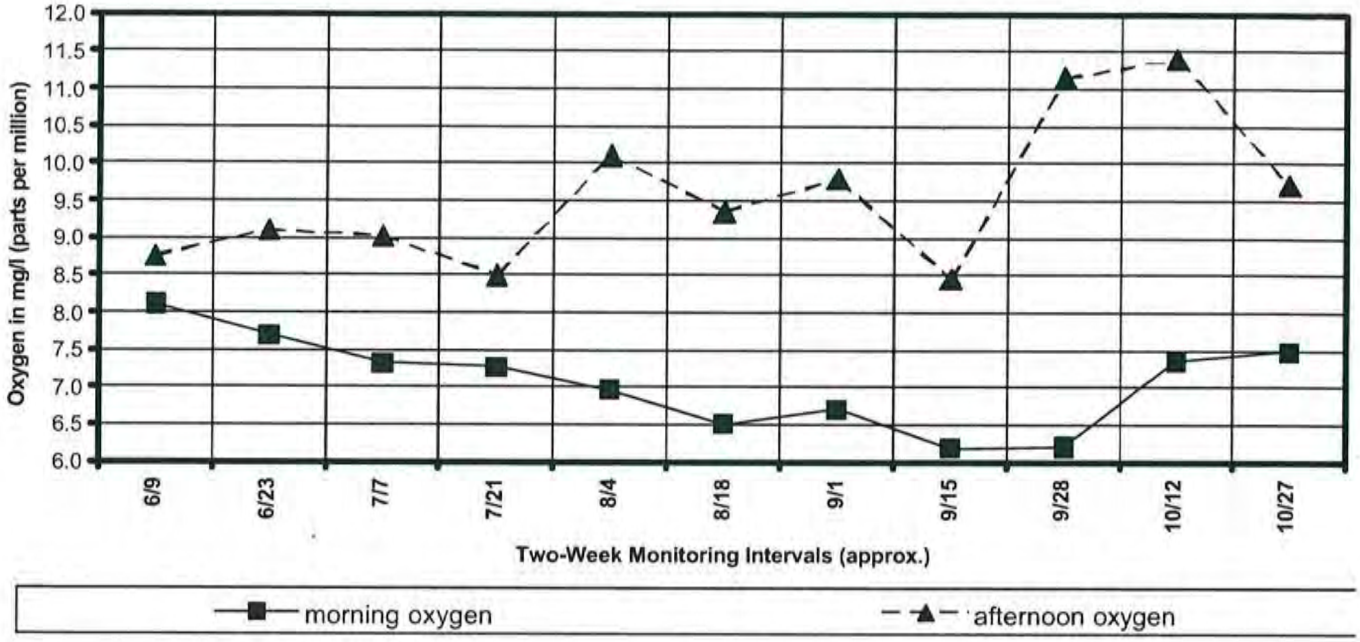


Figure 9d. Soquel Lagoon/Stream Oxygen Concentration at Dawn, 13 June - 15 October 2004, Within 0.25 Meters of the Bottom at 5 Stations.

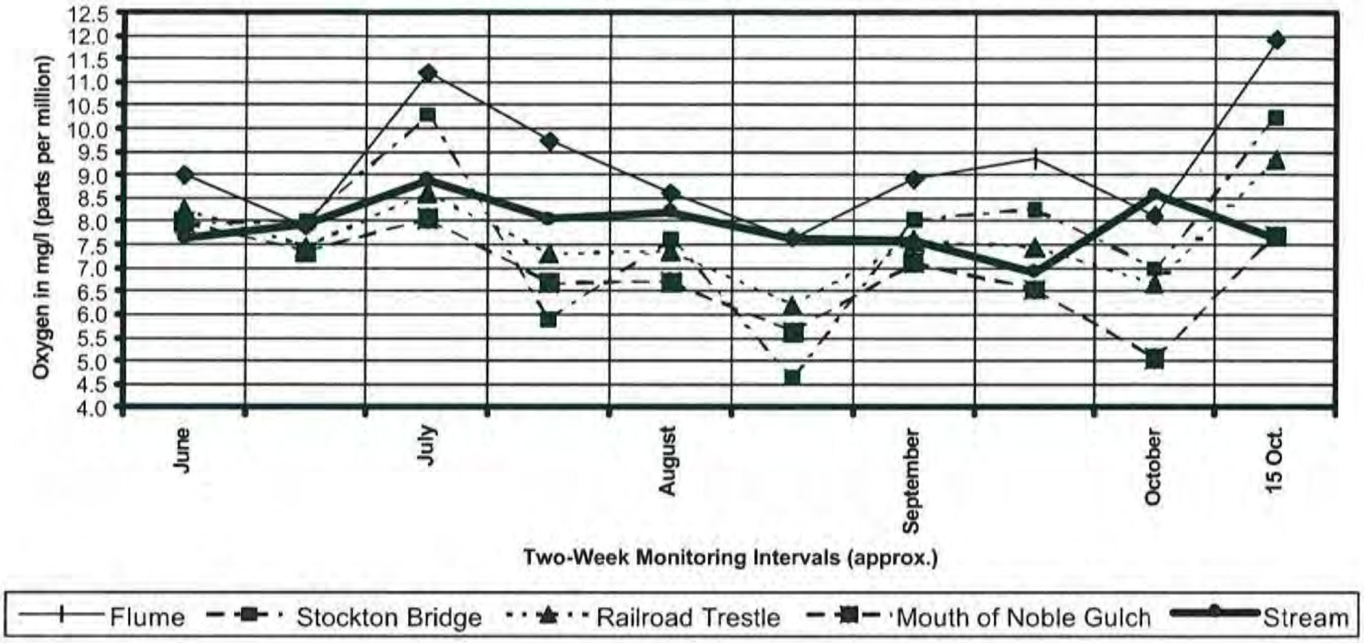


Figure 9e. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon, 13 June - 15 October 2004, Within 0.25 Meters of the Bottom at Station 2, Stockton Avenue Bridge.

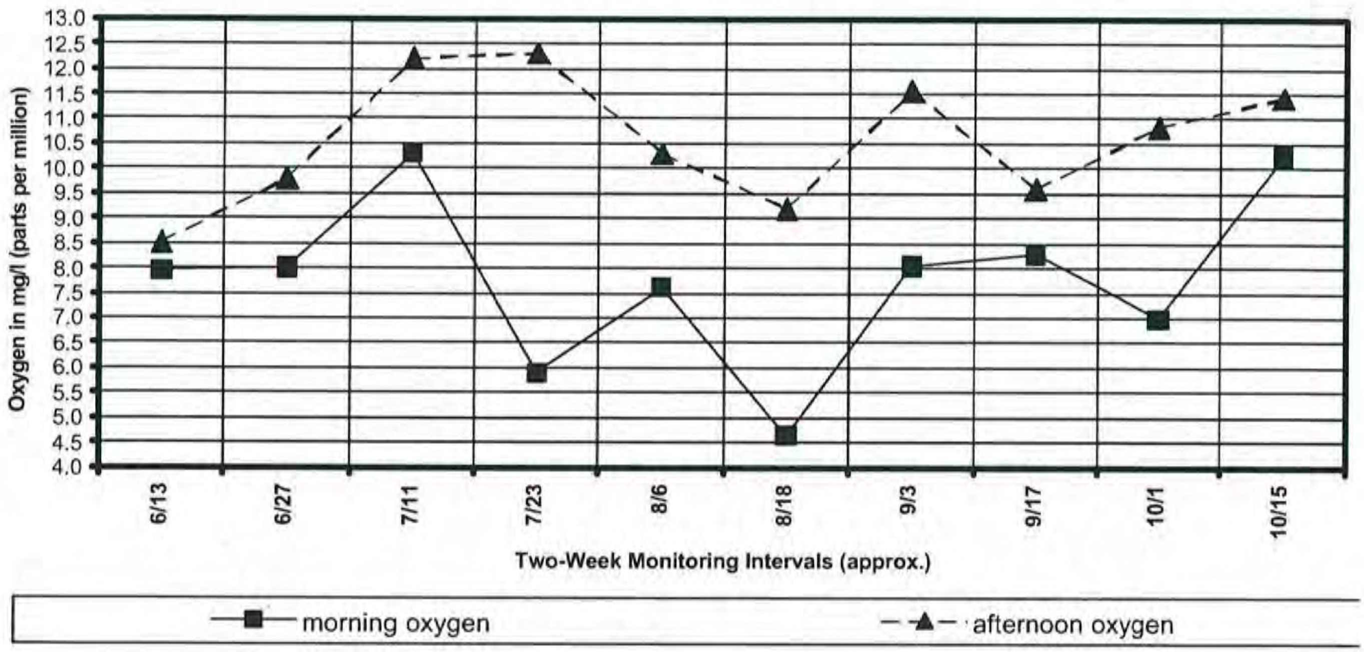


Figure 9f. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon, 13 June - 15 October 2004, Within 0.25 Meters of the Bottom at Station 4, Mouth of Noble Gulch.

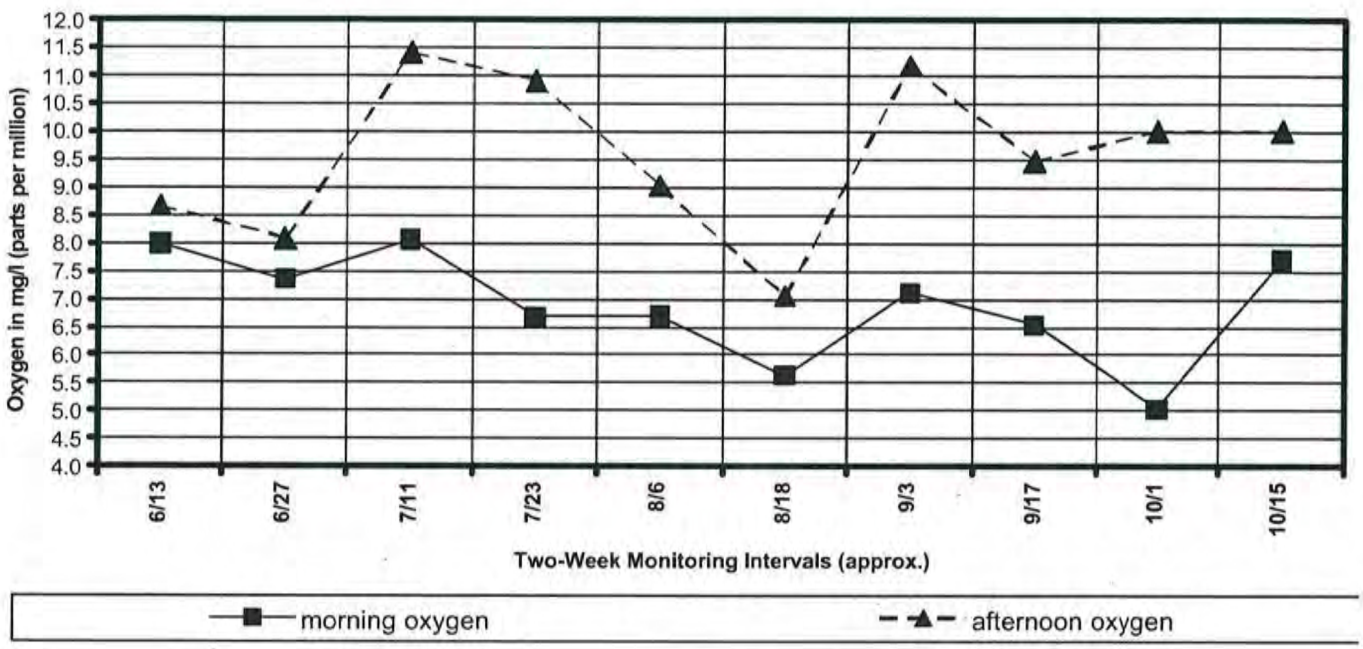


Figure 9g. Soquel Lagoon/Stream Oxygen Concentrations at Dawn Within 0.25 Meters of the Bottom at 5 Stations, 19 June - 1 December 2005.

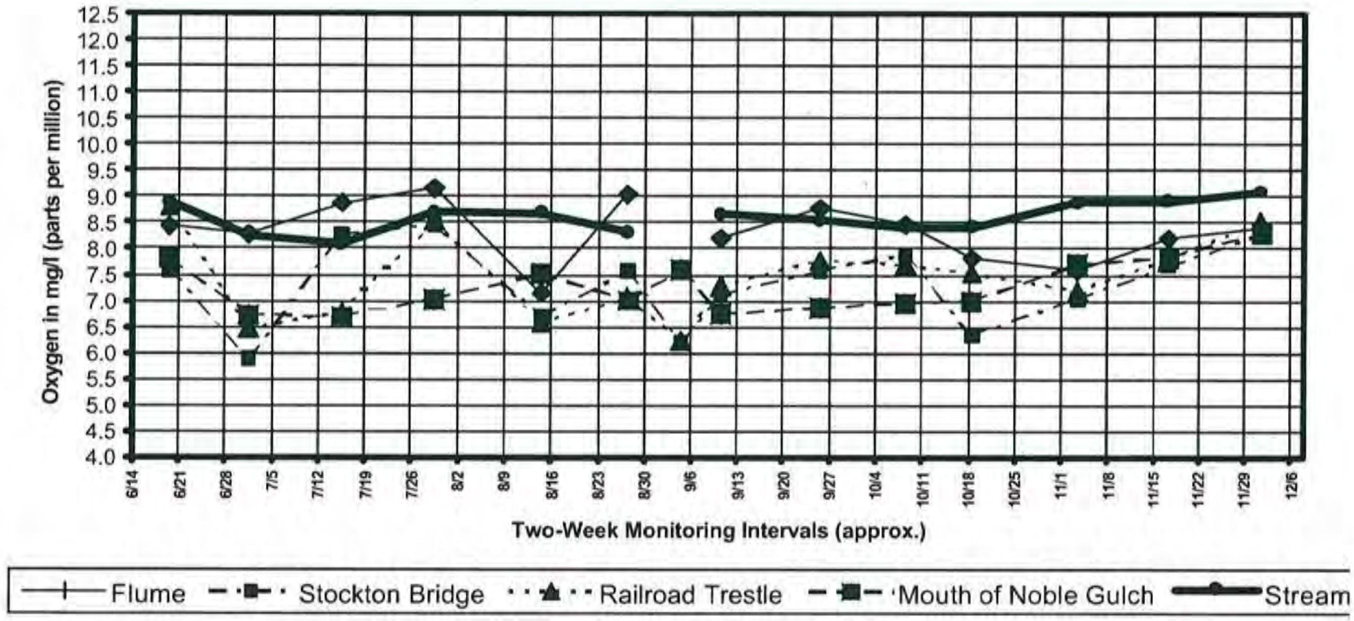


Figure 9h. Soquel Lagoon Oxygen Concentrations in the Morning and Afternoon Within 0.25 Meters of the Bottom at Station 1, the Flume, 19 June - 1 December 2005.

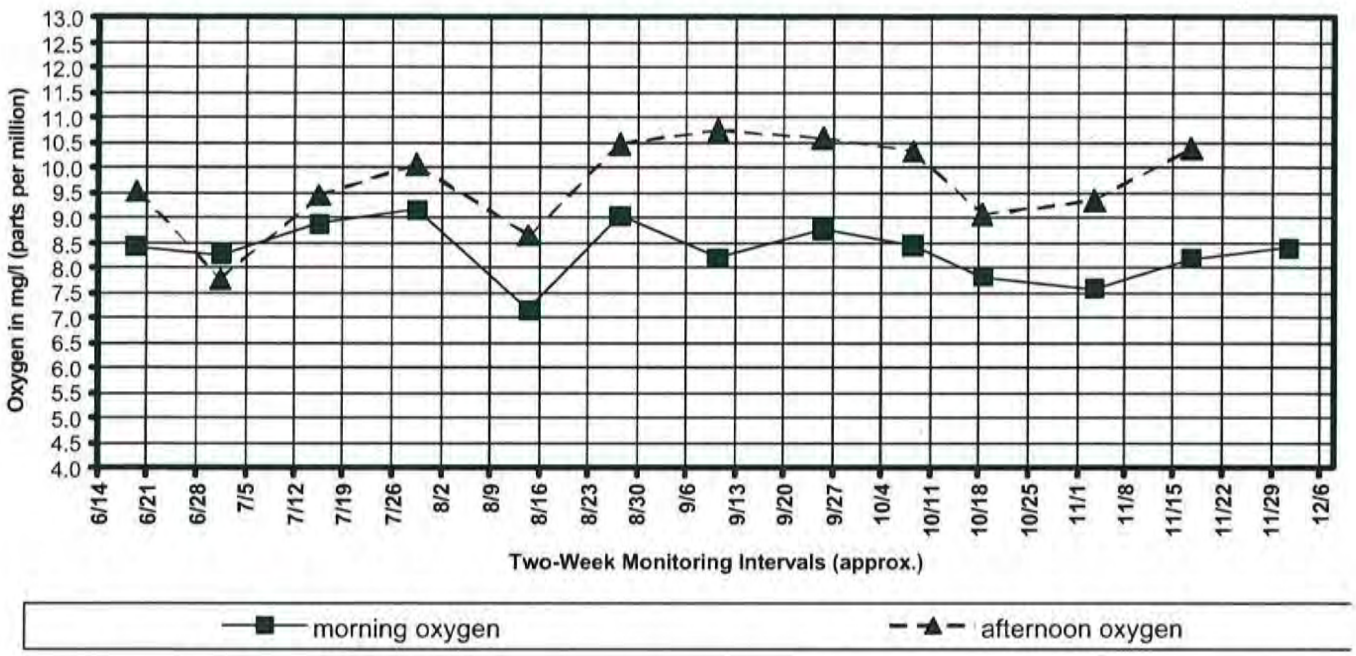


Figure 9i. Soquel Lagoon Oxygen Concentrations in the Morning and Afternoon Within 0.25 Meters of the Bottom at Station 2, Stockton Avenue Bridge, 19 June - 1 December 2005.

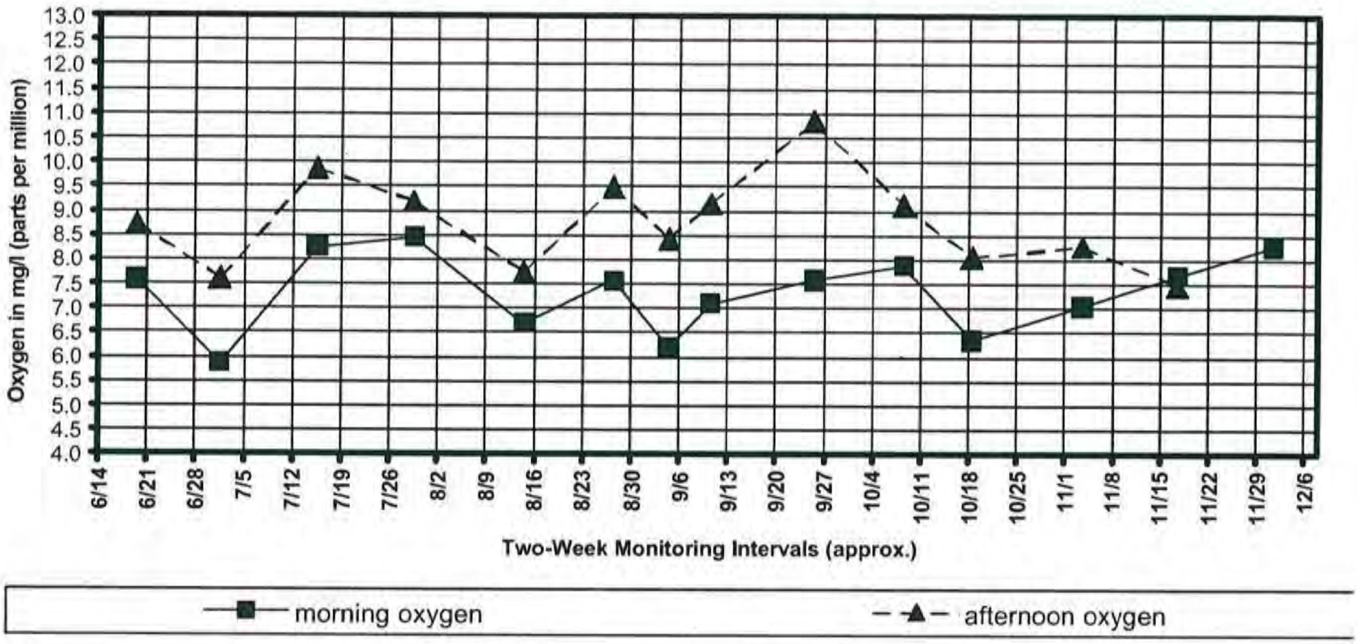


Figure 9j. Soquel Lagoon Oxygen Concentrations in the Morning and Afternoon Within 0.25 Meters of the Bottom at Station 3, the Railroad Trestle, 19 June - 1 December 2005.

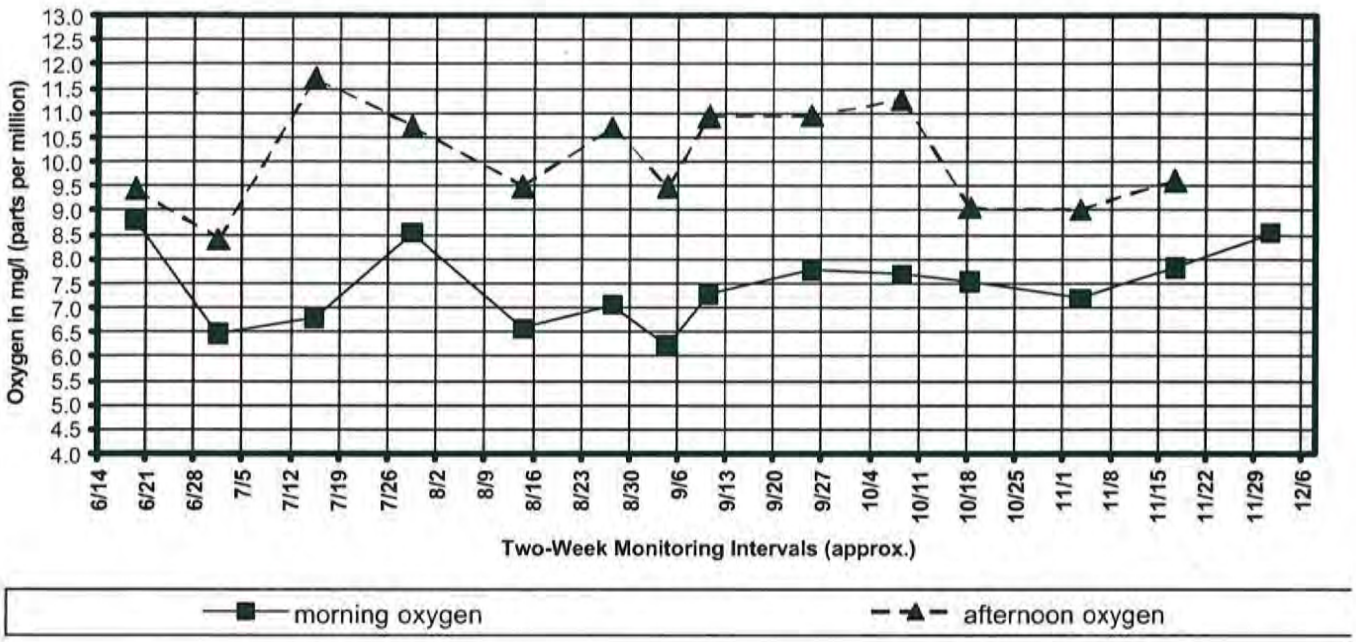


Figure 9k. Soquel Lagoon Oxygen Concentrations in the Morning and Afternoon Within 0.25 Meters of the Bottom at Station 4, Mouth of Noble Gulch, 19 June - 1 December 2005.

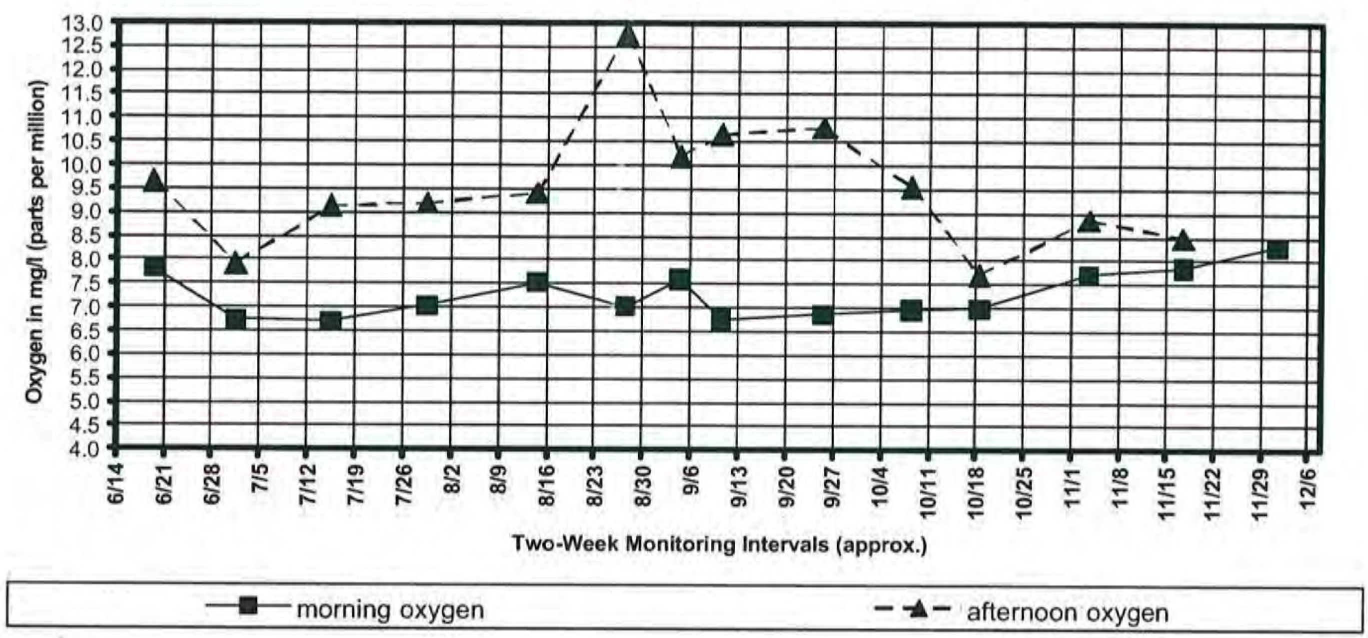


Figure 10. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 2 and 9 October 2005 in Soquel Lagoon.

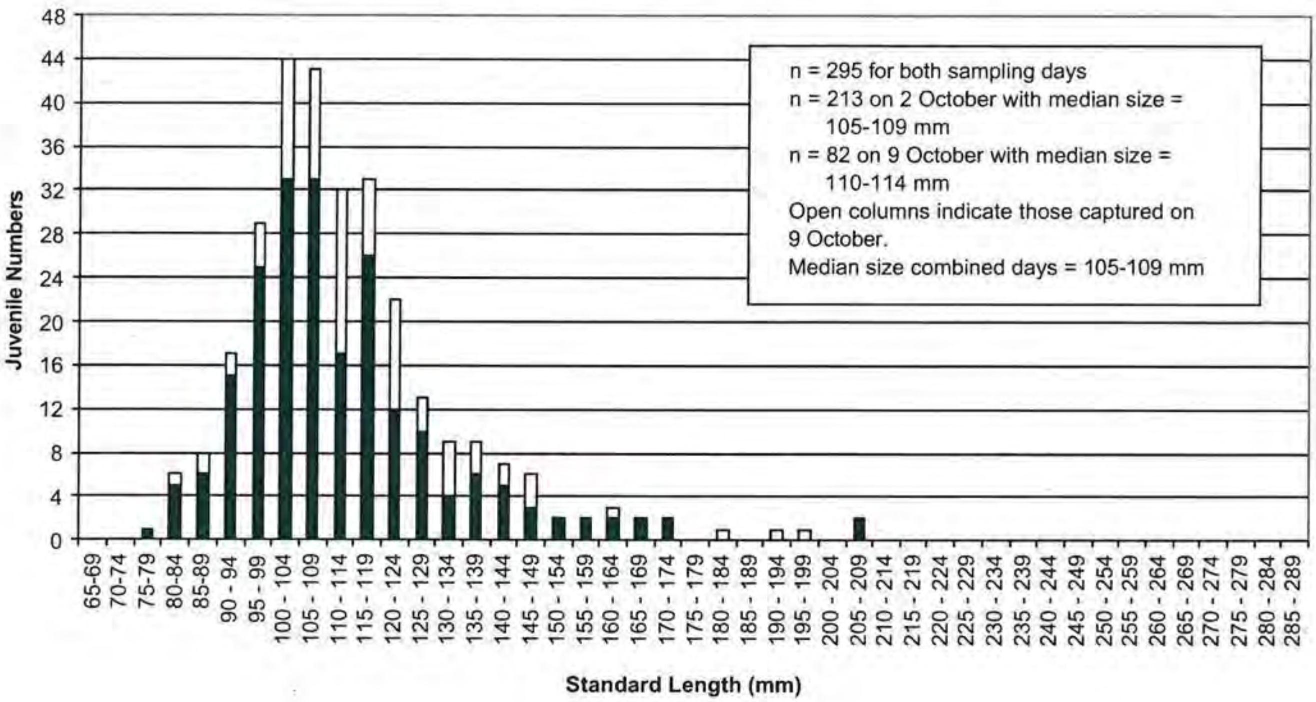


Figure 13. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 6 and 13 October 2002 in Soquel Lagoon.

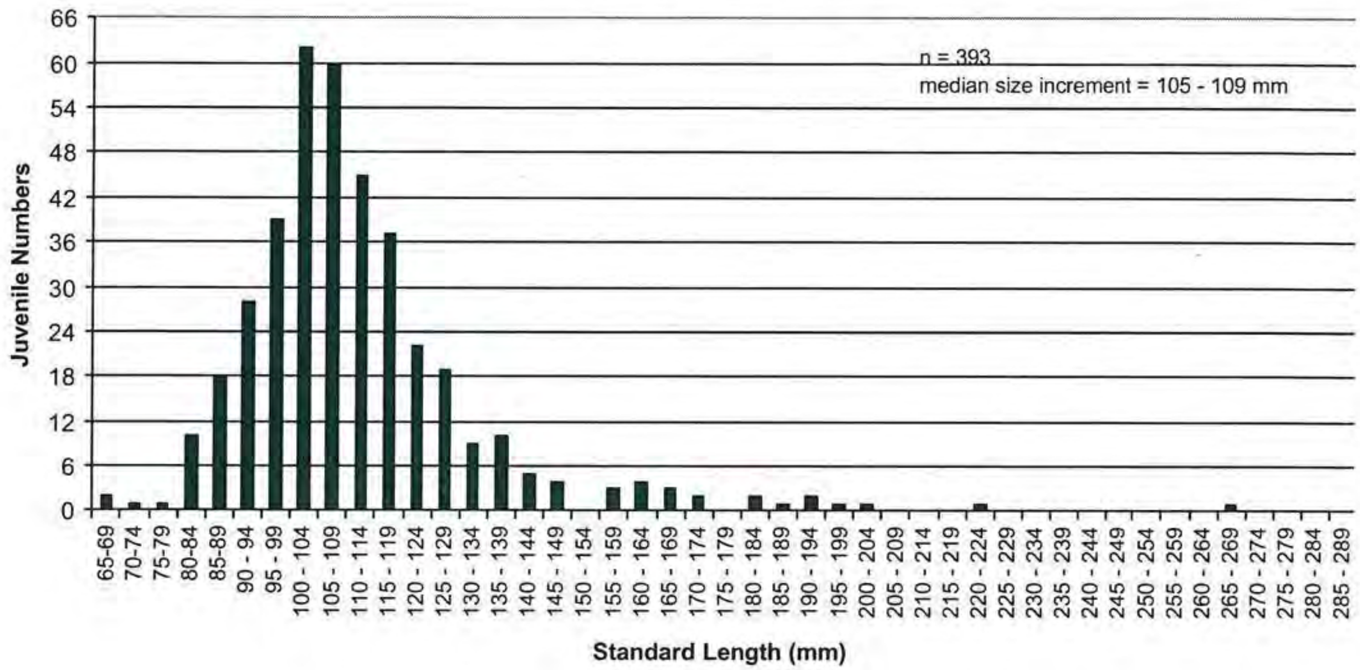


Figure 14. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 7 and 14 October 2001 in Soquel Lagoon.

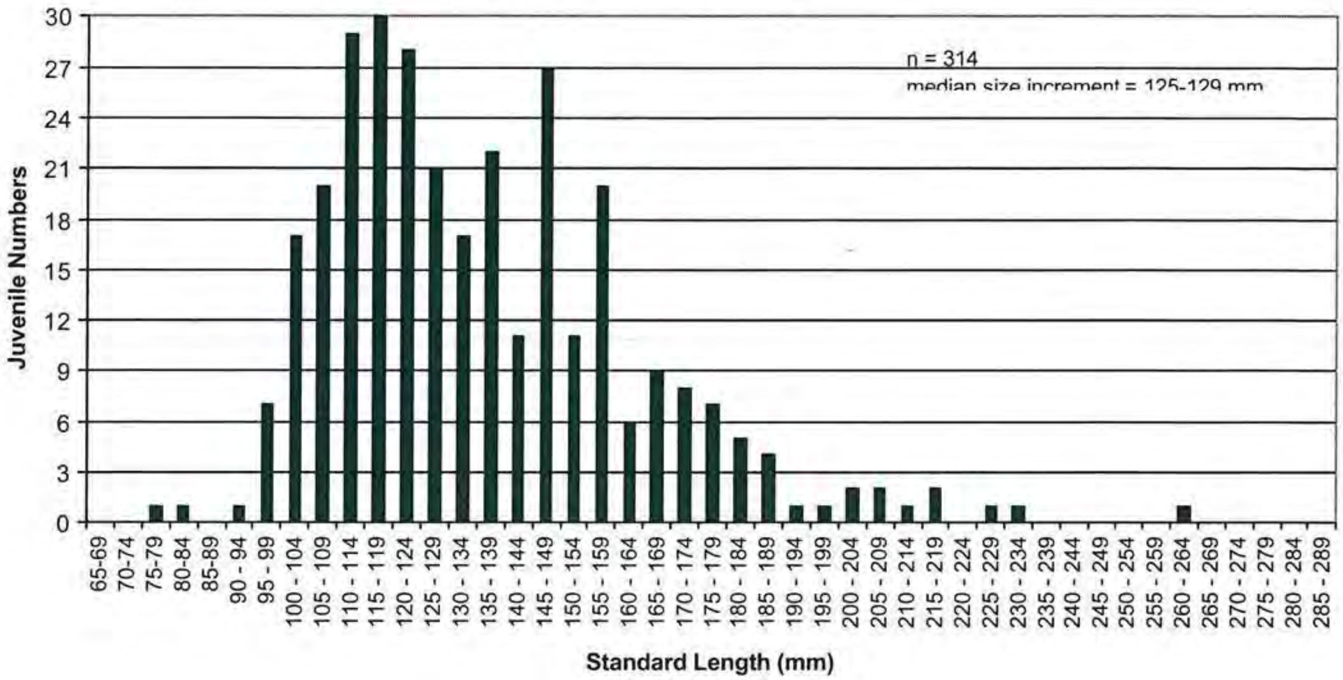


Figure 15. Size Frequency Histogram of Unmarked Juvenile St elhead Captured on 1 and 8 October 2000 in Soquel Lagoon.

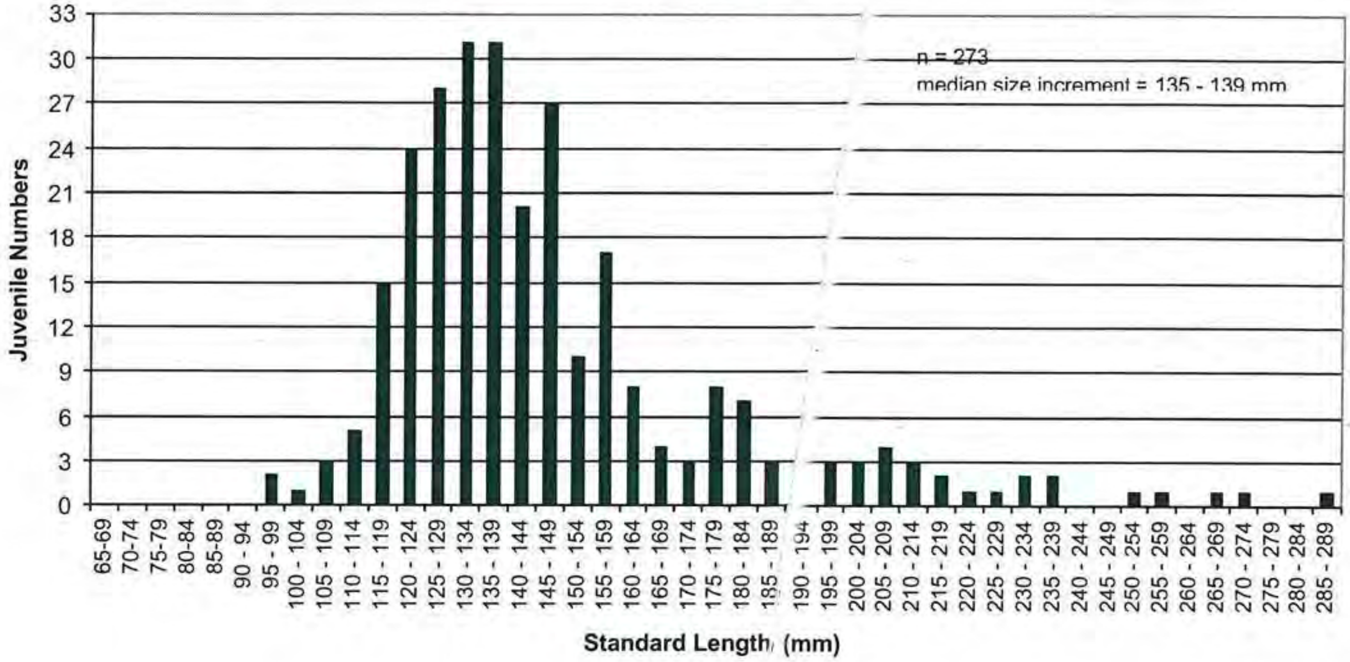


Figure 16. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 3 October 1999 (only) in Soquel Lagoon.

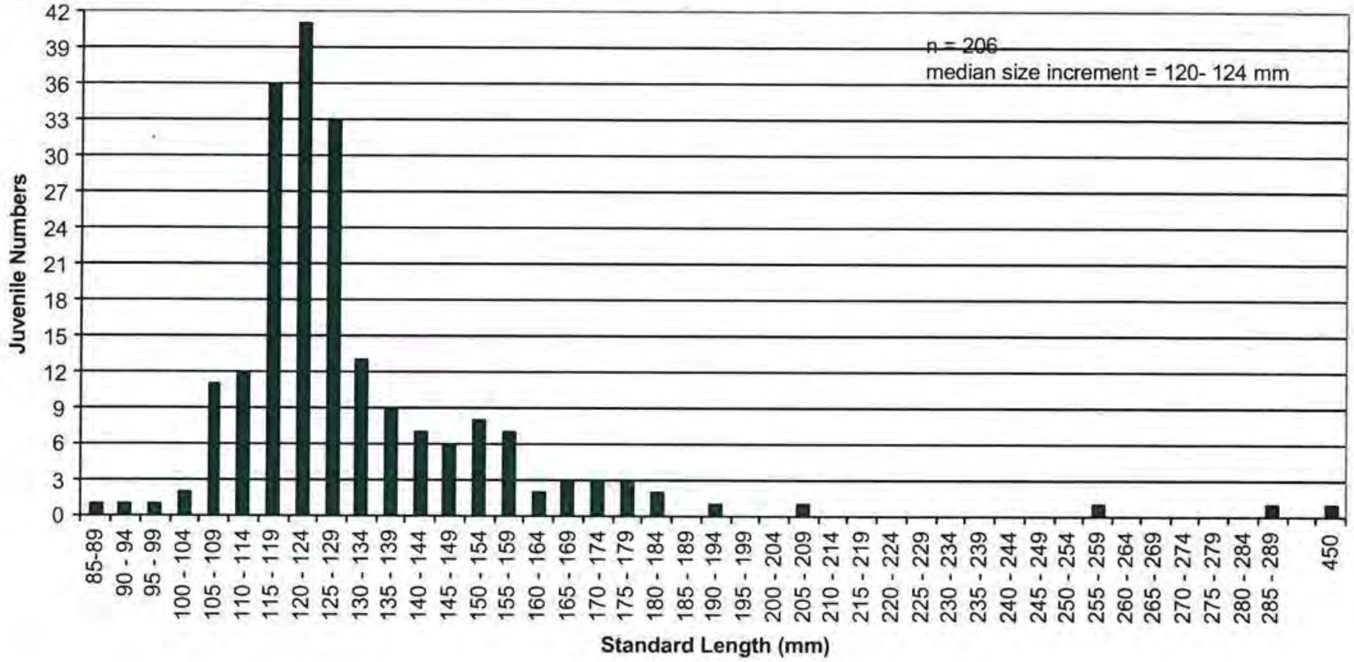


Figure 17. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 4 and 11 October 1998 in Soquel Lagoon.

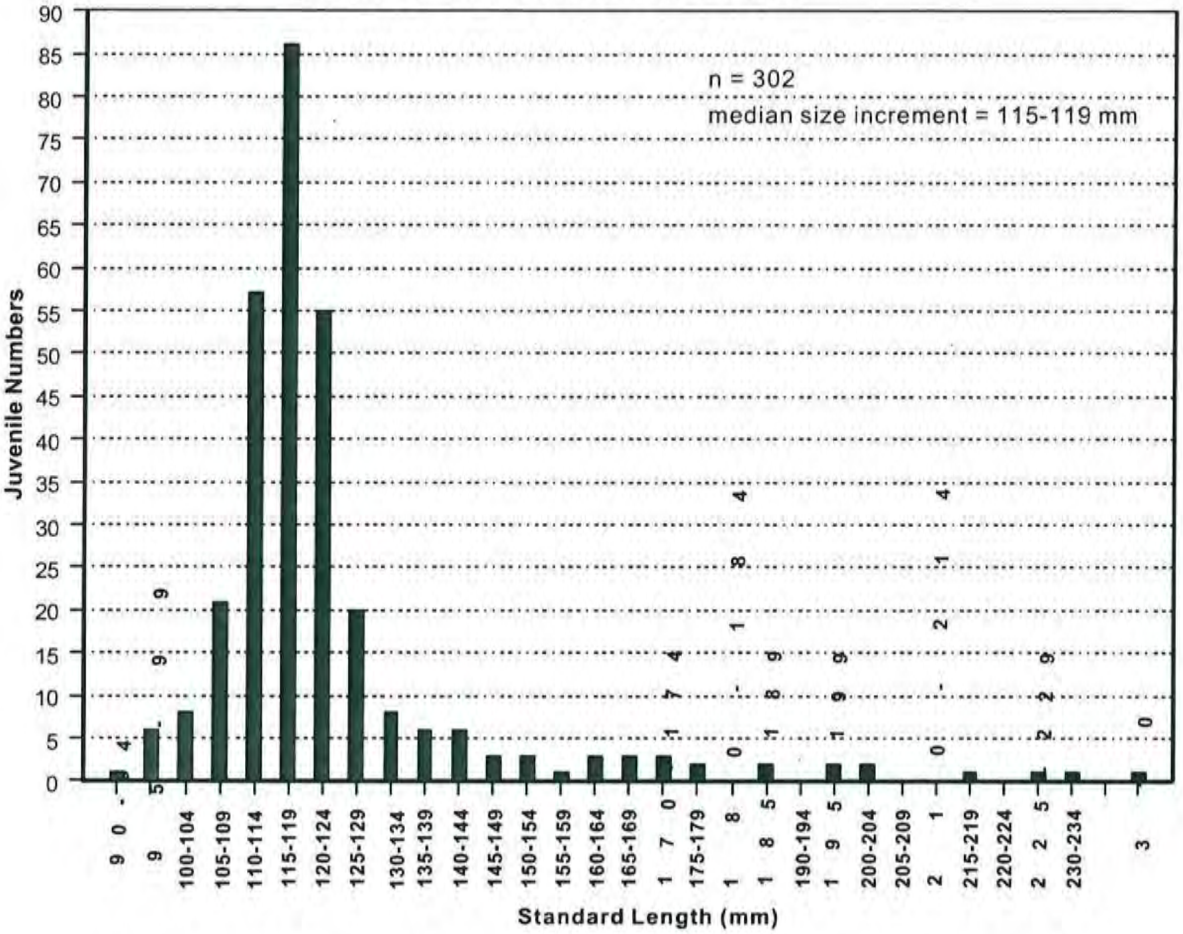
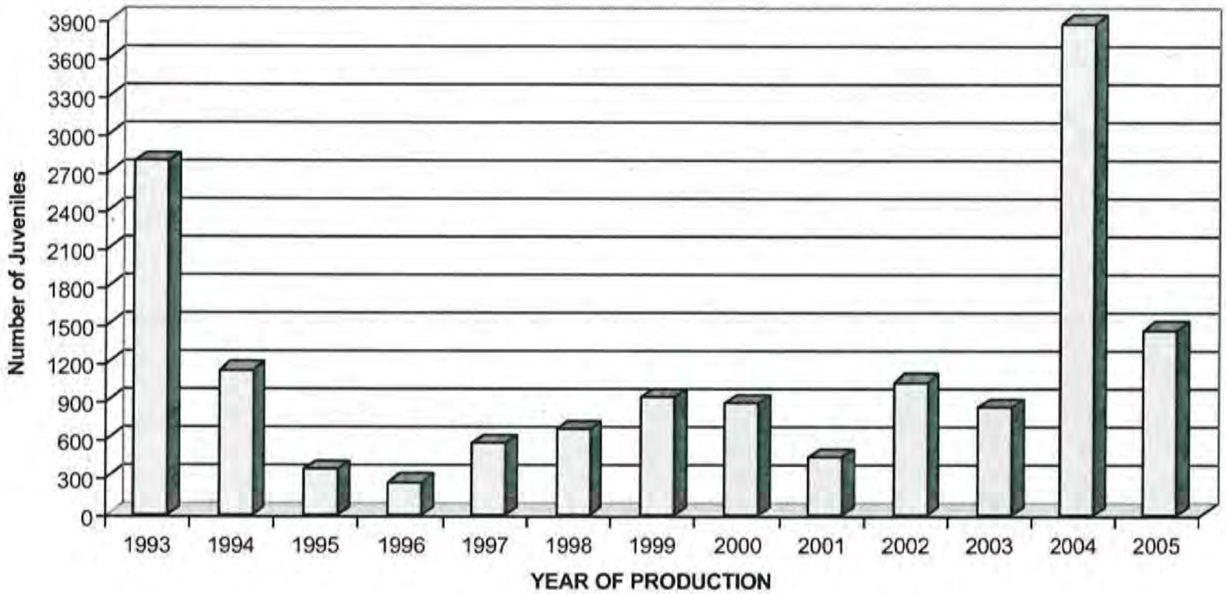


Figure 18. Juvenile Steelhead Production in Soquel Creek Lagoon, 1993-2005, Estimated by Mark and Recapture Experiment.



APPENDIX A.

WATER QUALITY DATA AND GENERAL OBSERVATIONS OF BIRDS AND AQUATIC VEGETATION 12 JUNE – NOVEMBER 2005.

10 June 2005. Launched temperature probes in the lagoon and upstream. Riffle observed just below Perry Park walk-bridge with gage height of 2.03.

	12-June-05							
	Flume Inlet				**Stockton Ave Bridge Thalweg**			1055 hr
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 Umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 Umhos**
0.00					17.8	0.4	7.61	671
0.25					17.8	0.4	7.60	671
0.50					17.6	0.4	7.36	670
0.75					17.5	0.4	7.58	670
1.00					17.5	0.4	7.36	670
1.25					16.9	0.4	7.36	669
1.50					16.7	0.4	7.71	670
1.75					16.7	0.4	5.96	671

	Railroad Trestle				**Mouth of Noble Gulch**			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 umhos**
0.00								
0.25								
0.50								
0.75								
1.00								
1.25								
1.50								

12 June 2005. Gage height 2.15. No residual saltwater detected from sandbar closure.

16 June 2005. At night in response to rain storm, Matt Kotila opened boards on both sides of the inlet and outlet with the top grate in place. The lagoon water level rose to within 6 inches of a sandbar breach at about 42 cfs flow passing through the flume. A channel had been dug through the beach, 2 bulldozers wide with a dam near the lagoon. However, the sandbar held.

	19-June-05							
	Flume Inlet 0710 hr				**Stockton Ave Bridge Thalweg** 0732 hr			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 Umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 Umhos**
0.00	16.5	0.3	8.61	548	16.2	0.3	8.01	544
0.25	16.8	0.3	8.71	548	16.2	0.3	8.34	544
0.50	16.7	0.3	8.47	549	16.2	0.3	8.10	544
0.75	16.7	0.3	8.43	550	16.2	0.3	7.87	544
Bottom1.00	16.7	0.3	5.36	548	16.2	0.3	7.92	544
1.25					16.2	0.3	7.78	545
1.50					16.2	0.3	7.59	545
Bottom1.60					16.2	0.3	3.27	545

	Railroad Trestle 0801 hr				**Mouth of Noble Gulch** 0816 hr			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 umhos**
0.00	15.7	0.3	8.76	539	15.3	0.3	8.63	521
0.25	15.6	0.3	8.96	539	15.2	0.3	9.01	525
0.50	15.6	0.3	8.81	539	15.1	0.3	8.68	536
0.75	15.6	0.3	8.84	539	15.1	0.3	8.78	536
1.00	15.6	0.3	8.79	539	15.1	0.3	7.82	537
Bottom1.25	15.6	0.3	3.92	539	15.1	0.3	2.16	537
1.50								

19 June 2005. Gage height 1.85. Weather clear. Air temperature 12.6 C at 0710 hr. Half screens in flume inlet on both sides. Flume inlet greater than 2 feet. Flume outlet greater than 2 feet. Sheet metal was in place under sidewalk grates on the Esplanade and storm drain cap in place. A sand berm had been constructed completely around the lagoon by this time.
Station 1: Flume at 0710 hr. Reach 1- no surface or bottom algae, slight phytoplankton bloom in all three reaches. 5 gulls bathing. Swallows flying overhead.
Station 2: Stockton Avenue Bridge at 0732 hr. Secchi depth to bottom. Reach 2- no surface or bottom algae. 1 mallard.
Station 3: Railroad Trestle at 0801 hr. Reach 3- no surface or bottom algae. 4 mallards roosting on trestle abutment.
Station 4: Mouth of Noble Gulch at 0816 hr. No surface or bottom algae. 2 western pond turtles on cottonwood log across lagoon. 13 mallards floating near Shadowbrook Restaurant.
Station 5: Nob Hill at 0858 hr. Water temperature 14.5°C. Conductivity 528 umhos. Oxygen 8.89 mg/l. Visible streamflow estimate of 15 cfs.

				19-Jun-05				
	Flume			1555 hr	**Stockton Avenue Bridge**			1530 hr
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 umhos**
0.00	18.4	0.3	9.12	577	18.6	0.3	8.34	580
0.25	18.3	0.3	8.88	573	18.6	0.3	8.29	579
0.50	17.9	0.3	9.22	571	18.4	0.3	8.21	578
0.75	17.5	0.3	9.53	568	18.4	0.3	8.35	573
1.00	17.4	0.3	9.48	555	17.9	0.3	9.38	571
1.10 b	17.0	0.3	7.98	550		0.3	9.12	566
1.25					17.4			
1.50					17.2	0.3	8.73	564
1.60 b					17.2	0.3	4.59	564
2.00								
2.25								

	Railroad Trestle			1510 hr	**Mouth of Noble Gulch**			1451 hr
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 umhos**
0.00	18.6	0.3	9.25	582	20.3	0.3	7.91	593
0.25	18.6	0.3	8.92	582	19.6	0.3	8.73	584
0.50	18.5	0.3	9.11	579	18.1	0.3	8.64	528
0.75	18.4	0.3	9.24	576	17.8	0.3	8.90	546
1.00	18.3	0.3	9.44	567	17.6	0.3	9.65	564
1.25 b	17.5	0.3	6.07	566	17.9	0.3	6.09	571
1.50								
1.75								

19 June 2005. Gage height of 1.94 in afternoon. Sunny. Boy observed feeding cheezits to gulls off of Stockton Avenue Bridge.

1-July-05								
	Flume			0703 hr	**Stockton Avenue Bridge**			0716 hr
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 umhos**
0.00	18.9	0.3	8.34	620	18.9	0.3	7.31	619
0.25	19.0	0.3	8.38	620	18.9	0.3	7.11	619
0.50	19.0	0.3	8.26	620	18.9	0.3	6.92	619
0.75	19.0	0.3	8.30	620	18.9	0.3	6.78	619
1.00	19.1	0.3	8.22	620	18.9	0.3	7.01	618
1.25 b	19.1	0.3	6.42	621	18.9	0.3	6.99	618
1.50					18.9	0.3	6.73	617
1.55					18.7	0.3	5.88	616
1.80 b					18.7	0.3	3.16	616
2.00								

	Railroad Trestle			0737 hr	**Mouth of Noble Gulch**			0749 hr
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 umhos**
0.00	18.7	0.3	6.86	617	18.1	0.3	6.65	610
0.25	18.7	0.3	7.07	617	18.0	0.3	6.76	609
0.50	18.7	0.3	7.00	617	17.9	0.3	6.65	609
0.75	18.7	0.3	6.95	616	17.9	0.3	6.84	608
1.00	18.4	0.3	6.49	616	17.8	0.3	6.74	609
1.25 b	18.3	0.3	6.47	614	17.6	0.3	5.07	627
1.37 b	18.3	0.3	3.46	614				

1 July 2005. Gage height of 2.39. Overcast. Air temperature of 15.4°C at 0703 hr. Flume inlet greater than 1.5 ft. Flume outlet also more than 1.5 ft.

Station 1: Flume at 0703 hr. Reach 1- no surface algae, 80% of bottom from film to 0.5 ft, averaging 0.3 feet. 21 mallards roosting on beach at Venetian Court. 6 gulls bathing.
Station 2: Stockton Avenue Bridge at 0716 hr. Secchi depth to bottom. Reach 2- no surface algae, 100% of bottom covered with algae 0.1-1.0 ft thick, averaging 0.3 ft.
Station 3: Railroad Trestle at 0737 hr. Reach 3- no surface algae, 100% of bottom from film to 0.66 ft, averaging 0.25 ft. 3 mallards roosting on trestle abutment
Station 4: Mouth of Noble Gulch at 0749hr. No surface algae, 100% of bottom from film to 0.25 ft thick. 10 mallards floating near Gulch. Gray water entering lagoon from Noble Gulch.
Station 5: Nob Hill at 0837 hr. Water temperature 16.6°C. Conductivity 588 umhos. Oxygen 8.26 mg/l.

	1-July-05								
	Flume			1625 hr	**Stockton Avenue Bridge**			1606 hr	
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 umhos**
0.00	19.1	0.3	7.64	625	19.4	0.3	7.08	628
0.25	19.1	0.3	7.60	625	19.4	0.3	7.26	628
0.50	19.1	0.3	7.79	623	19.4	0.3	7.19	628
0.75	18.9	0.3	7.69	621	19.3	0.3	7.15	628
1.00	18.9	0.3	7.77	621	19.3	0.3	7.05	627
1.25 b	18.8	0.3	4.42	618	19.2	0.3	7.28	626
1.50					19.0	0.3	7.37	624
1.75					18.9	0.3	7.60	621
1.80					18.9	0.3	1.75	621
2.25								

	Railroad Trestle			1549 hr	**Mouth of Noble Gulch**			1533 hr
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 umhos**
0.00	19.2	0.3	7.52	625	19.1	0.3	7.33	622
0.25	19.2	0.3	7.60	623	18.9	0.3	7.47	622
0.50	18.9	0.3	7.65	622	18.9	0.3	7.26	622
0.75	18.9	0.3	7.67	622	18.8	0.3	7.74	622
1.00	18.6	0.3	8.87	618	18.3	0.3	7.91	622
1.25 b	18.5	0.3	8.41	618	18.2	0.3	4.34	629
1.37 b	18.5	0.3	5.10	618				
1.50								

1 July 2005. Gage height of 2.39 in afternoon. Cloudy all day and overcast. Went to partly cloudy late in day. Air temperature of 18.1°C at 1545 hr. 48 gulls bathing in Reach 1 in afternoon. Tide incoming. 3 domestic ducks roosting on redwood stump in afternoon, slightly downstream of Noble Gulch on west side.

0714hr			15-July-05					0731hr
	Flume				**Stockton Avenue Bridge**			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 umhos**
0.00	19.6	0.4	9.02	651	19.5	0.4	9.01	648
0.25	19.7	0.4	8.95	652	19.5	0.4	9.02	647
0.50	19.7	0.4	9.03	652	19.5	0.4	8.99	647
0.75	19.7	0.4	8.97	651	19.5	0.4	8.91	647
1.00	19.7	0.4	8.88	651	19.4	0.4	8.85	646
1.15 b	19.7	0.4	7.58	650				
1.25					19.3	0.4	8.34	645
1.50					19.3	0.4	8.26	645
1.75 b					19.4	0.4	3.20	645
2.00								

0747hr			15-July-05					0801hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 umhos**
0.00	19.0	0.4	6.71	643	18.3	0.4	6.43	628
0.25	19.1	0.4	6.83	642	18.3	0.4	6.43	633
0.50	19.0	0.4	6.98	643	18.2	0.4	6.49	632
0.75	19.0	0.4	7.10	642	18.2	0.4	6.48	632
1.00	19.0	0.4	7.08	642	18.0	0.4	6.70	631
1.20					18.0	0.4	2.98	630
1.25	19.0	0.4	6.78	643				
1.35	19.1	0.4	2.72	643				

15 July 2005. Gage height of 2.05. Light fog. Air temperature of 15.5°C.

Station 1: Flume at 0714 hr. Reach 1- 23 mallards and 1 domestic goose roosting on sand at Venetian Court. No surface algae. Lighting prevented seeing bottom.
Station 2: Stockton Avenue Bridge at 0731 hr. Secchi depth to bottom. Reach 2- no surface algae. 1 cormorant present.
Station 3: Railroad Trestle at 0747 hr. Reach 3- 5% surface algae in morning.
Station 4: Mouth of Noble Gulch at 0801 hr. Domestic trio of ducks roosting on cottonwood log. 3 % surface algae in morning.
Station 5: Nob Hill at 0832 hr. Water temperature 16.9°C. Conductivity 606 umhos. Oxygen 8.08 mg/l. Streamflow visually estimated at between 6 and 8 cfs.

.1627hr			15-July-05					1606hr
	Flume				**Stockton Avenue Bridge**			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 umhos**
0.00	20.3	0.4	9.31	662	20.5	0.4	8.97	663
0.25	20.3	0.4	9.42	662	20.5	0.4	8.69	663
0.50	20.2	0.4	9.22	661	20.5	0.4	8.58	663
0.75	20.1	0.4	9.45	660	20.4	0.4	8.40	662
1.00	20.0	0.4	9.45	655	20.4	0.4	8.51	661
1.25 b	20.3	0.4	5.14	655	20.2	0.4	9.03	660
1.50					20.0	0.4	9.27	654
1.75					19.8	0.4	9.86	650
2.00					19.7	0.4	5.10	650

1547hr			15-July-05					1534hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 umhos**
0.00	20.4	0.4	9.13	663	20.9	0.4	8.21	664
0.25	20.4	0.4	9.14	662	20.8	0.4	8.23	662
0.50	20.3	0.4	9.12	662	20.3	0.4	8.53	657
0.75	20.3	0.4	9.39	661	20.0	0.4	8.57	653
1.00	20.3	0.4	9.78	660	19.7	0.4	9.13	642
1.25 b	20.1	0.4	11.71	652	19.2	0.4	5.15	642
1.50 b	20.1	0.4	7.48	654				

15 July 2005. Gage height of 2.46 at 1606 hr. Sunny with onshore breeze. Air temperature of 23.3°C at 1536 hr. Flume inlet greater than 1 ft deep. Flume outlet greater than 1 ft. deep. Plywood sheet placed over flashboards on restaurant side of flume inlet.

Station 1: Flume at 1627 hr. Reach 1- 1% surface algae, 60% bottom algae 0.2-0.6 feet, averaging 0.3 ft, with remainder a film.
Station 2: Stockton Avenue Bridge at 1642 hr. Secchi depth to bottom. Reach 2- no surface algae, 100% bottom algae 0.3-2 feet thick, averaging 0.5 ft.
Station 3: Railroad Trestle at 1547 hr. Reach 3- no surface algae, 100% bottom algae 0.3-2.5 ft thick, averaging 0.5 ft.
Station 4: Mouth of Noble Gulch at 1534 hr. 3% surface algae, 90% bottom algae 0.1-2.0 thick, averaging 0.5 ft. 5 ducks, 1 goose and 1 western pond turtle on cottonwood log across from the Gulch. 7 ducks in water nearby.

0658hr			29-Jul-05					0712hr
	Flume				Stockton Avenue Bridge			
Depth (m)	Temp 1 (C)	Salin 1 (ppt)	O2 1 (mg/l)	Cond 1 umhos	Temp 2 (C)	Salin 2 (ppt)	O2 2 (mg/l)	Cond 2 Umhos
0.00	19.2	0.4	9.46	659	19.1	0.4	8.87	657
0.25	19.2	0.4	9.41	659	19.1	0.4	8.77	657
0.50	19.2	0.4	9.44	659	19.1	0.4	8.61	657
0.75	19.2	0.4	9.17	659	19.1	0.4	8.37	657
1.00	19.3	0.4	9.16	659	19.1	0.4	8.78	657
1.25 b	19.3	0.4	8.18	659	19.1	0.4	8.58	656
1.50					18.9	0.4	8.03	655
1.75					18.9	0.4	8.46	655
1.95					18.9	0.4	3.46	655

0734hr			29-Jul-05					0750hr
	Railroad Trestle				Mouth of Noble Gulch			
Depth (m)	Temp 3 (C)	Salin 3 (ppt)	O2 3 (mg/l)	Cond 3 umhos	Temp 4 (C)	Salin 4 (ppt)	O2 4 (mg/l)	Cond 4 Umhos
0.00	18.9	0.4	8.53	655	18.5	0.4	7.32	654
0.25	18.9	0.4	8.59	655	18.6	0.4	7.33	654
0.50	18.9	0.4	8.49	655	18.6	0.4	7.45	654
0.75	18.8	0.4	8.21	652	18.6	0.4	7.26	654
1.00	18.7	0.4	8.49	653	18.5	0.4	7.03	650
1.25 b	18.7	0.4	8.53	653	17.9	0.4	3.51	638
1.50 b	18.7	0.4	3.08	653				

29 July 2005. Gage height of 2.59 morning with water spilling over grate at flume inlet. Air temperature of 16.3°C at 0658 hr. Flume inlet 1.2 ft depth. 7 steelhead surface hits/ minute near Noble Gulch at 0800 hr. 105 hits/ minute above Stockton Avenue Bridge at 0735 hr.
Station 1: Flume at 0658 hr. Reach 1- No surface algae. 10 mallards roosting on sand adjacent Venetian Court early and 21 mallards later on. 1 goose with mallards. 13 Gulls bathing.
Station 2: Stockton Avenue Bridge at 0712 hr. Secchi depth to bottom. Reach 2- no surface algae. 1 pied-billed grebe present with 6 mallards.
Station 3: Railroad Trestle at 0734 hr. Reach 3- 10% surface algae in morning between trestle and Shadowbrook Restaurant and none upstream. **Heard bullfrog on west side near palm tree.**
Station 4: Mouth of Noble Gulch at 0750 hr. <1% surface algae. 2 mallards roosting on cottonwood log.

Station 5: Nob Hill at 0821 hr. Water temperature 16.8°C. Conductivity 621 umhos. Oxygen 8.71 mg/l. Streamflow visually estimated at 8 cfs. Greenback heron observed near Nob Hill.

1559 hr			29-Jul-05					1538 hr
	Flume				**Stockton Avenue Bridge**			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 Umhos**
0.00	20.1	0.4	9.65	671	20.2	0.4	8.92	662
0.25	20.1	0.4	9.64	671	20.2	0.4	8.91	662
0.50	20.0	0.4	9.73	667	20.1	0.4	8.89	662
0.75	19.9	0.4	9.73	666	20.0	0.4	8.48	660
1.00	19.8	0.4	10.07	664	20.0	0.4	8.53	660
1.25 b	20.0	0.4	5.76	655	20.0	0.4	8.93	657
1.50					19.7	0.4	9.08	653
1.75					19.6	0.4	9.18	653
2.00 b					19.6	0.4	4.24	653

1524hr			29 Jul-05					1509hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 Umhos**
0.00	20.1	0.4	8.91	671	21.0	0.4	11.1	666
0.25	20.0	0.4	9.15	669	20.7	0.4	11.3	660
0.50	20.0	0.4	9.09	667	20.2	0.4	11.1	653
0.75	19.9	0.4	9.01	666	19.2	0.4	11.2	642
1.00	19.9	0.4	9.08	660	18.9	0.4	11.6	638
1.25 b	19.3	0.4	10.73	659	19.0	0.4	11.4	634
1.50 b	19.4	0.4	5.16	659				

29 July 2005. Gage height of 2.61 at 1536 hr. Sunny. Air temperature of 18.5°C at 1518 hr. Flume inlet 1.2 ft. Flume outlet 1.5 ft with incoming tide.
Station 1: Flume at 1559 hr. Reach 1- 33 gulls bathing and 1 mallard swimming. <1% surface algae. 80% of bottom with algae 0.5-2 feet thick, averaging 1.0 ft.
Station 2: Stockton Avenue Bridge at 1538 hr. Secchi depth to bottom. Reach 2- less than 1% surface algae. 90% bottom algae 0.3- 3 ft thick, averaging 1 ft.
Station 3: Railroad Trestle at 1524 hr. Reach 3- 3% surface algae blown to margin, 80% bottom algae 0.2- 3 ft thick, averaging 0.5 ft. 1 pied-billed grebe and 1 mallard near trestle in water and more near Noble Gulch
Station 4: Mouth of Noble Gulch at 1509 hr. <1% surface algae, 60% bottom algae 0.2-0.8 ft thick, averaging 0.4 ft. 16 ducks (mostly mallards with some domestic) and 1 pied-billed grebe in Reach 3 downstream of Noble Gulch. 5 ducks adjacent Shadowbrook Restaurant.

0706 hr			14-Aug-05					0717 hr
	Flume				Stockton Avenue Bridge			
Depth (m)	Temp 1 (C)	Salin 1 (ppt)	O2 1 (mg/l)	Cond 1 umhos	Temp 2 (C)	Salin 2 (ppt)	O2 2 (mg/l)	Cond 2 umhos
0.00	18.2	0.4	7.76	657	18.3	0.4	7.74	657
0.25	18.3	0.4	7.89	657	18.3	0.4	7.62	657
0.50	18.3	0.4	7.84	657	18.4	0.4	7.54	657
0.75	18.3	0.4	7.90	665	18.4	0.4	7.70	656
1.00	18.3	0.4	7.15	665	18.3	0.4	7.24	655
1.25 b	18.2	0.4	5.16	655	18.2	0.4	6.60	652
1.50					17.8	0.4	6.68	648
1.75					17.8	0.4	6.70	648
1.95 b					17.8	0.4	4.22	648

0740hr			14-Aug-05					0754 hr
	Railroad Trestle				Mouth of Noble Gulch			
Depth (m)	Temp 3 (C)	Salin 3 (ppt)	O2 3 (mg/l)	Cond 3 umhos	Temp 4 (C)	Salin 4 (ppt)	O2 4 (mg/l)	Cond 4 umhos
0.00	18.2	0.4	7.85	656	17.5	0.4	7.41	644
0.25	18.2	0.4	7.71	655	17.5	0.4	7.38	644
0.50	18.2	0.4	7.78	655	17.5	0.4	7.26	642
0.75	18.2	0.4	7.63	650	17.4	0.4	7.31	633
1.00	18.1	0.4	6.64	647	17.2	0.4	7.52	619
1.25 b	17.6	0.4	6.58	648	17.2	0.4	2.87	617
1.50 b	17.6	0.4	2.95	648				

14 August 2005. Gage height of 2.56 (morning) and 2.54 (afternoon). Overcast and misty at 0706 hr with air temperature at 15.7°C. Air temperature 18.7°C at 1502 hr with it cool and overcast the entire day. Flume entrance greater than 1.2 ft. Flume exit at 1.5 ft with incoming tide in afternoon.

Station 1: Flume at 0706 hr and 1558 hr. Reach 1- no surface algae. Could not see lagoon bottom except near the flume where there were 0.5 ft high tufts of algae over 10% of the bottom with a film elsewhere. In afternoon, 67 gulls bathing.
Station 2: Stockton Avenue Bridge at 1535 hr. Secchi depth to the bottom probably. Reach 2- No surface algae. 85% of bottom covered by algae but could not observe more with it overcast and breezy. 55 gulls and 61 pigeons roosting on restaurant roofs.
Station 3: Railroad trestle at 1515 hr. Reach 3- no surface algae. 60% of bottom covered by algae and height unknown. No birds in vicinity of trestle but congregated by Noble Gulch.
Station 4: Mouth of Noble Gulch at 1500 hr. No surface algae. 95% of bottom covered by algae 0.3-2.5 ft thick, averaging 2.0 ft. 12 ducks (mostly mallards) roosting on cottonwood log and redwood stump across from Noble Gulch. 10 mallards floating adjacent Shadowbrook Restaurant with wedding occurring.
Station 5: Nob Hill at 0824 hr. Water temperature at 15.9°C. Conductivity 619 umhos, Oxygen 8.68 mg/l. Visually estimated flow of 6.5 cfs.

1558 hr			14-Aug-05					1535 hr
	Flume				**Stockton Avenue Bridge**			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 Umhos**
0.00	18.4	0.4	8.14	659	18.5	0.4	7.65	660
0.25	18.4	0.4	7.84	659	18.5	0.4	7.44	660
0.50	18.4	0.4	8.14	656	18.5	0.4	7.49	660
0.75	18.3	0.4	8.26	656	18.5	0.4	7.58	659
1.00	18.3	0.4	8.65	655	18.4	0.4	7.69	658
1.25 b	18.4	0.4	5.62	654	18.2	0.4	8.11	655
1.50					18.1	0.4	8.42	651
1.75					18.0	0.4	7.74	650
1.95 b					18.0	0.4	3.63	651

1515hr			14-Aug-05					1500 hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 umhos**
0.00	18.4	0.4	8.40	656	18.5	0.4	7.78	656
0.25	18.3	0.4	8.37	656	18.3	0.4	7.57	655
0.50	18.3	0.4	7.95	656	18.2	0.4	7.77	653
0.75	18.3	0.4	8.28	656	18.0	0.4	7.81	641
1.00	18.3	0.4	8.24	655	17.1	0.4	9.41	637
1.25 b	18.0	0.4	9.49	643	17.2	0.4	6.68	639
1.50 b	18.0	0.4	4.56	643				

0735hr			27-Aug-05					0749hr
	Flume				**Stockton Avenue Bridge**			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 umhos**
0.00	18.3	0.4	9.01	661	18.2	0.4	8.02	661
0.25	18.3	0.4	9.12	661	18.2	0.4	8.23	661
0.50	18.4	0.4	9.15	661	18.3	0.4	8.08	661
0.75	18.4	0.4	9.14	661	18.3	0.4	8.24	660
1.00	18.4	0.4	9.04	661	18.3	0.4	8.27	660
1.25 b	18.4	0.4	6.34	648	18.3	0.4	8.17	660
1.50					18.3	0.4	7.97	661
1.75					18.3	0.4	7.57	662
1.95 b					18.3	0.4	3.28	662

0809hr			27-Aug-05					0823hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 umhos**
0.00	17.9	0.4	7.29	658	17.4	0.4	7.12	
0.25	18.0	0.4	7.36	658	17.4	0.4	7.02	
0.50	18.0	0.4	7.37	658	17.5	0.4	6.91	
0.75	18.0	0.4	7.23	658	17.5	0.4	6.84	
1.00	18.0	0.4	7.26	658	17.4	0.4	7.01	
1.25 b	18.0	0.4	7.06	658	17.0	0.4	3.06	
1.50 b	18.0	0.4	3.08	659				

27 August 2005. Gage height of 2.50 (morning) and 2.51 (afternoon). Clear. Air temperature of 14.0°C at 0735 hr and 18.6°C at 1521 hr. Flume inlet at 1.2+ ft. Flume outlet at 1.0+ feet with incoming tide. Overcast and calm in the morning and sunny in the afternoon.

Station 1: Flume at 0735 hr. Reach 1- 9 gulls bathing and 300+ gulls on beach. 1 merganser feeding at 0840 hr. Flume at 1600 hr. Reach 1- No surface algae. 1% pondweed 3-4 ft tall. 35% of bottom with algae averaging 1 ft thick and film over remainder. Poor visibility. 75 gulls bathing.
Station 2: Stockton Avenue Bridge at 1535 hr. Secchi depth to bottom. Reach 2- no surface algae. 95% of bottom covered with algae 0.6-2 ft thick, averaging 1 ft: remainder has film.
Station 3: Railroad trestle at 0809 hr. 5 mallards and 1 domestic duck near trestle. At 1520 hr in Reach 3- No surface algae. 100% of bottom covered with algae 0.5- 2.5 ft thick, averaging 1.5 ft. A cormorant present.
Station 4: Mouth of Noble Gulch at 0823 hr. 15 mallards floating near Gulch. 5 mallards and a domestic goose roosting on cottonwood log. At 1511 hr at Gulch mouth- No surface algae. 100% of bottom covered by algae 2- 4.5 ft thick, averaging 4.0 ft.
Station 5: Nob Hill at 0853 hr. Water temperature 15.6°C. Oxygen 8.31 mg/l. Conductivity 620 umhos.

1600hr			27-Aug-05					1535hr
	Flume				**Stockton Avenue Bridge**			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 umhos**
0.00	19.7	0.4	9.85	677	19.8	0.4	9.69	
0.25	19.7	0.4	10.11	677	19.8	0.4	9.42	
0.50	19.5	0.4	10.67	674	19.6	0.4	9.11	
0.75	19.5	0.4	10.84	673	19.6	0.4	9.07	
1.00	19.3	0.4	10.48	674	19.5	0.4	9.24	
1.25 b	19.3	0.4	8.16	673	19.4	0.4	9.33	
1.50					19.0	0.4	9.53	
1.75					18.9	0.4	9.49	
2.00 b					18.9	0.4	4.63	

1520hr			27-Aug-05					1507hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 umhos**
0.00	20.0	0.4	9.46	687	20.8	0.4	9.26	
0.25	20.0	0.4	9.63	686	20.6	0.4	9.08	
0.50	20.0	0.4	9.34	685	20.1	0.4	9.28	
0.75	19.9	0.4	9.35	675	19.4	0.4	9.33	
1.00	19.6	0.4	12.09	664	18.4	0.4	12.78	
1.25 b	18.7	0.4	10.71	664	18.4	0.4	6.62	
1.50 b	18.6	0.4	5.37	664				

	04-Sep-05								0930hr
	Flume				**Stockton Avenue Bridge**				
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 Umhos**	
0.00					18.0	0.4	7.88	661	
0.25					18.0	0.4	7.57	662	
0.50					18.0	0.4	7.46	661	
0.75					18.0	0.4	7.70	660	
1.00					18.0	0.4	7.70	656	
1.25					17.5	0.4	6.32	654	
1.50					17.4	0.4	6.27	653	
1.75					17.4	0.4	6.20	653	
1.95 b					17.5	0.4	2.80	653	

1005 hr	04-Sep-05								1015hr
	Railroad Trestle				**Mouth of Noble Gulch**				
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 Umhos**	
0.00	17.9	0.4	7.38	660	17.5	040	8.35	652	
0.25	18.0	0.4	7.38	660	17.4	0.4	7.94	652	
0.50	18.0	0.4	7.65	660	17.1	0.4	7.62	650	
0.75	17.9	0.4	7.51	659	16.7	0.4	7.38	647	
1.00	17.7	0.4	7.85	657	16.8	0.4	7.60	646	
1.25 b	17.5	0.4	6.24	653	16.8	0.4	3.29	646	
1.50 b	17.2	0.4	3.11	650					

04 September 2005. Begonia Festival Day. Gage height of 2.48 (morning) and 2.48 (afternoon). Overcast, cool and breezy in morning with sun becoming visible by 1035 hr and sunny by afternoon. 5 floats and 21 other boats in water. None of the floats were propelled by wading this year. The lagoon bottom was left undisturbed. Float 1 propelled by 2 surfers on surf boards. Float 2 propelled by 2 kayakers in kayaks. Flat 3 propelled by 3 rowers in 1 canoe. Float 4 propelled by electric motor. Float 5 propelled by electric motor with a back-up motor for steering if needed. Air temperature of 15.5°C at 1005 hr and 19.8°C at 1416 hr. Secchi depth to the bottom before and after the Begonia Festival. Fewer begonia petals on the water after the festival than previous year, although children on floats were throwing flowers overboard as was done the previous year. Water samples taken for hydrogen sulfide testing in Reaches 1 and 2 before and after float procession- 1230 hr, 1235 hr, 1330 hr and 1335 hr.

04-Sep-05									1436 hr
	Flume				**Stockton Avenue Bridge**				
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 Umhos**	
0.00					19.2	0.4	8.39	675	
0.25					19.1	0.4	8.43	674	
0.50					19.0	0.4	8.36	673	
0.75					18.9	0.4	8.26	673	
1.00					18.8	0.4	7.93	672	
1.25					18.8	0.4	8.30	671	
1.50					18.6	0.4	8.64	667	
1.75					18.5	0.4	8.42	666	
1.95 b					18.6	0.4	3.64	669	

1436 hr				04-Sep-05				1456 hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 Umhos**
0.00	18.9	0.4	9.38	674	19.1	0.4	8.51	673
0.25	18.9	0.4	9.54	674	18.8	0.4	8.79	670
0.50	18.9	0.4	9.60	674	18.7	0.4	9.02	665
0.75	18.9	0.4	9.70	674	18.6	0.4	9.38	658
1.00	18.8	0.4	9.56	673	18.2	0.4	10.19	649
1.25 b	18.8	0.4	9.49	673	18.0	0.4	4.72	631
1.50 b	18.7	0.4	4.31	671				

0720 hr				10-Sep-05				0731 hr
	Flume				**Stockton Avenue Bridge**			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 Umhos**
0.00	16.6	0.4	8.27	643	16.7	0.4	8.09	642
0.25	16.7	0.4	8.39	643	16.8	0.4	7.88	643
0.50	16.8	0.4	8.28	643	16.8	0.4	8.06	642
0.75	16.8	0.4	8.25	643	16.8	0.4	7.82	642
1.00	16.8	0.4	8.20	643	16.8	0.4	7.56	642
1.25 b	16.9	0.4	7.12	643	16.8	0.4	7.52	642
1.50					16.8	0.4	7.59	642
1.75					16.8	0.4	7.11	642
1.95 b					16.8	0.4	3.46	642

0755 hr				10-Sep-05				0810 hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 Umhos**
0.00	16.5	0.4	7.59	637	16.1	0.4	7.02	634
0.25	16.5	0.4	7.58	637	16.2	0.4	7.18	633
0.50	16.5	0.4	7.49	637	16.2	0.4	6.99	632
0.75	16.5	0.4	7.55	637	16.2	0.4	6.89	632
1.00	16.5	0.4	7.56	637	16.1	0.4	6.75	632
1.25 b	16.6	0.4	7.29	638	16.2	0.4	2.93	634
1.50 b	16.7	0.4	3.17	639				

10 September 2005. Gage height of 2.50 (morning) and 2.50 (afternoon). Clear, cool and breezy in morning and clear and windy in afternoon. Air temperature of 12.1°C at 0720 hr and 16.9°C at 1622 hr. Flume entrance at 1.2+ ft. Flume outlet at 1.0 feet.

Station 1: Flume at 1615 hr. Reach 1- No surface algae. Could not see bottom very well, but could see pondweed. 66 gulls bathing and an equal number roosting on the restaurant roofs.
Station 2: Stockton Avenue Bridge at 1548 hr. Reach 2- <<1% surface algae. 100% of bottom covered by algae 0.5-4.0 ft, averaging 1.5 ft thick. No begonias observed.
Station 3: Railroad Trestle at 1529 hr. Reach 3- <<1% surface algae. 100% of bottom covered by algae 1.0-4.0 ft, averaging 2.5 ft thick. No begonias observed.
Station 4: Mouth of Noble Gulch at 0801hr. Gray water emanating from Gulch, with a plume extending 50 ft from mouth. Resident stated that the gray water volume was worse the previous day. He had called the City of Capitola and County Environmental Health about the problem. At 1513 hr. 2% surface algae. 60% of bottom covered by algae 0.5-4 ft thick, averaging 2.0 ft. No pondweed observed. 10 mallards and 1 domestic duck dabbling near Gulch with 2 pied-billed grebe and 1 domestic goose. 3 mallards roosting and a western pond turtle using cottonwood log across from the Gulch.
Station 5: Nob Hill at 0846 hr. Water temperature of 14.7°C. Conductivity of 608 umhos. Oxygen 8.65 mg/l. Visually estimated streamflow 6.0 cfs.

1615 hr			10-Sep-05					1548 hr
	Flume				**Stockton Avenue Bridge**			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 Umhos**
0.00	18.1	0.4	10.56	655	18.5	0.4	9.77	664
0.25	18.1	0.4	10.56	655	18.5	0.4	9.88	663
0.50	18.0	0.4	10.92	654	18.3	0.4	9.84	662
0.75	18.0	0.4	11.05	653	18.2	0.4	9.64	662
1.00	17.9	0.4	10.76	654	18.1	0.4	9.42	659
1.25 b	17.9	0.4	6.73	650	18.1	0.4	9.58	658
1.50					18.0	0.4	9.36	657
1.75					17.9	0.4	9.14	656
1.95 b					17.9	0.4	4.44	656

1529 hr			10-Sep-05					1513 hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 Umhos**
0.00	18.5	0.4	9.97	665	19.3	0.4	9.12	672
0.25	18.5	0.4	10.01	664	18.8	0.4	8.89	669
0.50	18.4	0.4	10.12	663	18.4	0.4	8.52	658
0.75	18.3	0.4	10.21	659	17.6	0.4	10.71	639
1.00	18.2	0.4	10.28	653	17.2	0.4	10.65	620
1.2 5 b	17.9	0.4	10.92	651	17.5	0.4	5.27	628
1.50 b	17.7	0.4	5.05	651				

0754 hr			25-Sep-05					0807 hr
	Flume				**Stockton Avenue Bridge**			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 Umhos**
0.00	16.3	0.4	8.73	641	16.5	0.4	8.33	643
0.25	16.4	0.4	8.90	641	16.5	0.4	8.14	643
0.50	16.5	0.4	8.86	641	16.6	0.4	8.21	643
0.75	16.5	0.4	8.81	641	16.6	0.4	7.82	643
1.00	16.5	0.4	8.77	641	16.6	0.4	8.02	643
1.25 b	16.5	0.4	7.48	641	16.6	0.4	8.23	643
1.50					16.6	0.4	8.07	643
1.75					16.6	0.4	7.59	643
2.00 b					16.6	0.4	3.59	644

0826 hr			25-Sep-05					0840 hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 Umhos**
0.00	16.1	0.4	7.67	638	15.1	0.4	6.70	625
0.25	16.1	0.4	7.81	637	15.0	0.4	6.98	625
0.50	16.0	0.4	7.70	637	15.0	0.4	7.03	624
0.75	16.0	0.4	7.66	636	15.0	0.4	6.96	625
1.00	15.9	0.4	7.71	636	15.0	0.4	6.87	625
1.25 b	15.9	0.4	7.78	635	15.1	0.4	2.67	627
1.45 b	16.1	0.4	3.49	636				

25 September 2005. Gage height of 2.54 (morning) and 2.53 (afternoon). Sunny and breezy in morning. Partly overcast and breezy in afternoon. Air temperature of 9.6°C at 0754 hr and 16.2°C at 1608 hr. Flume inlet 1.2 ft deep. Flume outlet 1.0 ft.

Station 1: Flume at 0754 hr. Reach 1- 2% surface algae. At 1608 hr. Reach 1- <<1% surface algae. 100% bottom algae and pondweed 0.3-4 ft, averaging 2 ft. 18 gulls bathing and 55 pigeons roosting on Paradise Beach roof.

Station 2: Stockton Avenue Bridge at 0807 hr. Reach 2- 2% surface algae and 1 coot present. At 1545 hr in Reach 2- <1% surface algae. 100% of bottom covered by algae 1.0-4.0 ft, averaging 2.0 ft thick.

Station 3: Railroad Trestle at 0826 hr. Reach 3- 20% surface algae to Shadowbrook Restaurant and little upstream. At 1530 hr- Reach 3- surface algae concentrated around Noble Gulch with 5% coverage upstream. 100% of bottom covered with algae 2.0-4.5 ft, averaging 3.0 ft thick.

Station 4: Mouth of Noble Gulch at 0840 hr. Gray water at mouth. Most surface algae directly downstream of the Gulch. Resident sees gray water at mouth nearly every morning now. At 1515 hr- 60% surface algae. 95% of bottom covered by algae 0.5-4 ft thick, averaging 3.0 ft. Mallards, 1 pied-billed grebe and 1 coot floating near Gulch.

Station 5: Nob Hill at 0910 hr. Water temperature of 13.0°C. Conductivity of 583 umhos. Oxygen 8.55 mg/l. Visually estimated streamflow 4.5 cfs.

1608 hr			25-Sep-05					1545 hr
	Flume				**Stockton Avenue Bridge**			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 Umhos**
0.00	17.3	0.4	10.62	651	17.4	0.4	9.78	653
0.25	17.2	0.4	10.53	651	17.4	0.4	9.77	654
0.50	17.1	0.4	10.66	648	17.4	0.4	9.82	653
0.75	17.0	0.4	11.41	648	17.4	0.4	9.73	653
1.00	17.0	0.4	10.59	646	17.4	0.4	9.89	653
1.25 b	17.0	0.4	8.62	646	17.3	0.4	9.58	650
1.50					16.9	0.4	10.67	645
1.75					16.8	0.4	10.84	642
1.95 b					16.8	0.4	4.84	642

1530 hr			25-Sep-05					1515 hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 Umhos**
0.00	17.5	0.4	9.95	656	18.6	0.4	9.48	650
0.25	17.5	0.4	9.82	656	17.9	0.4	8.78	646
0.50	17.5	0.4	9.93	656	16.6	0.4	9.02	630
0.75	17.4	0.4	9.55	655	16.2	0.4	10.62	628
1.00	16.7	0.4	10.92	648	16.0	0.4	1080	634
1.2 5 b	16.5	0.4	10.95	639	16.0	0.4	5.16	631
1.50 b	16.6	0.4	4.91	636				

0757 hr			8-Oct-05					0810 hr
	Flume				Stockton Avenue Bridge			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 Umhos**
0.00	15.3	0.4	9.91	629	15.5	0.4	8.42	632
0.25	15.4	0.4	9.59	629	15.6	0.4	8.21	632
0.50	15.4	0.4	9.77	629	15.5	0.4	8.26	632
0.75	15.4	0.4	9.64	629	15.5	0.4	8.43	632
1.00	15.4	0.4	9.36	629	15.5	0.4	8.45	632
1.20 b/1.25	15.4	0.4	5.60	629	15.5	0.4	8.32	632
1.50					15.5	0.4	8.21	632
1.75					15.5	0.4	7.89	633
1.95					15.5	0.4	3.59	633

0826 hr			8-Oct-05					0837 hr
	Railroad Trestle				Mouth of Noble Gulch			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 Umhos**
0.00	15.2	0.4	7.67	627	14.5	0.4	6.95	620
0.25	15.1	0.4	7.67	627	14.5	0.4	6.98	618
0.50	15.2	0.4	7.73	627	14.4	0.4	6.92	620
0.75	15.1	0.4	7.71	627	14.4	0.4	6.96	620
1.00	15.1	0.4	7.75	627	14.4	0.4	6.96	620
1.20 b/1.25	15.1	0.4	7.69	627	14.4	0.4	2.69	620
1.45 b	15.1	0.4	3.47	627				

8 October 2005. Gage height of 2.43 (morning) and 2.43 (afternoon). Sunny and cool in morning and clear and windy in afternoon. Air temperature of 11.6°C at 0757 hr, 18.2°C at Noble Gulch at 1612 hr and 16.9°C at flume at 1612 hr.

Station 1: Flume at 1612 hr. Reach 1- No surface algae. Could not see bottom.

Station 2: Stockton Avenue Bridge at 1550 hr. Reach 2- <1% surface algae. Could not see bottom.

Station 3: Railroad Trestle at 0826 hr. Reach 3- 2% surface algae At 1538 hr. Reach 3- <1% surface algae. Could not see the bottom.

Station 4: Mouth of Noble Gulch at 0837 hr. Gray water at mouth. Oil scum on surface with a 30 ft plume from the mouth. 10% surface algae near Gulch. 5% surface algae near Shadowbrook Restaurant. 5 coots floating near Gulch. 6 ducks and 1 goose roosting on cottonwood log. At 1525 hr, 20% surface algae at Gulch. 100% of bottom algae 3-4.5 ft thick, averaging 3 feet. 6 ducks, 1 coot and 1 snowy egret roosting on cottonwood log.

Station 5: Nob Hill at 0908 hr. Water temperature of 12.5°C. Conductivity of 578 umhos. Oxygen 8.40 mg/l. Streamflow measured the previous day at 2.93 cfs.

1612 hr			8-Oct-05					1550 hr
	Flume				**Stockton Avenue Bridge**			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 Umhos**
0.00	17.4	0.4	10.34	659	16.8	0.4	10.15	649
0.25	17.5	0.4	10.34	659	16.7	0.4	9.71	649
0.50	17.4	0.4	10.29	659	16.7	0.4	9.71	649
0.75	17.4	0.4	10.26	653	16.8	0.4	9.58	648
1.00	17.3	0.4	10.34	653	16.7	0.4	9.25	647
1.20 b/1.25	17.1	0.4	6.22	653	16.7	0.4	9.16	645
1.50					16.4	0.4	9.34	643
1.75					16.4	0.4	9.12	641
2.00 b					16.4	0.4	4.47	639

1538 hr			8-Oct-05					1525 hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 Umhos**
0.00	27.0	0.4	10.75	649	16.6	0.4	9.21	644
0.25	16.5	0.4	10.89	646	16.5	0.4	9.37	641
0.50	16.7	0.4	11.30	645	16.3	0.4	9.65	639
0.75	16.6	0.4	11.64	644	16.0	0.4	9.80	634
1.00	16.5	0.4	11.24	642	15.8	0.4	9.55	623
1.25 b	16.4	0.4	11.27	642	15.7	0.4	4.44	622
1.45 b	16.4	0.4	5.27	642				

0742 hr			18-Oct-05					0750 hr
	Flume				**Stockton Avenue Bridge**			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 Umhos**
0.00	15.4	0.4	7.87	636	15.4	0.4	7.58	637
0.25	15.4	0.4	7.86	636	15.5	0.4	7.54	637
0.50	15.4	0.4	7.85	636	15.5	0.4	7.85	637
0.75	15.4	0.4	7.81	636	15.5	0.4	7.60	636
1.00	15.4	0.4	7.82	636	15.4	0.4	7.42	636
1.20 b/1.25	15.4	0.4	4.53	629	15.4	0.4	7.39	636
1.50					15.4	0.4	7.16	636
1.75					15.4	0.4	6.35	636
1.95 b					15.4	0.4	1.74	636

0809 hr			18-Oct-05					0826 hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 Umhos**
0.00	15.4	0.4	7.90	631	15.2	0.4	8.11	624
0.25	15.4	0.4	7.83	631	15.2	0.4	8.02	630
0.50	15.3	0.4	8.23	631	15.1	0.4	7.19	635
0.75	15.3	0.4	8.02	631	15.0	0.4	6.99	636
1.00	15.3	0.4	7.89	630	15.0	0.4	7.00	635
1.25 b	15.3	0.4	7.53	631	15.0	0.4	3.36	635
1.45 b	15.3	0.4	1.67	637				

18 October 2005. Gage height of 2.44 (morning) and 2.47 (afternoon). Cloudy in morning and then sunny to partly cloudy in afternoon. Air temperature of 14.6°C at 0742 hr and 16.8°C at 1610 hr. Flume open.
Station 1: Flume at 0742 hr. Reach 1- No surface algae. A snowy egret perched on flume inlet. 126 gulls bathing in lagoon and 200-300 preening on beach nearby. At 1610 hr in Reach 1, 52 gulls bathing and 24 pigeons on Paradise Beach restaurant roof. No surface algae and bottom too dark to observe.
Station 2: Stockton Avenue Bridge at 0750 hr. Reach 2- 10% surface algae. 8 coots, 1 pied-billed grebe. Mallards absent. At 1549 hr in Reach 2, no surface algae and could not observe bottom. 2 pied-billed grebes and 9 coots.
Station 3: Railroad Trestle at 0809 hr. Reach 3- 15% surface algae and 22 coots above trestle. At 1535 hr. Reach 3- 1% surface algae at margin. Could not observe lagoon bottom.. 11 coots near trestle.
Station 4: Mouth of Noble Gulch at 0826 hr. Gray water emanating from Gulch with a 25 ft plume. No birds roosting on cottonwood log. 3 coots and only 2 male mallards floating nearby. At 1520 hr, 3% surface algae and 50% of the bottom covered with algae 0.3-2 feet thick, averaging 0.5 ft. The goose was limping on the cottonwood log. A green soup emanating from the Gulch. 7 ducks adjacent to Shadowbrook restaurant and 9 coots floating in vicinity of Gulch.
Station 5: Nob Hill at 0856 hr. Water temperature of 14.4°C. Conductivity of 0623 umhos. Oxygen 8.41 mg/l. Visually estimated streamflow 3.0 cfs. Approximately 20-30 mallards congregated in a pool upstream of Nob Hill instead of being in the lagoon.

1610 hr			18-Oct-05					1549 hr
	Flume				**Stockton Avenue Bridge**			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 Umhos**
0.00	16.0	0.4	8.80	643	16.3	0.4	8.55	649
0.25	16.0	0.4	8.90	643	16.3	0.4	8.20	648
0.50	16.0	0.4	8.86	643	16.2	0.4	7.85	648
0.75	15.9	0.4	9.02	643	16.2	0.4	7.82	646
1.00	15.9	0.4	9.07	643	15.8	0.4	8.57	641
1.25 b	16.0	0.4	5.12	642	15.6	0.4	8.16	640
1.50					15.6	0.4	7.89	639
1.75					15.6	0.4	8.05	640
1.95 b					15.6	0.4	4.12	640

1535 hr			18-Oct-05					1520 hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 Umhos**
0.00	16.3	0.4	8.84	648	17.1	0.4	8.54	649
0.25	16.3	0.4	8.73	648	16.5	0.4	8.70	648
0.50	16.3	0.4	8.76	648	16.0	0.4	8.16	636
0.75	16.1	0.4	8.54	647	15.8	0.4	7.89	641
1.00	16.1	0.4	8.56	647	15.5	0.4	7.71	641
1.25 b	15.8	0.4	9.05	645	15.4	0.4	3.51	643
1.50 b	15.6	0.4	4.65	642				

0649 hr			03-Nov-05					0700 hr
	Flume				**Stockton Avenue Bridge**			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 Umhos**
0.00	13.0	0.4	7.58	609	13.0	0.4	7.39	607
0.25	13.1	0.4	7.59	609	13.1	0.4	7.38	607
0.50	13.1	0.4	7.54	608	13.1	0.4	7.42	607
0.75	13.2	0.4	7.57	608	13.1	0.4	7.43	607
1.00	13.1	0.4	7.58	608	13.1	0.4	7.29	607
1.25 b	13.2	0.4	5.34	608	13.1	0.4	7.39	607
1.50					13.1	0.4	7.25	607
1.75					13.1	0.4	7.05	607
2.00					13.1	0.4	3.52	607

0717 hr			03-Nov-15					0732 hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 Umhos**
0.00	12.8	0.4	7.05	603	12.3	0.4	7.78	599
0.25	12.8	0.4	7.12	602	12.3	0.4	7.84	601
0.50	12.8	0.4	7.15	602	12.3	0.4	7.76	601
0.75	12.8	0.4	7.14	602	12.3	0.4	7.84	601
1.00	12.8	0.4	7.18	602	12.3	0.4	7.71	601
1.25 b	12.8	0.4	7.20	602	12.3	0.4	2.89	601
1.50 b	12.8	0.4	2.83	602				

03 November 2005. Gage height of 2.48 (morning) and 2.48 (afternoon). Sunny, cool and calm in morning and sunny in afternoon. Air temperature of 10.6°C at 0649 hr and 14.6°C at 1546 hr. Notch cut in beach with 2 berms, one near lagoon and one near surf. In afternoon, flume inlet 1.2 ft and outlet 1.2 ft deep. One board in base of outlet.
Station 1: Flume at 1546 hr. Reach 1- No surface algae. Could not observe lagoon bottom. 73 gulls (4 waiting for handouts near Margaritaville, 16 coots, 2 pied-billed grebes and 1 mallard (waiting for handouts).
Station 2: Stockton Avenue Bridge at 0700hr. Reach 2- 12 coots, 10 mallards and 1 pied-billed grebe under bridge. At 1526 hr, Reach 2- No surface algae. Could not see bottom.
Station 3: Railroad Trestle at 1513 hr. Reach 3- No surface algae. Could not see bottom.
Station 4: Mouth of Noble Gulch at 0732 hr. Gray water present. 1 pied-billed grebe and 9 coots from Gulch to Shadowbrook restaurant. 3 domestic ducks, 1 goose and 3 coots roosting on cottonwood log. At 1450 hr, more gray water and secchi depth not to bottom (1 m). No surface algae and could not observe bottom. 9 coots, 1 pied-billed grebe and 18 ducks floating in water. 18 ducks roosting on cottonwood log.
Station 5: Nob Hill at 0803 hr. Water temperature of 10.6°C. Conductivity of 560 umhos. Oxygen 8.89 mg/l. Visually estimated streamflow 3.0 cfs.

1546 hr			03-Nov-05					1526 hr
	Flume				**Stockton Avenue Bridge**			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 Umhos**
0.00	13.9	0.4	9.44	617	14.0	0.4	8.48	622
0.25	13.9	0.4	9.72	618	14.0	0.4	8.55	622
0.50	13.8	0.4	9.49	618	14.0	0.4	8.44	621
0.75	13.8	0.4	9.50	617	13.9	0.4	8.38	620
1.00	13.8	0.4	9.36	617	13.9	0.4	8.37	619
1.25 b	13.8	0.4	5.21	613	13.8	0.4	8.37	618
1.50					13.8	0.4	8.26	615
1.75					13.7	0.4	8.28	614
1.95 b					13.8	0.4	3.88	614

1513 hr			03Nov-05					1450 hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 Umhos**
0.00	13.9	0.4	8.98	620	14.2	0.4	8.76	613
0.25	13.9	0.4	8.83	620	13.9	0.4	8.86	609
0.50	13.9	0.4	8.83	620	13.8	0.4	8.96	606
0.75	13.8	0.4	9.02	619	13.6	0.4	8.83	615
1.00	13.8	0.4	9.00	619	13.4	0.4	8.87	615
1.25	13.7	0.4	9.01	619	13.3	0.4	5.21	615
1.50 b	13.8	0.4	3.93	619				

0720 hr			17-Nov-05					0737 hr
	Flume				Stockton Avenue Bridge			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 Umhos**
0.00	12.7	0.4	8.32	615	12.8	0.4	8.27	616
0.25	12.8	0.4	8.21	615	12.9	0.4	7.92	616
0.50	12.8	0.4	8.18	615	12.9	0.4	8.02	616
0.75	12.8	0.4	8.14	614	12.9	0.4	7.92	616
1.00	12.8	0.4	8.19	614	12.9	0.4	7.89	616
1.25 b	12.8	0.4	4.36	614	12.9	0.4	7.77	616
1.50					12.9	0.4	7.74	615
1.75					12.9	0.4	7.68	616
2.00					12.9	0.4	3.43	616

0755 hr			17-Nov-15					0810 hr
	Railroad Trestle				Mouth of Noble Gulch			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 Umhos**
0.00	12.8	0.4	7.75	612	12.6	0.4	7.83	609
0.25	12.8	0.4	7.78	612	12.5	0.4	7.79	609
0.50	12.8	0.4	7.76	612	12.5	0.4	7.79	609
0.75	12.8	0.4	7.78	612	12.5	0.4	7.81	609
1.00	12.8	0.4	7.81	612	12.5	0.4	7.85	609
1.25 b	12.8	0.4	7.82	612	12.5	0.4	1.62	610
1.50 b	12.8	0.4	2.84	612				

17 November 2005. Gage height of 2.56 (morning) and 2.58 (afternoon). Two boards removed on both sides of flume inlet 4-14 November in anticipation of additional runoff from early storms. On 17 November it was clear, cool and calm in morning and sunny in afternoon. Air temperature of 9.2°C at 0720 hr and 15.7°C at 1551 hr. In afternoon, flume inlet 1.2 ft and outlet 1.0 ft deep.

Station 1: Flume at 0720 hr. Reach 1- No surface algae. ~ 50 gulls, 42 coots, 1 cormorant. At 1551 hr, Reach 1- No surface algae. Near restaurants 100% bottom coverage of algae and pondweed 1.5 ft thick. Near flume 50% coverage with algae 0.1-1.0 ft thick, averaging 0.2 ft. 33 gulls bathing, 44 coots, 1 pied-billed grebe. Improvement on restaurant roofs with only 1 gull and no pigeons. Wires running across roofs in about 1 ft parallel lines.

Station 2: Stockton Avenue Bridge at 0737 hr. Reach 2- No surface algae. 14 coots. At 1532 hr, Reach 2- No surface algae. Near bridge- 70% of bottom with algae 0.1-0.5 ft thick, averaging 0.3 ft. White, pollen-like sheen on water surface, covering a 25ft x 10 ft area near willows on west side.

Station 3: Railroad Trestle at 0755 hr. Reach 3- No surface algae. 1 pied-billed grebe. At 1512 hr. Reach 3- No surface algae. Could not see bottom. 1 gull, 40 coots, 5 mallards, 4 domestic ducks 1 goose from trestle to Shadowbrook restaurant.

Station 4: Mouth of Noble Gulch at 0810 hr. No surface algae and no gray water present. 2 coots and 2 cormorants sunning themselves on cottonwood log. 2 mallards and 2 coots roosting on redwood stump. 21 coots from Gulch to beyond Shadowbrook restaurant. At 1455 hr, no surface algae. 60% of bottom coverd with algae 0.1-0.2 ft thick. Gray water present. Of the waterfowl tallied for Reach 3, 4 domestic ducks, 3 mallards and 1 goose were just beyond the Gulch.

Station 5: Nob Hill at 0838 hr. Water temperature of 11.2°C. Conductivity of 581 umhos. Oxygen 8.91 mg/l. Visually estimated streamflow 3.5 cfs. 8 mallards observed in the pool nearest Nob Hill. There were fewer mallards in the lagoon than earlier in the summer. They appear to be spreading out in the watershed.

1551 hr			17-Nov-05					1532 hr
	Flume				**Stockton Avenue Bridge**			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 Umhos**
0.00	13.9	0.4	9.37	626	13.9	0.4	8.78	627
0.25	13.8	0.4	9.47	625	13.9	0.4	8.86	629
0.50	13.6	0.4	9.78	625	13.8	0.4	8.76	628
0.75	13.6	0.4	10.18	623	13.7	0.4	8.78	627
1.00	13.5	0.4	10.40	624	13.6	0.4	8.47	623
1.25 b	13.5	0.4	4.40	625	13.4	0.4	8.60	621
1.50					13.2	0.4	8.31	620
1.75					13.1	0.4	7.47	618
2.00 b					13.1	0.4	3.65	618

1512 hr			17-Nov-05					1455 hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 Umhos**
0.00	14.4	0.4	8.88	631	14.2	0.4	8.95	Gray water 578
0.25	14.2	0.4	8.93	629	13.8	0.4	9.24	Gray water 572
0.50	14.0	0.4	8.96	629	13.9	0.4	8.50	626
0.75	13.8	0.4	9.14	626	13.8	0.4	8.40	618
1.00	13.7	0.4	9.49	624	13.3	0.4	8.48	618
1.25 b	13.3	0.4	9.62	619	13.2	0.4	3.51	619
1.50 b	13.4	0.4	3.73	620				

23 November 2005. Two boards (8 inches) were removed from either side of the flume in anticipation of a storm event on Friday (25 November) after Thanksgiving. The small storm caused a rise in streamflow to about 10 cfs, as reported by Morrison, at the USGS gage in Soquel Village during the Friday storm. The water passed through the flume. Then the resulting baseflow was 5 cfs after the stormflow passed.

28 November 2005. At 2100 hr, Morrison removed 5 boards (20 inches) were removed from the restaurant side and 4 boards (16 inches) were removed from the Venetian Court side of the flume inlet in preparation for nighttime rain. Screens were inserted in the gaps created.

29 November 2005. At 0600 hr as reported by Morrison, the screens were fouled with debris. The lagoon level was 1 inch above the flume top. The debris was removed and the lagoon level lowered to the flume top as of 0645 hr as reported by Morrison. Morrison reported that streamflow peaked at about 25 cfs at the USGS gage during the night and was 14 cfs at 0615 hr, according to the USGS website. More rain is forcasted for Wednesday evening (30 November).

30 November 2005. By afternoon, the notch in the sandbar was deepened and the berm at the lagoon margin was lowered to correspond to the flooding elevation. Boards remain out. Lagoon elevation about 16 inches below the flume top, reported by Morrison. Heavy rain forecasted for the evening. Jennifer Nelson was notified of the likely breach this evening or tomorrow. Streamflow at the gage at 1815 hr was 7.5 cfs.

0738 hr			01-Dec-05						0753 hr
	Flume				**Stockton Avenue Bridge**				
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 Umhos**	
0.00	11.9	0.3	8.85	522	12.2	0.3	8.37	431	
0.25	11.7	0.4	8.88	529	12.2	0.3	8.41	431	
0.50	11.6	0.4	8.65	535	12.2	0.3	8.39	440	
0.75	11.6	0.4	8.41	539	12.2	0.3	8.33	469	
1.00 b	11.4	0.4	7.14	541	12.1	0.3	7.93	523	
1.25					11.7	0.4	8.16	554	
1.50					11.6	0.4	8.28	558	
1.75 b					11.5	0.4	3.32	558	

0815 hr			01-Dec-05						0830 hr
	Railroad Trestle				**Mouth of Noble Gulch**				
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 Umhos**	
0.00	12.4	0.3	8.75	400	12.6	0.2	8.27	310	
0.25	12.4	0.3	8.69	400	12.6	0.2	8.49	323	
0.50	12.4	0.3	8.58	405	12.5	0.2	8.40	358	
0.75	12.3	0.3	8.68	401	12.4	0.2	8.31	381	
1.00 b	12.3	0.3	8.53	412	12.3	0.3	2.71	406	
1.25 b	11.1	0.4	3.07	546					

1 December 2005. Gage height of 1.83 (morning). 5 boards (20 inches) were removed from the restaurant side and 4 boards (16 inches) were removed from the Venetian Court side of the flume inlet on 28 November in anticipation of stormflow. On 1 December it was overcast and windy with light rain. Air temperature of 13.9°C at 0738 hr. The sandbar was breached in the afternoon. Refer to the afternoon description below.

Station 1: Flume at 0738 hr. Reach 1- No surface algae. ~ 100 gulls bathing. Lagoon bottom was invisible in the morning. Wires observed running across roofs of the restaurants previously were not visible this day.
Station 2: Stockton Avenue Bridge at 0753 hr. Reach 2- No surface algae. Bottom invisible. Secchi depth 25.6 inches (0.65 meters).
Station 3: Railroad Trestle at 0815 hr. Reach 3- No surface algae. Lagoon bottom invisible.
Station 4: Mouth of Noble Gulch at 0830 hr. No surface algae with oil sheen on water. Bottom invisible.
Station 5: Nob Hill at 0936 hr. Water temperature of 12.5°C. Conductivity of 356 umhos. Oxygen 9.09 mg/l. Visually estimated streamflow at 10-12 cfs. Reading of 12 cfs at USGS gage at 1015 hr.

1 December 2005 (afternoon). The lagoon level increased 5 inches in 3 hours during the morning with the flume running at full capacity. By 1400 hr, the decision was made to facilitate breaching with continued rain in the forecast. The biological monitor was notified, and he arrived at the lagoon at 1450 hr. Under the supervision of Ed Morrison of Capitola Public Works, an opening was made with a tractor in the berm nearest the surf. A channel was re-cut through the beach to the berm nearest the lagoon. The sand became spongy, preventing the tractor from working on the lagoon berm. Hand shovels were used to notch the lagoon berm and begin the water channel through the beach. At this time, the lagoon level was approximately 8 inches below the lower bolt. The water slowly streamed onto the beach and a channel began to cut through the beach by 1600 hr. The lagoon level continued to rise to within 5 inches of the lower bolt. The stream channel widened to approximately 20 feet by 1700hr and the lagoon level had begun to recede. The Public Works crew left the beach at this time. By 1800 hr, as reported by Morrison, the streamflow at the Soquel Village gage reached over 60 cfs. By 2300 hr streamflow reached 150 cfs at the USGS gage in Soquel Village.

2 December 2005. By 0615 hr, streamflow at the gage had declined to 78 cfs. The sandbar remained open to the ocean.

APPENDIX B.

2005 DRAIN LINE TEST FOR RESTAURANTS CONTIGUOUS WITH SOQUEL CREEK LAGOON.

APPENDIX C.

WATER QUALITY TESTING RESULTS FOR HYDROGEN SULFIDE IN THE LAGOON IMMEDIATELY BEFORE AND AFTER THE BEGONIA FESTIVAL.

ANALYTICAL CHEMISTS
and
BACTERIOLOGISTS
Approved by State of California

SOIL CONTROL LAB

42 HANGAR WAY

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P.O. Box 200
Brookdale CA 95007

13 SEP 05

MATERIAL:	Water samples received 06 September 2005
IDENTIFICATION:	Begonia Festival Monitoring, 9/4/05
REPORT:	Quantitative chemical analysis is as follows expressed as milligrams per liter (parts per million):

Sample Identification	Total Sulfide
R1 Before (1230)	0.60
R2 Before (1235)	0.80
R1 After (1330)	< 0.2
R2 After (1335)	< 0.2

A Division of Control Laboratories Inc.

APPENDIX D.

CRITIQUE OF THE ON-GOING SANTA CRUZ COUNTY-WIDE LAGOON STUDY.

Review of the February 2005 CLEAP Progress Report For the City of Capitola
By Donald Alley, Certified Fisheries Scientist
April 2005

Vocabulary. You use the term "lagoon" for systems with and without intact sandbars. However, the common terminology normally used is to call the system an "estuary" if the sandbar is open and a "lagoon" only after the sandbar has closed. We believe this delineation should be made because the communities, community structure, species composition and water chemistry may become very different once the sandbar is allowed to close and remains closed for a period of time. For systems where the sandbar is breached multiple times in the dry season, they are lagoon/estuaries.

The term "community" is sometimes used in your progress report when only a portion of the ecological community is being discussed, such as "benthic community " or "fish community". We believe that in these cases, the term "component" should be used as in "benthic component." This relates to the use of the Simpson's Diversity Index in this study. We believe the intention of the index is to include all species in the community. You have computed Simpson's indices for separate components of the community, such as indices for phytoplankton, zooplankton, benthic invertebrates and fish. Sometimes the index for one component is relatively low while the index for another component is relatively high within the same ecological community at the same sampling time. Shouldn't an overall Simpson's Diversity Index be calculated? It is our understanding that the Simpson's Diversity Index is to be calculated for the community as a whole and not for separate portions of the community. All of these community components are connected by energy and nutrient flow through the ecosystem. They do not exist in isolation.

Questionable Underlying Ecological Assumptions. You stated in the last meeting that it is healthier to have an open sandbar (estuary) than a closed sandbar (lagoon). The implication from the effort in this study to calculate the Simpson Diversity Index is that a higher index somehow indicates healthier conditions. The Simpson's Diversity Index is a measure of the species richness (number) and the species evenness in terms of biomass or numbers of individuals. The report should provide a list the species identified and the biomass or numbers of individuals of each species for phytoplankton, submerged aquatic vegetation (SAV), zooplankton, benthic invertebrates and fish for each lagoon or estuary at each sampling period. Our experience is that when political pressure is brought to bear on environmental analyses, complete transparency is necessary to establish credibility.

We suspect that management recommendations will be forthcoming from this study. There are key questions to be answered in the process. Is it appropriate to assume that a community with a higher Simpson's Diversity Index is healthier than one with a lower index? Is it healthier to increase the biomass of common, unlisted watershed species such as prickly sculpin or Sacramento suckers or the common top smelt and reduce the biomass of the Threatened steelhead in order to achieve species evenness and a higher Simpson's Index? With a federally listed species, such as steelhead, with considerable recreational value and a management goal of both the federal and state governments to increase their numbers, should species evenness that would increase the Simpson Index be a goal of lagoon/estuary management? Fish are very opportunistic feeders. Is it healthier for fish to feed on a variety of zooplankton and benthic invertebrates, independent of prey species biomass, or is merely prey biomass more important for fish growth? Is it healthier for a larger number of zooplankton species and zooplankton numbers to feed on a variety of phytoplankton species, or is the phytoplankton biomass most important? Phytoplankton and SAV (pondweed and filamentous algae) are competing for nutrients. Is it healthier to have a system dominated by either phytoplankton or SAV or a combination of both?

We have observed in Soquel Lagoon that a freshwater lagoon provides good enough water quality for steelhead to thrive and grow relatively rapidly compared to the remainder of the watershed. Soquel Lagoon can raise a significant number of rapidly growing young-of-the-year juvenile steelhead that reach smolt size their first summer. And these lagoon-reared smolt-sized juveniles constitute a substantial portion of the watershed's smolts and improve this species' chances of persistence in the watershed. With the Soquel Lagoon population estimate of more than 3,800 juvenile steelhead (all smolt-sized) in 2004, the lagoon contribution as an estimated 45% of the smolt-sized juveniles produced in the entire watershed. Would it be advantageous to periodically breach the sandbar to drain much of the lagoon at low tide and allow marine kelp, seagrass and saltwater to enter the newly formed estuary at high tide, only to become entrained on the bottom. This will encourage increased decomposition of dead marine vegetation, increased biological oxygen demand, reduced oxygen for fish and increased water temperature where saltwater becomes stagnant on the bottom? Steelhead could be severely reduced in a system managed with periodic artificial breaches followed by temporary sandbar closure. Tidewater goby are also hampered from sandbar breaching. Healthy conditions need to be clearly defined by you. Which organisms are you trying to make the lagoon healthier for?

Is a more stable community considered healthier? Is there a clear connection between community stability and species biodiversity as measured by the Simpson's Diversity Index. Does increased species richness necessarily generate community stability? Is temporarily high species diversity on one trophic level a good indication of a stable community? Community stability can be measured in at least 3 ways: (1) persistence through time of all species or certain species combinations (less stability = more extinctions), (2) evenness of species abundance patterns- persistence of certain relative abundance relations through time and (3) ability of the community to maintain its functional organization following an external perturbation. The Simpson's Diversity Index does not measure persistence and cannot predict the community's response to perturbation. To assess community stability, one cannot merely look at the Simpson's Index of species richness and evenness at one point in time. One must also look at species persistence in the lagoon/estuary through the summer and look at how stable the population size of each species is through time. This study has not thus far addressed species persistence or species population fluctuations in Soquel Lagoon or other lagoons in the study.

The ability of a species to persist in a location depends on at least two functional attributes: (1)

the magnitude of change occurring the locations properties and (2) the ability of the species to cope effectively with changes that do occur. Because estuaries are at the interface between fresh and saltwater environments, the species composition is greatly influenced by species' physiological tolerances to varying concentrations of saltwater, oxygen and water temperature through the water column. Species adapted to osmoregulate in a variably saline environment (euryhaline) are favored in an estuary environment. Species adapted to a freshwater environment (stenohaline) are favored in a lagoon environment when the sandbar is allowed to remain closed to promote mostly or complete freshwater conversion.

With sandbar closure and the conversion of the lagoon to a freshwater condition (or mostly freshwater condition except for a few isolated deep pockets), a freshwater community is allowed to develop in Soquel Lagoon for the summer without salinity fluctuations, without warm saline water at the bottom, without wide fluctuations in water depth and without tidal action that creates in-coming and out-going water currents. In an estuary, inputs of saltwater from the ocean and freshwater inputs from the watershed inflow place such osmoregulatory demands on organisms, that an estuary environment may be fully utilized only by very mobile stenohaline species that can avoid either freshwater or saltwater with incoming or out-going tides and by more euryhaline species that can tolerate a wide variation in salinity. Once the sandbar closes and the water converts to freshwater (or mostly freshwater except in a few isolated deep pockets), a community structure of more stenohaline species may develop. This goes for species on all trophic levels.

The Simpson's Diversity Index for a primarily freshwater community cannot be easily compared to the index derived from an estuarine community for purposes of assessing community health. The community structure is different between the two. The utilization of nutrients goes through different pathways. From your 2004 work we see that where the sandbars close and mostly freshwater lagoons formed, then SAV developed (Figure VC). Where the sandbar was breached periodically, SAV did not develop. Soquel, Laguna and Scott Lagoons had SAV.

Comparing lagoons having stable, closed sandbars with significant SAV to lagoon/estuaries where the sandbar is breached during the summer and phytoplankton producers dominate is like comparing apples and oranges. The flow of energy and nutrients through the ecosystem is different in a phytoplankton-dominated primary producer system compared to one containing substantial SAV, like Soquel Lagoon. Submerged pondweed, provides physical structure for fish, invertebrates and algae to utilize. Spatial heterogeneity encourages species diversity. This physical component is completely lacking in a phytoplankton-dominated estuary. Is it healthier to have a forest of SAV growing on the bottom of a lagoon or to have only sand with decomposing ooze?

Will species diversity and species evenness increase through time with more stable physical conditions of salinity, temperature and oxygen? Stable environments allow for more specialized species to persist. Are water quality parameters more stable and predictable with a seasonally closed sandbar and lagoon or with periodic sandbar breaching followed by sandbar closure? Does a permanent estuary condition with no sandbar closure create a more stable environment?

Construction of the sandbar at Soquel Lagoon in early summer and its maintenance creates a very stable freshwater environment. In Soquel Lagoon, with the late May manual sandbar construction and rapid freshwater conversion, sufficient time is allowed during the dry season for a freshwater community structure to develop. The measured benthic community's Simpson's Index in just the lower end of Soquel Creek was higher than any other lagoon or estuary in the study.

<u>Lagoon Rankings.</u> A clearly stated rationale for how you ranked the lagoons and lagoon/estuaries in this study is needed. Was ranking by the degree of human disturbance? Your ranking from least subject to human interference to most was Scott, Laguna, Soquel, San Lorenzo and Aptos. How do you quantify human impact? Did you consider the human impacts that truly affect these biological systems the most? Each lagoon and lagoon/estuary has significant impacts of different kinds that make any ranking very subjective. The ranking was done before the lagoons were studied. Is a cookbook model in a textbook specific enough to apply to these specific Central Coast systems? Each year there may be varying amounts of human activity in each lagoon, depending on natural streamflow in relation to stream diversion, beach-goer interest in breaching sandbars and levee repair activities that require sandbar breaching.

Most will agree that Scott Lagoon is least impacted of the lagoons in this study. Even so, it has been substantially impacted. Highway 1 creates a very unnatural constriction that affects sandbar formation and natural sandbar breaching there. Scott Lagoon is often the first to have a closed sandbar in summer and the last to breach in the fall. That lagoon was nearly breached in 2004 by a beach-goer. That one breach could have greatly affected the water chemistry for the remainder of the summer. So, even it may be substantially impacted in some years. All of the other lagoons are impacted in many different ways that make ranking them extremely subjective. It is difficult to say which impacts are more severe because we know so little about non-impacted systems. Laguna Creek Lagoon had a stable sandbar through the summer. However, there were substantial upstream water diversions that nearly dried up the entire lagoon in 2004, as indicated by your photographs. Doesn't this seem like a severe impact? Yet Laguna Lagoon was ranked second only to Scott Lagoon as least impacted.

Soquel Lagoon had its sandbar manually constructed in late May at the time when it was naturally forming in 2004. That sandbar was constructed high enough to discourage tidal overwash. There was a flume through the beach that is used to maintain lagoon depth and to drain excess water through the summer. The sandbar was closed for the summer at low tide to minimize the saltwater trapped in the lagoon. Commercial water diversions exist upstream in Soquel Creek. But Soquel Lagoon probably had the most stable water quality conditions of any of the lagoons because it converted to freshwater quickly and stayed that way through the summer.

A large summer water diversion exists on the San Lorenzo River every year, just upstream of the lagoon. Depending on the natural streamflow of the river, this diversion is a relatively major or minor portion of the lagoon/estuary inflow. The amount of river inflow affects how quickly the sandbar forms and the rapidity of freshwater conversion after it forms. In addition, in 2004 there was substantial levee repair in San Lorenzo Lagoon/estuary that required an approximately 1,000-foot long portable dam along one side and constant pumping of water out of the work enclosure. Fish had to be removed from the enclosure before and during evacuation of water from the work area. The dam sustained holes and other compromises several times during the summer, with fish being trapped inside the enclosure followed by fish rescues. Water currents were undoubtedly affected by this artificial constriction. These activities may have had significant impacts on sandbar formation, fish distribution, fish survival and the degree of water column stratification that could develop with regard to salinity, water temperature and oxygen. The San Lorenzo sandbar was artificially breached in September with a minimum of inflow to allow construction activities to continue inside the enclosure. It had breached in July from unknown causes. What important conclusions could be drawn from the data collected in San Lorenzo Lagoon/estuary after a summer with such abnormal activities?

Although Aptos Creek may have the least impacted watershed with much of it draining out of a state park, Aptos Lagoon had its sandbar breached repeatedly through the summer by beach-goers, according to your data collectors. This prevented a freshwater conversion from occurring.

Water Quality Methods. With water quality data at only two locations in the water column (near the surface and near the bottom), no data are available for most of the water column. Periodic water quality measurements throughout the water column, such as are performed at Soquel Lagoon, would provide important data for assessing fish habitat quality.

Water Quality Results. The graphs of water quality lack biological meaning with regard to oxygen concentrations. The graphs express oxygen in percent saturation. They would have more biological meaning if oxygen concentration were expressed in mg/l. It is the absolute oxygen concentration that is relevant to fish. It decreases with increased water temperature. 100% oxygen saturation at a warmer temperature provides less oxygen to fish than 100% saturation at a cooler temperature.

It would be enlightening to distinguish between natural and artificial breaching on the water quality graphs.

In Figure IVG for Scott Lagoon there is no legend for the graph showing water depth and salinity. The same is true for Figure IVL for the San Lorenzo Estuary/lagoon, Figure IVN for Aptos Estuary/lagoon.

At Scott Lagoon, when there was tidal overwash with salinity increase at the bottom, water temperature near the bottom increased.

In San Lorenzo lagoon, water temperature near the bottom was higher than near the surface with saltwater on the bottom during the period of sandbar closure in August and September. Near-bottom water temperature began to drop until artificial sandbar breach in late September.

In Soquel Lagoon, the daily minimum % oxygen saturation was lower prior to sandbar closure and after sandbar breaching than while the sandbar was in place.

In Aptos lagoon near the bottom, water temperature increased when saltwater entered and was trapped behind the closed sandbar. Minimum % oxygen saturation near the bottom was particularly low in June and July while the sandbar was open and went to zero just prior to and during a brief sandbar closure in late July. Then in September and October during a period of repeated sandbar closures and breaches (presumably unnatural), % oxygen saturation was extremely low and likely very stressful to steelhead. The Simpson's Index for phytoplankton was relatively low during this period (Figure VB), as was the index for benthic invertebrates in late September. The index for zooplankton was relatively high, however. The biomass of steelhead captured in Aptos lagoon steadily declined in August, September and October (Figure VIII (F)). Is there a connection between poor water quality and declining steelhead biomass here? Or was gear efficiency (catch-per-unit effort) declining?

Nutrient Loading. The size of Soquel Lagoon was greatly underestimated in your report. According to your drawing of the lagoon, you determined that the lagoon was only approximately 800 feet long. However, it actually extends up to the Nob Hill Shopping Center parking lot in summer, making the lagoon approximately 0.6 miles (~3,200 feet) long. Therefore, your estimates of nutrient loading to Soquel Lagoon are considerably overestimated and need to be recalculated after an accurate estimate of surface area is made.

Primary Producer Methods. Data on species biomass of SAV were not presented for Soquel Lagoon or other lagoons. This is an important component of the ecosystem, providing significant nutrient uptake ability and storage. The abundance of filamentous algae on the lagoon bottom and attached to submerged pondweed increases and decreases in cycles through the summer in Soquel Lagoon. This affects the nutrient uptake rate and nutrient storage. Failure to collect standing biomass and pondweed/ filamentous algae growth data on these primary producers would be a major over-site in trying to understand energy and nutrient flow through aquatic systems. These plants compete with phytoplankton for nutrients. There may be an inverse relationship between SAV biomass and phytoplankton biomass. If the SAV take up most of the nutrients, the biodiversity of phytoplankton may also be reduced. According to your graphs, SAV developed in the lagoons with intact sandbars, such as Soquel, Scott and Laguna Lagoons. In lagoon/estuaries subject to sandbar breaches, SAV did not develop.

How was the number of replicates of plankton samples decided? Would more effort have yielded more species? The phytoplankton samples were taken from the upper 0.5 m only. By doing this, are you missing other species that are below 0.5 m from the surface? The zooplankton samples were taken from the entire water column. In Soquel lagoon, unlike in other studied lagoons, the sampling sites were not spread out through the lagoon but concentrated in the lower ¼ of the lagoon? Samples should be taken throughout the lagoon to adequately represent the lagoon's phytoplankton, zooplankton and benthic invertebrate populations and to obtain an accurate Simpson's Index. What were the results of afternoon plankton samples in relation to morning samples?

In Soquel Lagoon, unlike most other lagoons in the study, no phytoplankton samples were analyzed for August or September. Why was the sampling frequency so different in Soquel Lagoon? Were samples taken and not analyzed yet for this period? Were samples taken and somehow compromised? We need transparency. You cannot adequately compare Soquel Lagoon with other lagoons/estuaries in the absence of samples taken at the same time.

Phytoplankton Results. The data presented so far do not address species persistence except with fish species. Community stability cannot be evaluated unless species persistence is measured. Soquel, Scott and Aptos Lagoons had relatively high phytoplankton Simpson indices compared to the other lagoons (except for Laguna Lagoon in October) (Figure VB). The fact that the Simpson's Diversity Index varied so widely between sampling periods for phytoplankton in Soquel Lagoon and other lagoons/estuaries would imply that species persistence was limited. A high index at one time did not insure that the index would remain high the next sampling time. Only in Aptos Lagoon did the index remain stable but relatively low through most of the period. Did the species composition of plankton change at each sampling time within the same lagoon/estuary, or did species persist? Does the species composition naturally change from summer to fall? Are the same species found with the sandbar closed or open? Is there euryhaline and stenohaline phytoplankton? Is there a lag time between sandbar closure and when the freshwater community structure of phytoplankton becomes established? In Figure VB, the phytoplankton Simpson's Index declined greatly in Soquel Lagoon in October. What is the explanation for the reduction in the index in October? What are the causal factors for phytoplankton diversity?

There appears to be a poor correlation between phytoplankton biovolume and the Simpson's Diversity Index for phytoplankton in Soquel Lagoon and other lagoons. Why is that?

The Simpson's Index does not provide a pure measure of species richness. It would be enlightening to provide species richness for phytoplankton, zooplankton and benthic invertebrates, as it was done for fish.

Zooplankton Results. The same data gap existed for sampling of zooplankton in Soquel Lagoon in August and September as existed for phytoplankton. Will these data be provided later? Will Soquel Lagoon be sampled at the same frequency as other lagoons and lagoon/estuaries in 2005?

The zooplankton Simpson's Diversity Index fluctuated less than that for phytoplankton, but was similarly high in all lagoons in September and October, with the sandbars closed for varying lengths of time. The zooplankton index remained close to the 0.6-0.8 range in all lagoons from July through October, except for a lower index in Soquel Lagoon in July and a low reading in the upper SLR lagoon in August.

Your results indicate that sometimes when the Simpson's Diversity Index for the phytoplankton is low, the index for the zooplankton consumer trophic level is high (Figures VB and VID). Why does there seem to be an inverse relationship between the Simpson's Diversity Index for zooplankton species vs. that for phytoplankton species in Soquel Lagoon and other lagoons? In October 2004, the phytoplankton Simpson's Index in Soquel Lagoon was at its lowest while the zooplankton Simpson's Index was at its highest. In the San Lorenzo lagoon, there seemed to be a positive relationship between phytoplankton biovolume and the zooplankton Simpson's index at the end of the summer, at a time when the phytoplankton Simpson's index was low. Does this imply that zooplankton biodiversity was more a function of the amount of phytoplankton available than the biodiversity of phytoplankton in some situations? Is this what you would expect? How does this inverse diversity relationship between trophic levels relate to overall community stability?

When a Simpson's Index for all species in the community is calculated, will low indices on the phytoplankton trophic level be offset by higher indices on the zooplankton trophic level?

Soquel Lagoon was unique among the lagoons studied in that all zooplankton in June were brachionus (Figure VIB) and all zooplankton in July 2004 were rotifers. What is the explanation for this uniqueness?

The Simpson's indices for only benthic organisms seem very similar between Scott, Laguna, Soquel and the upper San Lorenzo lagoons (Figure VII (C)). How much difference between index values is considered ecologically meaningful? The relative contribution of different taxa that make up the biodiversity is very different in every lagoon. What generalizations can be made with such variation?

Benthic Invertebrate Methods. With benthic samples taken only once during the summer in each lagoon, no indication of variability in biomass or species persistence is available. A measure of stability of the benthic invertebrate component of the community is not possible with one sample. The sampling time for benthic fauna was late September for all lagoons except 1 October in upper San Lorenzo. This is at the end of the summer season when water temperatures are cooling off. What would the findings have been earlier in the summer?

How were the number of replicates of benthic transects decided? Methods between lagoons were not standardized from the description in regard to the length of the transects. The methods are misleading in that they state that an upstream and downstream station was sampled corresponding to water quality stations. In fact, all water quality stations were concentrated in the lower ¼ of Soquel Lagoon in 2004. Consequently, benthic samples were also biased toward the lower end of the lagoon, unlike in other lagoons. Why did the locations of water quality sampling stations determine the locations of benthic samples? What evidence is there that the benthic samples adequately represented the benthic community?

The sampling techniques and protocols need to be stated in the methods. Were the transects of equal lengths in each lagoon? Were the streambanks similar in spatial heterogeneity in each lagoon.

The benthic invertebrate biologist stated in the presentation that data were collected differently in each lagoon regarding types of habitat sampled (with or without emergent vegetation, walls vs. sandy shoreline, steep vs. gradual margins, transects of varying lengths, differing surface areas sampled. This lack of standardization of sampling between lagoons makes any quantitative comparisons between lagoons difficult. Our experience with sampling benthic invertebrates in streams indicates that invertebrate production varies widely from one benthic location in a riffle to another. In order to actually quantify invertebrate production in such spatially heterogeneous environments requires substantial sampling effort. Are you confident that your level of benthic sampling will provide accurate quantification of benthic invertebrate densities? Would benthic transects performed 10 feet away or 1,000 feet way from the previous transects have yielded quite different results with regard to biomass and species composition? How different would the Simpson's Index have been? Samples were concentrated in the lower ¼ of Soquel Lagoon.

Benthic Invertebrate Results. The abundance of filamentous algae on the lagoon bottom and amount attached to other SAV increases and decreases in cycles through the summer in Soquel Lagoon. Do some benthic invertebrate populations fluctuate with cycles of abundance of filamentous algae and pondweed? Timing of benthic samples may greatly influence the results. With such limited benthic sampling in only late September and only in the lower ¼ of Soquel Lagoon, it is doubtful that the analysis fully represents the benthic invertebrate production or diversity throughout Soquel Lagoon and throughout the summer season. If samples had been taken earlier in the summer, would the Simpson's Index for benthic invertebrates been different than that presented for Soquel Lagoon?

Fish Sampling Methods. Methods of sampling need more details regarding length of seines, height of seines, presence of bag or not on seines, depth of lagoon where seining, location of sampling, number of seine hauls, number of transects/trawls for invertebrates, length of transects for trawls. Maps of the lagoons should be used to denote locations of seining. What is the meaning of "standard sites."? The actual dates of fish sampling should be provided, with reference to whether the lagoon sandbar was open or closed at the time of sampling.

When we inquired from you at the last meeting about the number of seine hauls done in each lagoon, it appeared that the amount of sampling effort in each lagoon and the relative area sampled in each were not standardized. Even if the sampling effort is standardized, only a mark and recapture effort in various lagoons will allow fish biomass comparisons between lagoons. This is because gear effectiveness will not be the same in all lagoons due to varying depths, differences in irregularities on lagoon bottoms, differences in the distribution of fish cover and varying opportunities for landing the seine in each lagoon. Furthermore, experience indicates that fish are not evenly distributed throughout the lagoon. Therefore, the catch from a given area of seining cannot be multiplied by a factor that would include the entire lagoon area. It is doubtful that species evenness used in the Simpson Index can be accurately determined from the limited fish sampling done in the lowermost of Soquel Lagoon. With the limited sampling access in Soquel Lagoon, mark and recapture is the only way to objectively estimate population size of steelhead or other fish species. We do not see how catch-per unit-effort can be standardized across lagoons and lagoon/estuaries because of the variability in equipment effectiveness. Catch-per-unit-effort differs between purse seines and beach seines. Equipment effectiveness varies with water depth, proximity of fish cover in relation to sampling effort, number of obstacles on the bottom, number of locations where beach seines can be landed and number of areas where only purse seines may be used.

Fish Sampling Results. Can the fish sampling data gathered by Fruend (NOAA Fisheries) and Alley in early October be used somehow? The methods were different than at other sampling times, but it sounded like methods were somewhat different at each sampling time and between lagoons? One could clearly state the amount of effort expended at each sampling time as a qualifier to the results. It may show that with different techniques and different effort in sampling, more or less juvenile steelhead were captured. We captured more steelhead in early October than were captured at other times. 281 steelhead were captured with 4 effective seine hauls on 3 October 2004.

Also, the results of the mark and recapture effort in Soquel Lagoon in 2004 could be included in your report. The juvenile steelhead population estimate was the highest in 12 years in that lagoon.

Table VIII (J) indicates that Soquel Lagoon was sampled with 166 steelhead caught in October. Figure VIII (I) shows a % Frequency histogram for the October catch. However, Soquel Lagoon data from October sampling are missing for the fish biomass estimate in Figure VIII (F), the October ranking of fish species abundance in Table VIII (E) and October species catch composition by biomass in Figure VIII (G). Why is this? The Aptos Lagoon catch is included. It appears from Table VIII (J) that your fish capture effectiveness for steelhead was better after the lagoon was breached and the estuary depth was reduced in October. Is this true?

It would be informative to include whether the sandbars were open or closed at the time of sampling in Figures VIII (F) and VIII (G). If the sandbar was closed, it would be informative to know how long it had been closed at the time of sampling or whether it had been overtopped.

It would be enlightening to have graphs of size class frequency histograms for fish in each lagoon for each sampling period, with the date of sampling provided. The percent frequency graphs provide some good comparisons, but absolute numbers by size class are lost. These graphs would supplement and complement the growth rate data that you provide from pit-tagged recaptures.

It would be enlightening to provide results of growth rates in Soquel Lagoon along with the data already provided from other lagoons and lagoon/estuaries. Will there be data forthcoming in

2005 for Soquel Lagoon?

The way the fish catch results are presented in Figure VIII (F), it implies that abundance comparisons are possible between lagoons. This cannot be done because of variation in seining effectiveness with differing lagoon depths, variation in lagoon access for seining, differences in effort and possibly differences in equipment used. Aptos Lagoon is much more shallow than Soquel Lagoon, making it easier to capture fish in Aptos Lagoon. The virtual absence of steelhead biomass indicated in the graph from July in Scott Lagoon looks like an artifact caused by a change in sampling effectiveness. Do you think this rapid increase in steelhead biomass from 0 to nearly 5,000 grams was real? If so, do you know why they would suddenly appear in the middle of summer? This pattern was not shown in other sampled lagoons and lagoon/estuaries, such as Soquel Lagoon. Are there data from fish traps set in Scott Creek that would indicate when steelhead move into Scott Lagoon for the summer?

Figure VIII (F) is misleading. It was not possible to estimate fish biomass of Soquel Lagoon with limited sampling in the lower ¼ of the 0.6-mile long. Once the sandbar was constructed, only a small portion of Soquel Lagoon was accessible to beach seining, and nearly all of that was down at the lower end. Was a purse seine used in Soquel Lagoon the way it was in the San Lorenzo Lagoon/estuary?

The Y-axis entitled "Biomass Estimate" should be entitled "Biomass of the Catch." A footnote should be included that states that no comparison of abundance between lagoons is intended from these data. The graphs imply that the fish biomass present in Soquel Lagoon was less than 1/6 that in Aptos Lagoon in July 2004. In fact, the true fish biomass of the two lagoons was unknown. Since Aptos Lagoon was much more shallow, it is probable that seining was much more effective in capturing steelhead in Aptos Lagoon, based on our experience with seining lagoons of varying depths.

The comparisons of fish species richness and Simpson's indices of fish diversity between Soquel Lagoon and other lagoons/estuaries are of questionable value in assessing the habitat quality of each lagoon and the persistence of each fish species. Lagoons are at the transition point between fresh and saltwater. With an open sandbar, both marine and freshwater fish may be found in the estuary. The boundary for an estuarine community is quite large, encompassing the nearshore marine fauna and flora. In the estuary you find the euryhaline species, such as Pacific herring, topsmelt, staghorn sculpin, striped bass, tidewater goby and threespine stickleback, that can tolerate both fresh and saltwater, along with the more marine nearshore surfperches and surfsmelt. Once the sandbar closes, the lagoon environment begins to convert to a freshwater system with its own community structure of species made up of and more stenohaline species, such as Sacramento sucker (tolerate up to 4 ppt saltwater), Sacramento blackfish (tolerate up to 7-9 ppt) and hitch (tolerate up to 7-9 ppt), that are more common in freshwater environments (Jerry Smith, pers. communication). Juvenile steelhead can adjust to salinity, but initially probably go higher in the water column in an estuary system to avoid salinity. They cannot survive, however in warm saline layers on the bottom where oxygen becomes depleted from decomposition.

When some marine species become trapped in lagoons, they do poorly and disappear in time. Species such as surf smelt, dwarf surfperch and redtail surfperch drop out sooner than shiner perch (tolerate down to 3 ppt saltwater) (Jerry Smith, pers. communication). Mortality and fungal infection are commonly observed in fish species poorly adapted physiologically to freshwater, such as we have observed with larger starry flounders in Salinas Lagoon. Dead topmelt were observed in Soquel Lagoon a few days after tidal overwash, indicating that they cannot tolerate sudden change to freshwater. However, fish species that thrive in a freshwater environment can persist in the closed freshwater lagoon, such as Sacramento suckers and steelhead. Species that require freshwater to reproduce, such as tidewater goby, can persist. It has been asserted that artificial breaching of lagoon sandbars is one of the factors leading to extirpation of tidewater goby from some systems.

If the sandbar is breached and then allowed to close again, saltwater species may enter and become trapped. Many of them will drop out as salinity declines. If sufficient saltwater and ocean kelp and sea grass become trapped and begin to decompose. Water temperatures will become elevated and oxygen depletion will occur. Fish that do better in a cooler, freshwater lagoon, such as juvenile steelhead, will decline if water becomes too warm and oxygen becomes too low. We have observed an anoxic zone develop with this scenario in Soquel Lagoon. Oxygen was absent in an area from the beach, upstream to near Noble Gulch, which was close to the uppermost water quality sites in this study.

Hagar stated that sampling intensity and gear types that were used in 2004 in the San Lorenzo Lagoon might have been insufficient to characterize the fish "community" (i.e. component). He stated that fish data might have been insufficient to identify effects of environmental parameters and to compare fish abundance to other lagoons/estuaries. He was uncertain whether differences in relative abundance of fish captured from one sampling time to the next was a result of an actual change in the fish component or an effect of the sampling protocol. It seems like when the sandbar closed on the San Lorenzo and the lagoon became deeper, he had trouble in capturing steelhead. He reports in one place of the disappearance of steelhead in fall samples. But this may have been due to difficulty in capturing them. He is recommending that more effort be placed on capturing steelhead in 2005. Would a long beach seine (106 ft by 6 ft by ¼-inch mesh size) with a bag in the center be more successful than a purse seine where there is a landing spot available near the trestle? This is what we have used on Soquel Lagoon and the San Lorenzo Estuary in the past, where there is a sandy beach to bring it in.

Is it "healthier" to have a lagoon dominated by steelhead and threespine stickleback like in Soquel and Scott Lagoons in 2004 or to have a lagoon/estuary that was dominated mostly my marine fish species like top smelt, as the data from the San Lorenzo Lagoon/estuary indicates in the fall? What are our management goals?

Cautionary Final Remarks. You stated in the last meeting that lagoons are "healthier" when the sandbar is open rather than closed. This statement implies a premature bias. Your study is not complete. When it is, you will have looked at only a very few years of data that will not likely span the wide breadth of possible conditions in the respective systems if interest. You certainly have not looked at the systems under drought conditions. Furthermore, you do not include a largely undisturbed system with which to compare. Yet you make this blanket ascertain.

Our experience at Soquel Lagoon over the past 15 years has indicated that the estuary conditions in late spring vary widely regarding the depth of the estuary, the location of the thalweg, the amount of stream inflow, the amount of kelp and seagrass washed into the estuary, the amount of sand on the beach and the path of the estuary through the sandbar. The only two lagoons in your study which had a sandbar formed early in the summer in 2004, with the sandbar remaining intact AND with sufficient stream inflow to maintain the lagoons were Scott and Soquel Lagoons. Although the Laguna Lagoon sandbar closed early, the lagoon nearly dried up. The San Lorenzo and Aptos lagoon/estuaries were subject to artificial sandbar breaching.