TIDAL EXCHANGE AND WATER QUALITY MONITORING
SALT RIVER ECOSYSTEM RESTORATION PROJECT
PHASE 1 & 2
YEAR 2 – 2015

Prepared for: Humboldt County
Resource Conservation District
5630 South Broadway, Eureka CA 95503
Submitted: 26 January 2016

PURPOSE

In 2013 restoration work was completed to re-convert over 300 acres of reclaimed pasture back to a variety of tidal marsh habitats. This work represents the first phase (Phase 1) of a watershed-scale restoration effort known as the Salt River Ecosystem Restoration Project. In 2014, 1.2 miles of Salt River channel was restored/enhanced from the restored estuary (Phase1), upstream to the upper extent of tidal inundation (portion of Phase 2). Presented in this Tidal Exchange and Water Quality Monitoring Report are the results of three months of continuous sampling for water quality parameters including salinity, dissolved oxygen, temperature, and water-level within the aforementioned described project footprint.

INTRODUCTION

The Salt River Ecosystem Restoration Project is located in Humboldt County, California near the City of Ferndale. The purpose of the Salt River Ecosystem Restoration Project (SRERP) is to restore hydrological processes and functions to the Salt River watershed. These processes and functions are necessary to re-establish a functioning riverine, riparian, wetland and estuarine ecosystem as part of a land use, flood alleviation, and watershed management program.

An essential element to the design of the SRERP is the restoration, or re-conversion, of 330 acres of tidal estuary on the former Riverside Ranch dairy. This work was largely completed in 2013 and represents the first phase of a multi-year, multi-phase ecosystem restoration effort. This component of the larger project was also known as the Riverside Ranch Tidal Marsh Restoration (Phase 1) for the purposes of some grant funds secured for the project.

In 2014, and additional 1.2 miles of main stem Salt River channel was excavated and enhanced immediately upstream of the 2013 effort. The extent of the 2014 restoration terminated within feet of the expected tidal inundation (just above Dillon Road Bridge). This portion of the restoration efforts constitutes a portion of the project footprint known as Phase 2.

Restoration work re-established intertidal connection between the Eel River Estuary and the Salt River and substantially enhanced wetland habitat. The restored marsh area in combination with expansion of the Salt River channel and creation of an extensive internal slough network has increased tidal exchange and enhanced tidal prism (i.e. increasing the volume of water exchanged on each tidal cycle). These restored features are intended to help sustain the Salt River channel's width and depth.

Some primary objectives of the tidal marsh restoration include specific items to help attain the overall project goals:

- Use the increase in tidal prism to help maintain the constructed Salt River channel geomorphology and conveyance.
- Improve drainage and water quality in the lower Salt River and Eel/Salt River estuary.

- Restore tidal connectivity to historic tidal wetlands to allow for the natural evolution of diverse and self-sustaining salt- and brackish water tidal marshes, intertidal mudflat and shallow water habitats.
- Create a template for the natural evolution of a complex tidal drainage network. The network will maximize subtidal and intertidal habitats beneficial to target fish and wildlife species. This includes the enhancement of rearing and migration conditions for estuarine-dependent species including: coho salmon, Chinook salmon, steelhead trout, coastal cutthroat trout, tidewater goby, and commercially and recreationally valuable species such as redtail perch.
- Provide wintering habitat for migratory waterfowl and shorebirds.

METHODS

An Adaptive Management Plan (AMP) was developed and adopted for the SRERP. The AMP describes the organizational structure for the adaptive management process, identifies key players and their roles, and provides a range of management thresholds and triggers. The process is intended to ensure that project goals and objectives are attained while also providing for on-going, long-term input from local property owners and other stakeholders. The AMP defines numerous monitoring requirements that encompass erosion, geomorphic, sediment, and habitat conditions. This report's monitoring effort focuses on the tidal prism and water quality objectives on Phase 1 and the lower portion of the Phase 2 restoration of the SRERP.

To measure tidal prism, multi-parameter recorders were deployed to determine tidal exchange, functional tidal prism, and a healthy salinity structure. The water quality parameters measured were water level, temperature, dissolved oxygen, and salinity levels. Recorders were deployed at four sites across Riverside Ranch (Figure 1). The sites include: 1) immediately downstream of the confluence of the southern slough channel with the Salt River; 2) at a terminal end of the southern slough channel network, associated with a fish sampling site; 3) immediately downstream of the confluence of the northern slough channel with the Salt River; 4) at a terminal end of the northern slough channel network, associated with a fish sampling site. Two additional sites were established outside of the Phase 1/Riverside Ranch footprint, which included a site near the confluence of the Salt River and Eel River and further upstream on the main stem Salt River channel near the upstream tidal extent (at Dillon Road Bridge).

In 2014 (Year 1), data loggers were deployed in PVC housings. However, the PVC housing may have inflated temperature data due to the housing heating up during low tide events during daylight hours. Therefore data loggers were simply attached to the outside of PVC covered rebar. Each recorder was programed to take samples every hour, on the hour, each day of deployment. This sampling regimen is a high enough resolution to determine the changing habitat conditions. Dissolved oxygen (DO) loggers are only required to be at two interior slough sites on Riverside Ranch. These sites are associated with two fish sampling sites. DO loggers are

deployed for only two weeks in July/August to determine DO levels in the slough channels during the warmest part of the year.

Figure 1: 2016 Water Quality Sampling Sites across the Salt River Ecosystem Restoration Project.

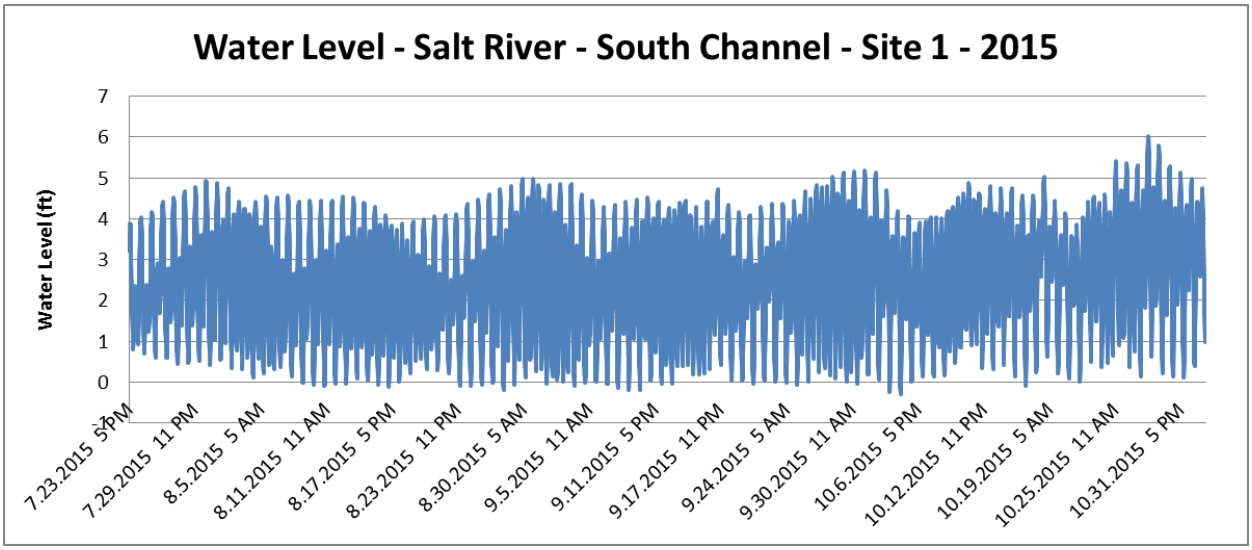
RESULTS

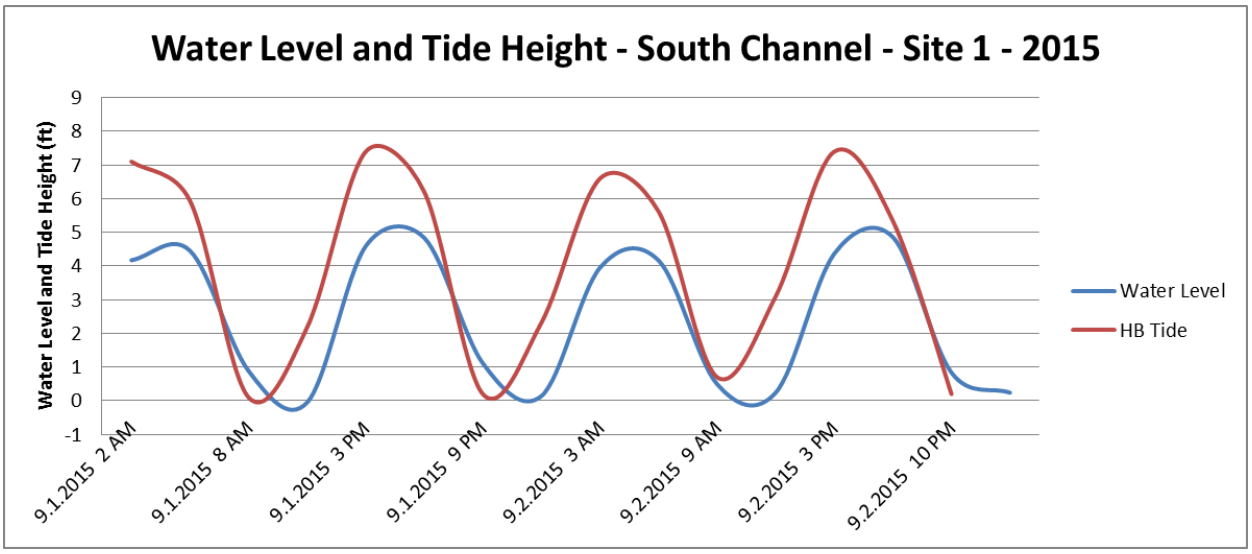
The results of last year's (2014) data indicated that the loggers fouled over time, thus providing erroneous data. In 2015, the sensors of each logger were cleaned in early August. However, due to time constraints, no further cleanings were performed. Some of the following salinity results indicate that the fouling of the salinity logger sensors likely impacted the recorded data. Additionally, the loggers deployed at the site near the confluence of the Salt River and Eel River were lost; either due to vandalism or scour and channel current.

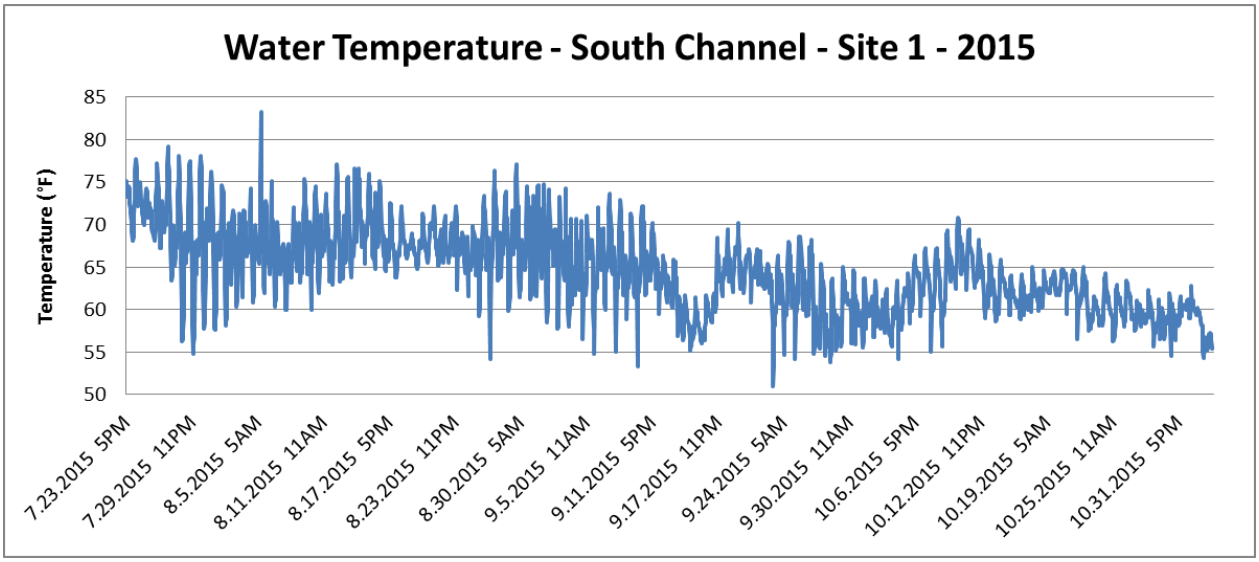
The following will present summarized data by site for water level, comparison of water level and tidal height (Humboldt Bay), salinity, and dissolved oxygen.

Site 1 – Southern Salt River Channel Adjacent to Riverside Ranch

Site 1 is located in the main stem Salt River in the estuary portion of the project area (Riverside Ranch), immediately downstream of the confluence of the southern slough channel network. In 2015, the site is influenced by tidal waters and fresh water inputs which are directly upstream (Reas Creek) and downstream (Smith Creek). The loggers were stationed on the right side of the channel, above the thalwag, to keep the equipment out of the way of any boat traffic. At low tides, the site is often completely dewatered; thus water quality loggers are exposed to the air. The loggers were deployed on July 23rd, 2015. Water level and salinity loggers were retrieved on November 4th, 2015.




Water Level and Tide Height - South Channel - Site 1 - 2015
Water Level and Tide Height (ft)
9
8
7
6
5
4
3
2
1
0
-1
9.1.2015 2 AM
9.1.2015 8 AM
9.1.2015 3 PM
9.1.2015 9 PM
9.2.2015 3 AM
9.2.2015 9 AM
9.2.2015 3 PM
9.2.2015 10 PM
Water Level
HB Tide


Water Temperature - South Channel - Site 1 - 2015
Temperature (°F)
85
80
75
70
65
60
55
50
7.23.2015 5PM
7.29.2015 11PM
8.5.2015 5AM
8.11.2015 11AM
8.17.2015 5PM
8.23.2015 11PM
8.30.2015 5AM
9.5.2015 11AM
9.11.2015 5PM
9.17.2015 11PM
9.24.2015 5AM
9.30.2015 11AM
10.6.2015 5PM
10.12.2015 11PM
10.19.2015 5AM
10.25.2015 11AM
10.31.2015 5PM

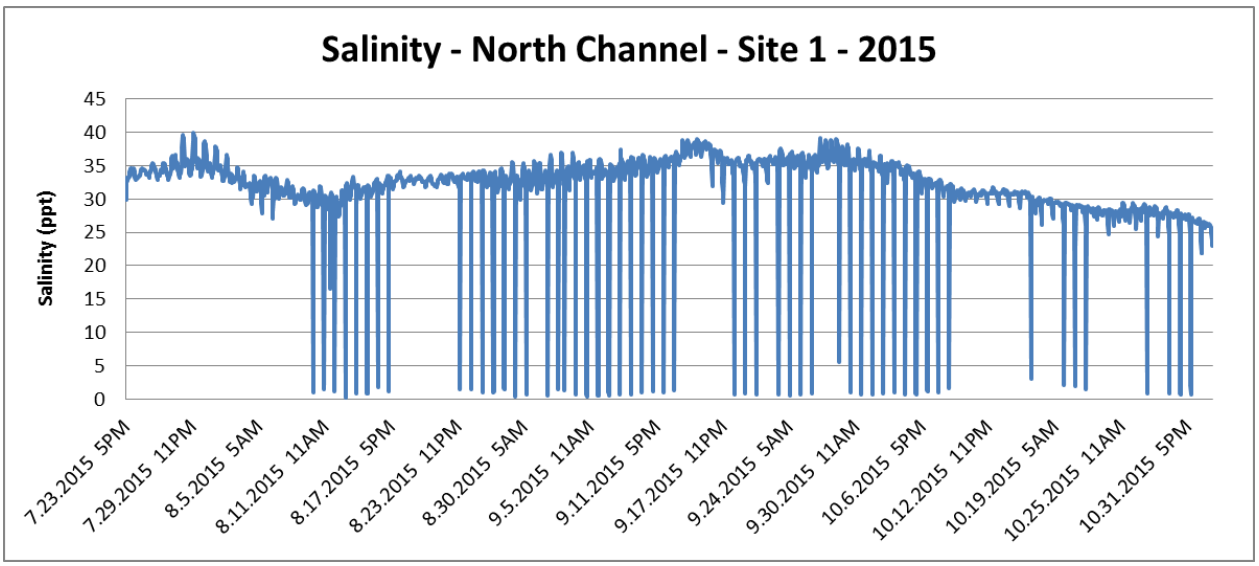

Salinity - North Channel - Site 1 - 2015
Salinity (ppt)
45
40
35
30
25
20
15
10
5
0
7.23.2015 5PM
7.29.2015 11PM
8.5.2015 5AM
8.11.2015 11AM
8.17.2015 5PM
8.23.2015 11PM
8.30.2015 5AM
9.5.2015 11AM
9.11.2015 5PM
9.17.2015 11PM
9.24.2015 5AM
9.30.2015 11AM
10.6.2015 5PM
10.12.2015 11PM
10.19.2015 5AM
10.25.2015 11AM
10.31.2015 5PM

Table 1. Water Parameter Statistics for Site 1

	Water Parameter - Site 1			
	Water Level	Temperature	Salinity	Dissolved Oxygen
	(ft)	(°F)	(ppt)	(mg/L)
Maximum	6.0	83.2	39.9	N/A
Minimum	-0.3	51	0.3	N/A
Average	2.5	64.5	31.7	N/A

Water Level – Site 1

Site 1 is located in the Eel River estuary and is directly affected by tidal water inundation. Large fluctuations in the water level, as depicted by the data, are due to the diurnal high and low tides. The tides are muted at the site compared to actual ocean conditions. Maximum water level during the sampling period (July through October) reached 6.0 feet and decreased to a minimum of -0.3 feet, with an average 2.5 feet (Table 1).

Water levels at site 1 are compared to tide heights at the Humboldt Bay North Spit tide station for two days in September (1st and 2nd). Though tides heights in the Humboldt Bay and water levels at site 1 should not be strictly equated to each other since the site is not at a 0.0 ft elevation, tides and water levels can be correlated to determine the lag time of tidal waters entering the site. Reviewing the graph above and the associated data, it appears at this site, the high tide lag is between 1 to 2 hours (average 1.25 hours) and the low tide lag is 2 hours within the two day interval.

Temperature – Site 1

Temperature readings were collected from the water level recorder. This recording device was likely exposed to air temperature during lower tides, thus recording large temperature spikes (i.e. high temperature spikes when low tides occurred during daylight hours, and low temperature spikes when low tide occurred during the night). The average temperature during the sampling period is calculated at 64.5 °F. The maximum temperature of 83.2 °F (Table 1) occurred on August 5th at noon with a 0.56 ft low tide. The minimum temperature of 51 °F (Table 1) occurred on September 23rd at 4 AM with a 0.018 ft low tide. The Water Temperature graph above shows a decreasing temperature trend from July to October. This is consistent with colder atmospheric and ocean temperatures developing as the seasons turn from summer to fall.

Salinity – Site 1

Salinity values ranged from 39.9 (ppt) to nearly zero (0.3ppt). The low salinity values correspond to the logger being out of the water during the logging time. However, if the outliers are neglected, salinity appears to range between 40 (ppt) and 23 (ppt). In 2014, salinity logger sensors proved to foul quickly. Thus the data collected may be erroneous. However, the data

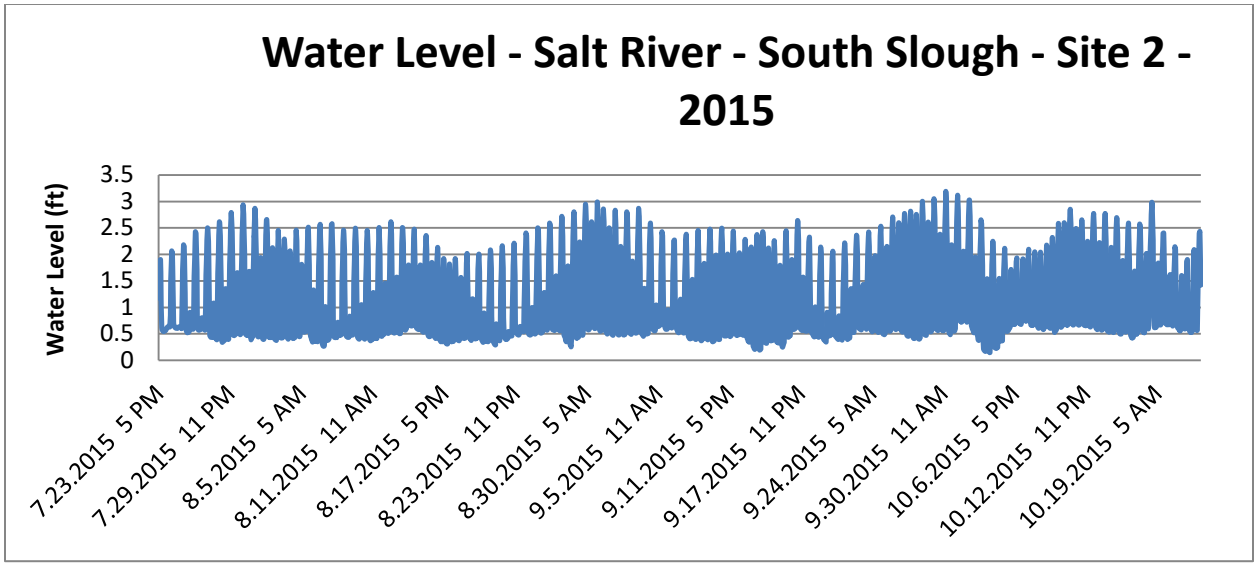
collected at this site (1) appears probable. The decreasing salinity values from late September to the end of the collection period (November), coincides with increasing rain events. These rain events produced increased fresh water inputs not only in the Salt River tributaries, but also in the Eel River which pushes up into the estuary at high tides.

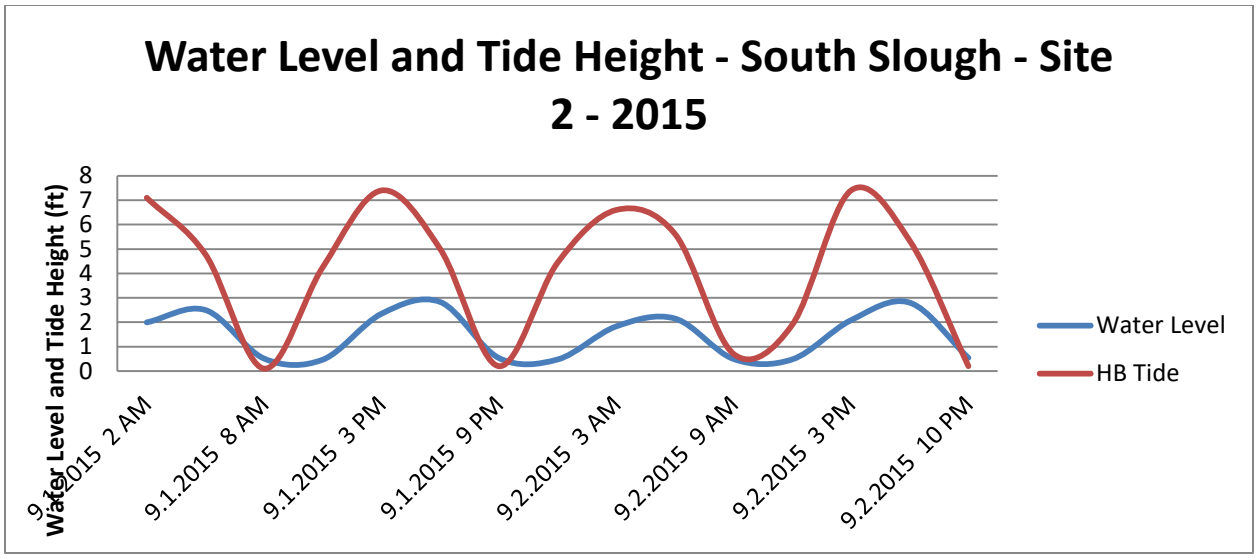
Dissolved Oxygen – Site 1

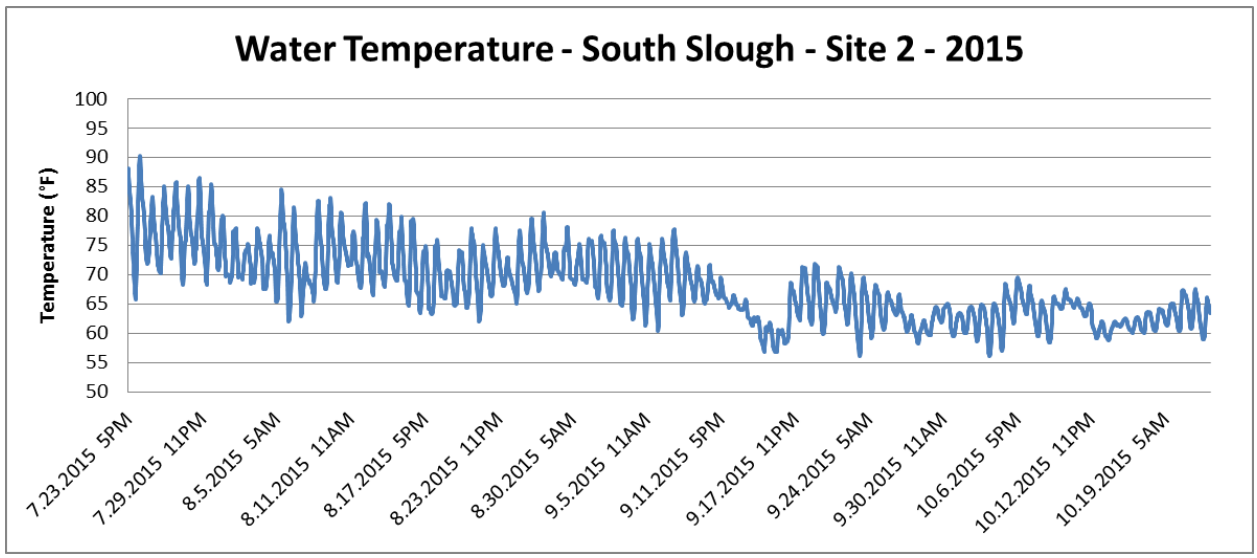
A dissolved oxygen logger was not deployed at this site. Dissolved oxygen loggers are only deployed in the interior slough channels of Riverside Ranch.

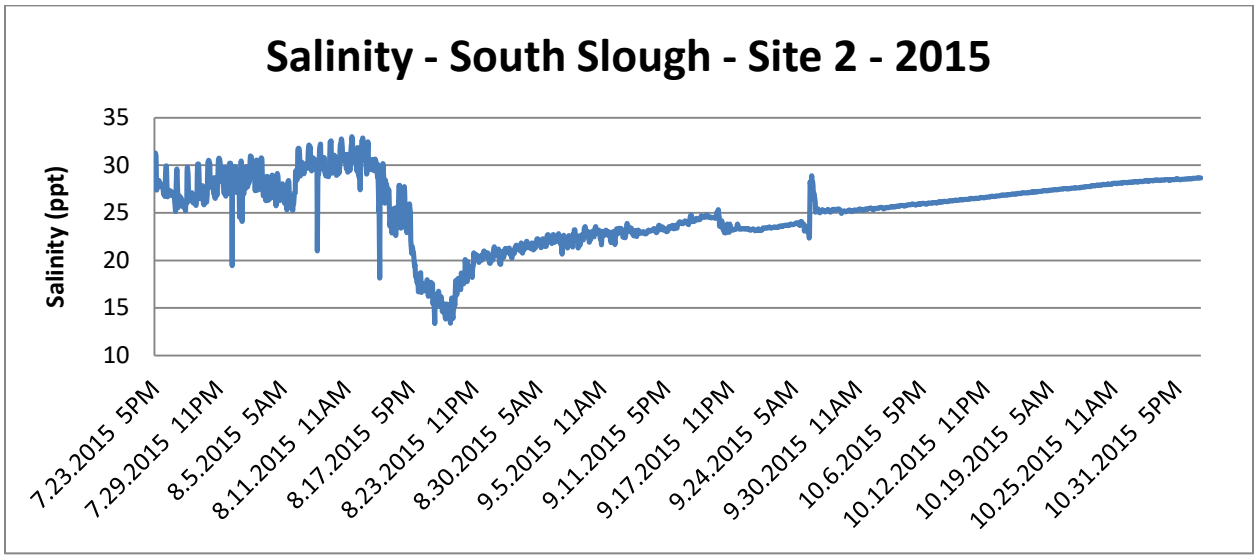
Site 2 – Southern Slough Network on Riverside Ranch

Site 2 is located in the southern slough network in the estuary portion of the project area (Riverside Ranch), at one of the terminal arms furthest away from the confluence of the Salt River. This site is not the same as site 2 in 2014. Staff relocated the site due to sedimentation variability at the original site 2. This site is almost exclusively tidally influenced. Fresh water inputs are incidental, and come in with the high tides. The loggers were stationed behind a channel feature that creates backwater at low tides. Therefore, at low tides, the site always holds water and the loggers are continually submerged. The loggers were deployed on July 23rd, 2015. The dissolved oxygen logger was retrieved two weeks later on August 6th, 2015. Water level and salinity loggers were retrieved on November 4th, 2015.




Water Level and Tide Height - South Slough - Site 2 - 2015
Water Level and Tide Height (ft)
8
7
6
5
4
3
2
1
0
9.1.2015 2 AM
9.1.2015 8 AM
9.1.2015 3 PM
9.1.2015 9 PM
9.2.2015 3 AM
9.2.2015 9 AM
9.2.2015 3 PM
9.2.2015 10 PM
Water Level
HB Tide


Water Temperature - South Slough - Site 2 - 2015
Temperature (°F)
100
95
90
85
80
75
70
65
60
55
50
7.23.2015 5PM
7.29.2015 11PM
8.5.2015 5AM
8.11.2015 11AM
8.17.2015 5PM
8.23.2015 11PM
8.30.2015 5AM
9.5.2015 11AM
9.11.2015 5PM
9.17.2015 11PM
9.24.2015 5AM
9.30.2015 11AM
10.6.2015 5PM
10.12.2015 11PM
10.19.2015 5AM


Salinity - South Slough - Site 2 - 2015
Salinity (ppt)
35
30
25
20
15
10
7.23.2015 5PM
7.29.2015 11PM
8.5.2015 5AM
8.11.2015 11AM
8.17.2015 5PM
8.23.2015 11PM
8.30.2015 5AM
9.5.2015 11AM
9.11.2015 5PM
9.17.2015 11PM
9.24.2015 5AM
9.30.2015 11AM
10.6.2015 5PM
10.12.2015 11PM
10.19.2015 5AM
10.25.2015 11AM
10.31.2015 5PM

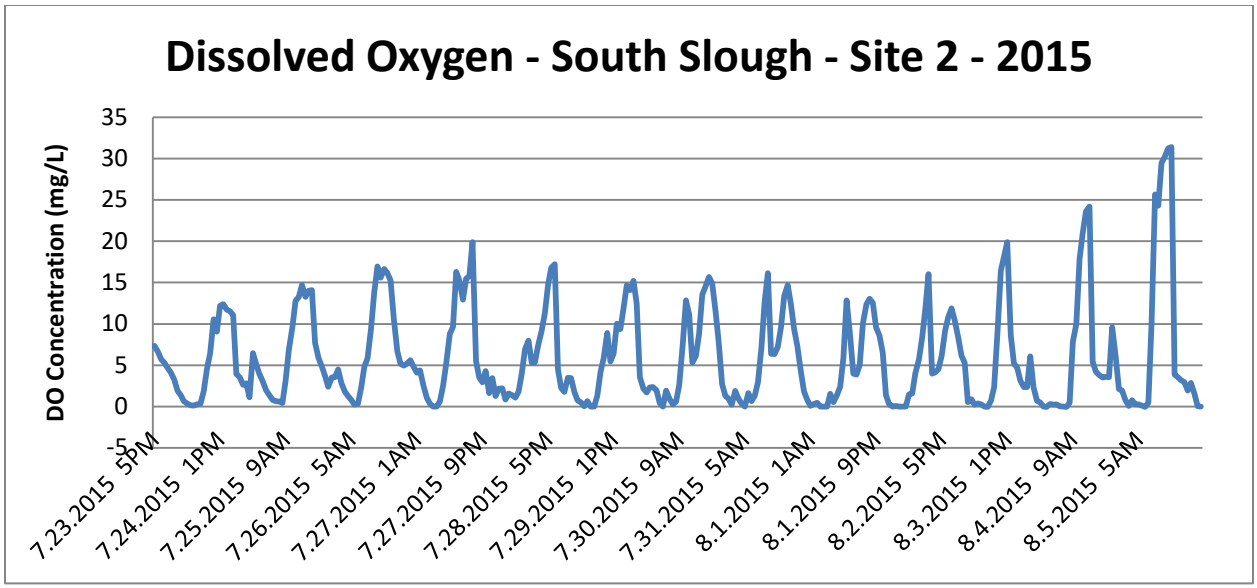


Table 2. Water Parameter Statistics for Site 2

	Water Parameter - Site 2			
	Water Level (ft)	Temperature (°F)	Salinity (ppt)	Dissolved Oxygen (mg/L)
Maximum	3.2	90.3	33	31.4
Minimum	0.1	56.1	13.3	-0.02
Average	1.1	68.2	25.3	5.9

Water Level – Site 2

Site 2 is located in the Eel River estuary and is directly affected by tidal water inundation. Fluctuations in the water level, as depicted by the data, are due to the diurnal high and low tides. The tides are muted at the site compared to actual ocean conditions. Maximum water level during the sampling period (July through October) reached 3.2 feet and decreased to a minimum of 0.1 feet, with an average 1.1 feet (Table 2).

Water levels at site 2 are compared to tide heights at the Humboldt Bay North Spit tide station for two days in September (1st and 2nd). Tides heights in the Humboldt Bay and water levels at site 2 should not be strictly equated to each other since site 2 is not at a 0.0 ft elevation. Tides and water levels can be correlated to determine the lag time of tidal waters entering the site. Reviewing the graph above and associated data, it appears at this site, the high tide lag is

between 1 to 2 hours (average 1.7 hours) and the low tide lag is 3 hours within the two day interval. These lag times indicate that the internal slough network fills quickly, but drains nearly twice as slow.

Temperature – Site 2

Temperature readings were collected from the water level recorder. No temperature spikes should have been recorded since the logger was continuously submerged. However, this is a very shallow site and temperatures can rise dramatically during sun exposure. The average temperature during the sampling period is calculated at 56.1 °F. The maximum temperature recorded is 90.3 °F and the minimum temperature is 68.2 °F (Table 2). The Water Temperature graph above shows a decreasing temperature trend from July to October. This is consistent with colder atmospheric and ocean temperatures setting in from summer to fall.

Salinity – Site 2

In 2014, salinity logger sensors proved to foul quickly. This site has slow water movement, and it appears the sensor became fouled. The Salinity graph above shows readings begin to gradually decrease after the first week. The sensor was cleaned in week two. A week after cleaning, the data shows a gradual decline then increasing values beyond to the end of the recording period. Therefore, a majority of the data collected is inaccurate.

The first week of data collection shows salinity values in the range between 30 (ppt) and 25 (ppt). The week after cleaning, salinity values range between 25 (ppt) and 35 (ppt). Spot salinity measurements, taken with a hand held meter, were at 30.98 (ppt) at deployment and 28.90 (ppt) at retrieval.

Dissolved Oxygen – Site 2

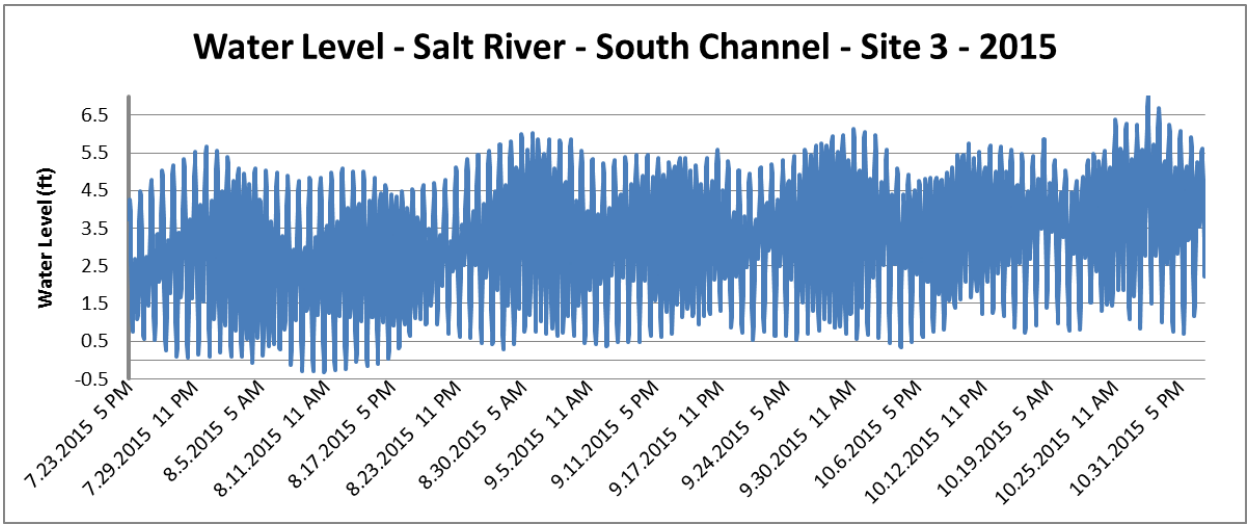
A dissolved oxygen (DO) logger was deployed between July 23rd and August 6th, 2015. The DO levels recorded at this site indicate that DO is positively correlated with temperature. That is, as temperature peaks, DO peaks; as temperatures decrease, DO decreases. This is contrary to rule that cold water contains higher DO levels than warm water. Analyzing the data, DO is not correlated with high tides or changing tides; unless it is coincides with temperature. For example, the highest DO recorded at the end of the sampling period is correlated with high temperatures and a high water levels from a high tide. After further analysis, it was determined that DO is directly and positively correlated with daylight, where DO concentrations are highest during midday (thus during the warmest part of the day). This is likely due to the increased photosynthesis of aquatic microbes in the water (e.g. phytoplankton).

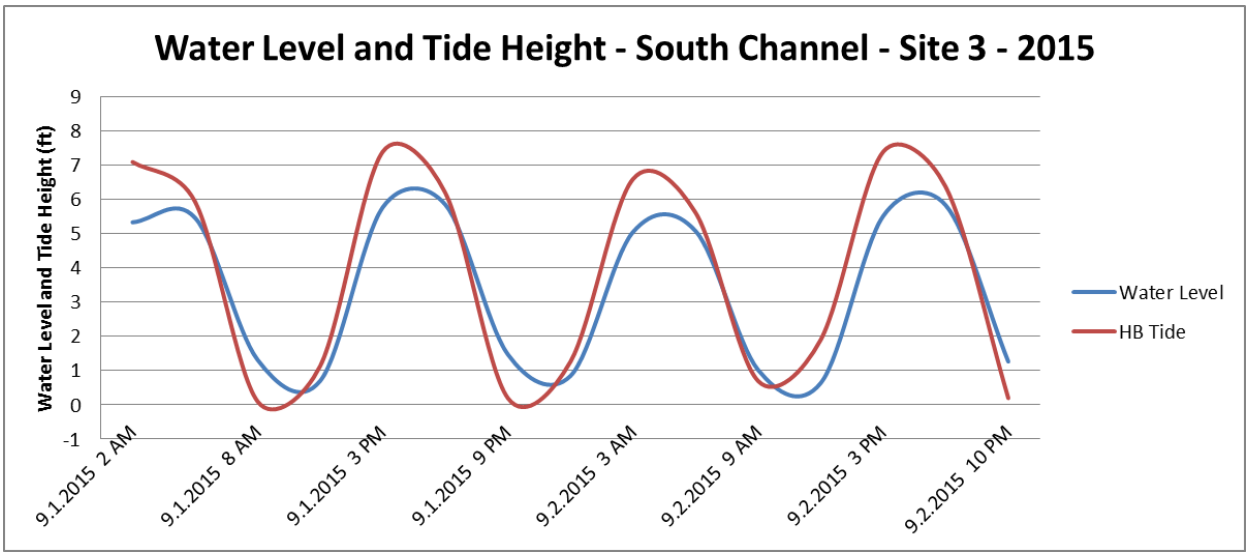
Typically, the amount of dissolved oxygen at 100% saturation is around 10 mg/L. However, water can become supersaturated (>100%) due to the photosynthesis of aquatic microbes. This could explain the maximum DO level of 31.4mg/L. The recorded minimum DO level is -0.02. It is unknown if these values are indicative of true levels. DO meters tend to read inaccurately. However spot DO measurements during fish surveys at the same site indicate supersaturated DO

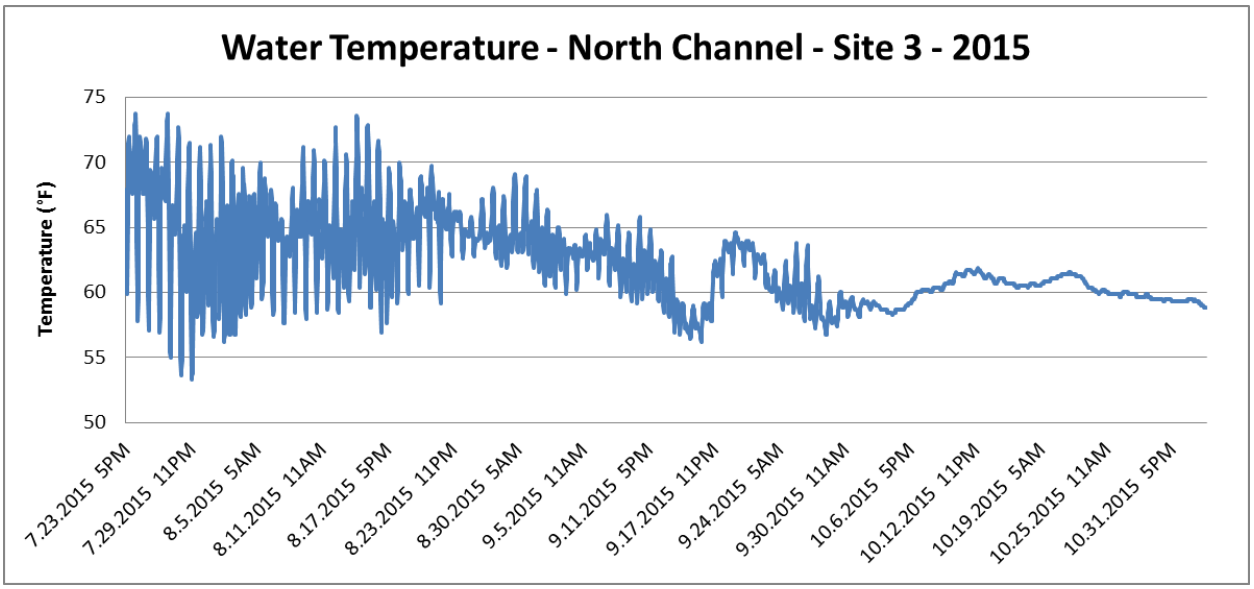
concentrations (approximately 17 mg/L and 23.5 mg/L in June and July respectively). This site supports a variety of fish species such as tidewater goby and juvenile smelt.

Site 3 – South Salt River Channel Adjacent to Riverside Ranch

Site 3 is located in the main stem Salt River in the estuary portion of the project area (Riverside Ranch), immediately downstream of the confluence of the northern slough channel network's confluence. In 2015, the site is influenced by tidal waters and fresh water inputs directly upstream (Reas Creek and Smith Creek). The loggers were stationed on the right side of the channel, above the thalwag to keep the equipment out of the way of any boat traffic. At low tides, the site is often dewatered; thus water quality loggers are exposed to the air. The loggers were deployed on July 23rd, 2015. Water level and salinity loggers were retrieved on November 4th, 2015.







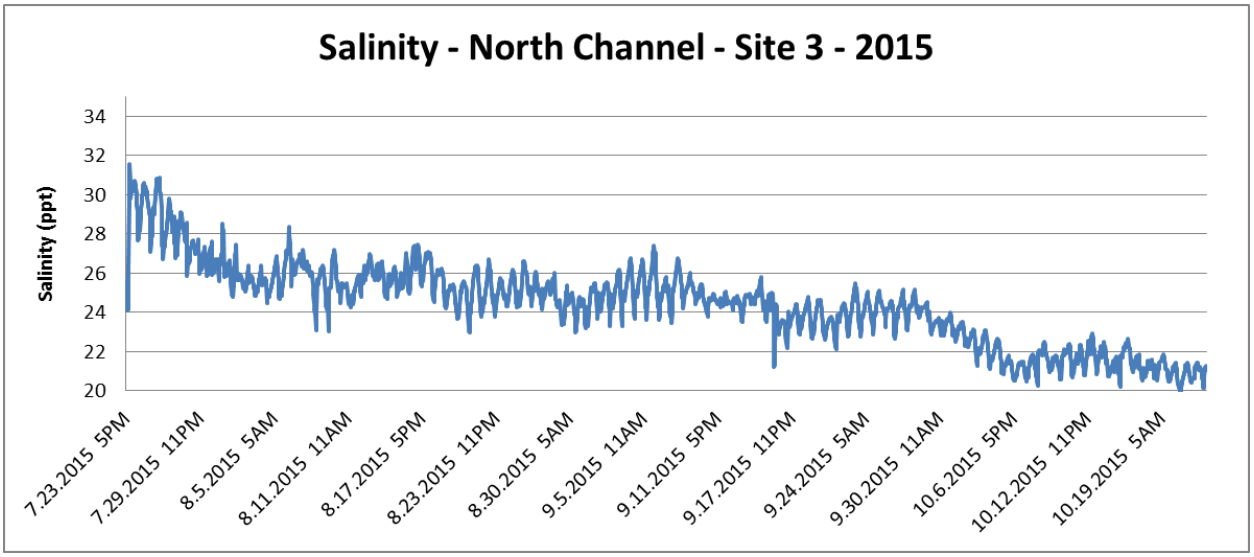


Table 3. Water Parameter Statistics for Site 3

	Water Parameter - Site 3			
	Water Level	Temperature	Salinity	Dissolved Oxygen
	(ft)	(°F)	(ppt)	(mg/L)
Maximum	7.1	73.8	31.6	N/A
Minimum	-0.3	53.3	19.8	N/A
Average	3.2	62.3	24.4	N/A

Water Level – Site 3

Site 3 is located in the Eel River estuary and is directly affected by tidal water inundation. Large fluctuations in the water level, as depicted by the data, are due to the diurnal high and low tides. The tides are muted at the site compared to actual ocean conditions. Maximum water level during the sampling period (July through October) reached 7.1 feet and decreased to the minimum to -0.3 feet, with an average 3.2 feet (Table 3).

Water levels at site 3 are compared to tide heights at the Humboldt Bay North Spit tide station for two days in September (1^{st} and 2^{nd}). Though tides heights in the Humboldt Bay and water levels at site 3 should not be strictly equated to each other since the site is not at a 0.0 ft elevation, tides and water levels can be correlated to determine the lag time of tidal waters entering the site. Reviewing the graph above and the associated data, it appears this site has a high tide lag of 1 hour and the low tide lag is also 1 hour within the two day interval.

Temperature – Site 3

Temperature readings were collected from the water level recorder. The average temperature during the sampling period is calculated at 62.3 °F. The maximum temperature was73.8 °F and the minimum temperature was 53.3 °F (Table 3). The Water Temperature graph above shows a decreasing temperature trend from July to October. This is consistent with colder atmospheric and ocean temperatures setting in from summer to fall. However, the sensor may have fouled as the hourly variable temperature ranges reduced significantly after the end of September; though temperatures during this time range are similar to temperatures recorded for Site 1.

Salinity – Site 3

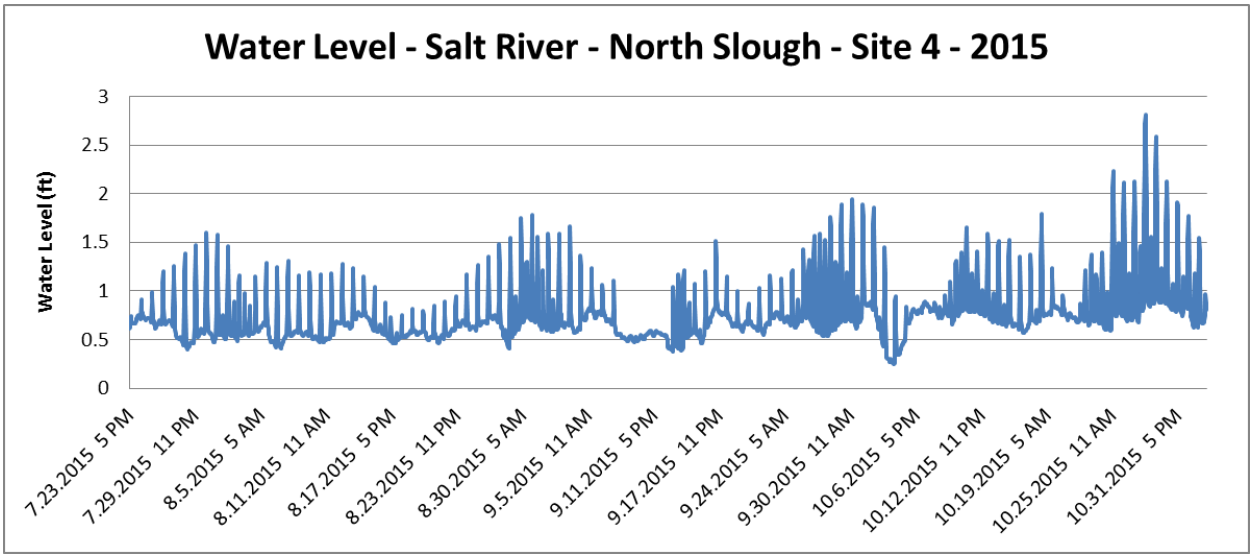
Salinity values ranged from a maximum of 31.6 (ppt) to a minimum 19.8 (ppt). In 2014, salinity logger sensors proved to foul quickly. Thus the data collected may be inaccurate. However, the data collected at this site (3) appears reliable. The decreasing salinity values from late September to the end of the collection period (November), coincides with increasing rain events. These rain events produced increased fresh water inputs not only in the Salt River tributaries, but also in the Eel River which pushes fresh water up into the estuary during high tides.

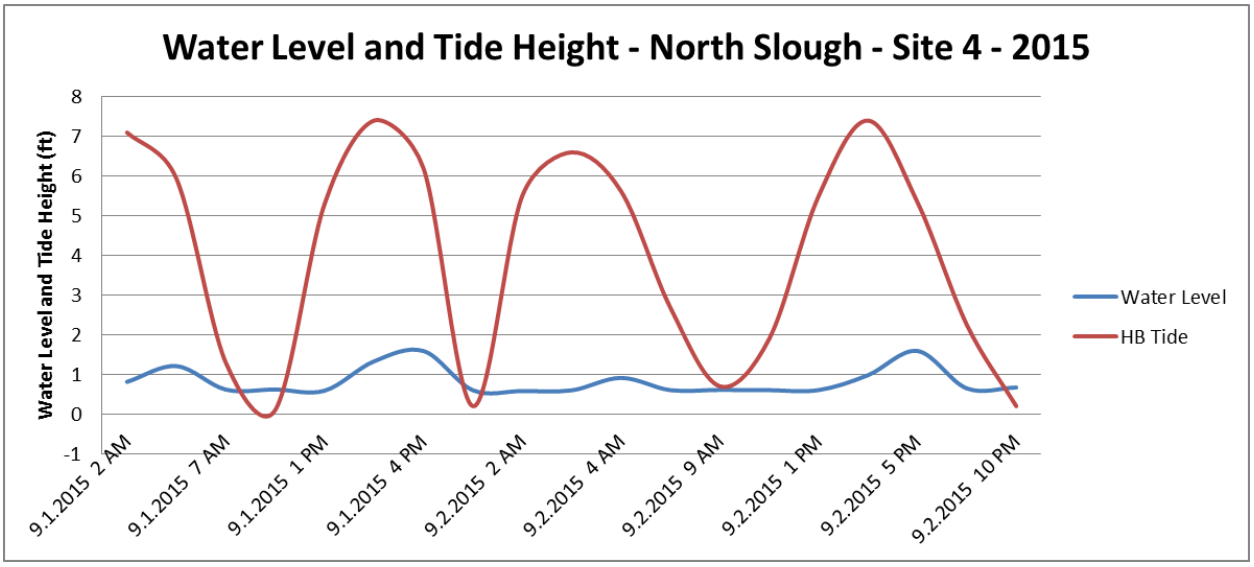
Dissolved Oxygen – Site 3

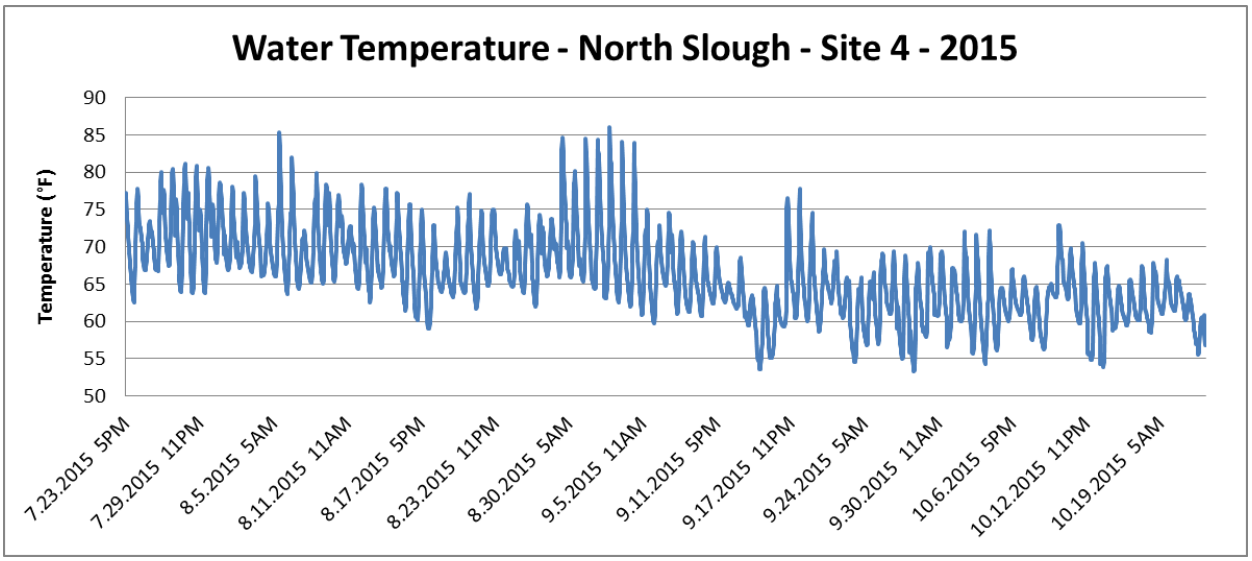
A dissolved oxygen logger was not deployed at this site. Dissolved oxygen loggers are only deployed in slough channels of the interior of Riverside Ranch.

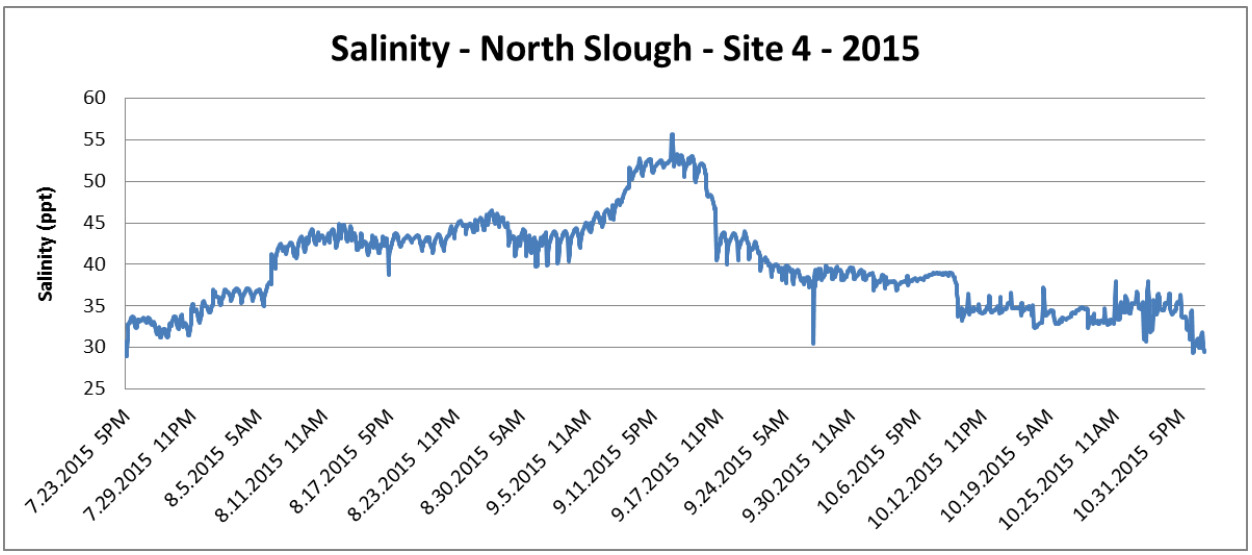
Site 4 – Northern Slough Network on Riverside Ranch

Site 4 is located in the northern slough network in the estuary portion of the project area (Riverside Ranch), at one of the terminal arms furthest away from the confluence of the Salt River. This site is almost exclusively tidally influenced. Fresh water inputs are incidental, and come in with the high tides. The loggers were stationed behind a channel feature that creates backwater at low tides. Therefore, at low tides, the loggers are continuously submerged. The loggers were deployed on July 23rd, 2015. The dissolved oxygen was retrieved two weeks later on August 6th, 2015. Water level and salinity loggers were retrieved on November 4th, 2015.






Water Temperature - North Slough - Site 4 - 2015
Temperature (°F)
90
85
80
75
70
65
60
55
50
7.23.2015 5PM
7.29.2015 11PM
8.5.2015 5AM
8.11.2015 11AM
8.17.2015 5PM
8.23.2015 11PM
8.30.2015 5AM
9.5.2015 11AM
9.11.2015 5PM
9.17.2015 11PM
9.24.2015 5AM
9.30.2015 11AM
10.6.2015 5PM
10.12.2015 11PM
10.19.2015 5AM


Salinity - North Slough - Site 4 - 2015
Salinity (ppt)
60
55
50
45
40
35
30
25
7.23.2015 5PM
7.29.2015 11PM
8.5.2015 5AM
8.11.2015 11AM
8.17.2015 5PM
8.23.2015 11PM
8.30.2015 5AM
9.5.2015 11AM
9.11.2015 5PM
9.17.2015 11PM
9.24.2015 5AM
9.30.2015 11AM
10.6.2015 5PM
10.12.2015 11PM
10.19.2015 5AM
10.25.2015 11AM
10.31.2015 5PM

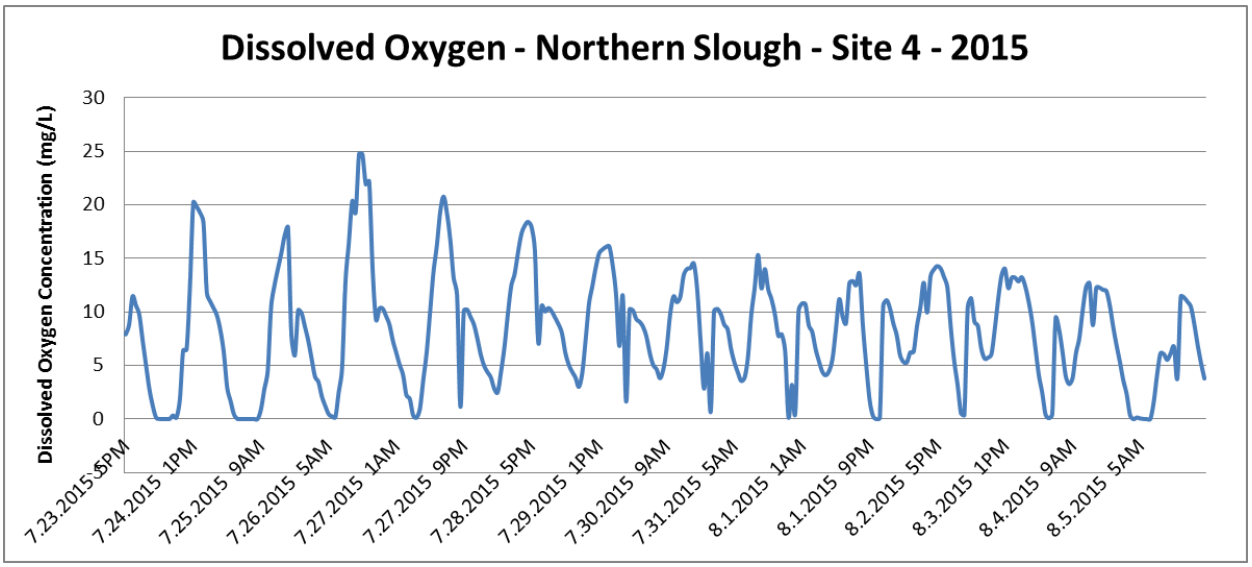

Dissolved Oxygen - Northern Slough - Site 4 - 2015
Dissolved Oxygen Concentration (mg/L)
30
25
20
15
10
5
0
7.23.2015 5PM
7.24.2015 1PM
7.25.2015 9AM
7.26.2015 5AM
7.27.2015 1AM
7.27.2015 9PM
7.28.2015 5PM
7.29.2015 1PM
7.30.2015 9AM
7.31.2015 5AM
8.1.2015 1AM
8.1.2015 9PM
8.2.2015 5PM
8.3.2015 1PM
8.4.2015 9AM
8.5.2015 5AM

Table 4. Water Parameter Statistics for Site 4

	Water Parameter - Site 4			
	Water Level	Temperature	Salinity	Dissolved Oxygen
	(ft)	(°F)	(ppt)	(mg/L)
Maximum	2.8	86.1	55.7	24.7
Minimum	0.2	53.2	28.9	-0.02
Average	0.7	66.2	39.9	8.1

Water Level – Site 4

Site 4 is located in the Eel River estuary and is directly affected by tidal water inundation. Fluctuations in the water level, as depicted by the data, are due to the diurnal high and low tides. The tides are muted at the site compared to actual ocean conditions. Maximum water level during the sampling period (July through October) reached 2.8 feet and decreased to a minimum of 0.2 feet, with an average 0.7 feet (Table 4).

Water levels at site 1 are compared to tide heights at the Humboldt Bay North Spit tide station for two days in September (1st and 2nd). Tides heights in the Humboldt Bay and water levels at site 4 should not be strictly equated to each other since the site is not at a 0.0 ft elevation. Tides and water levels can be correlated to determine the lag time of tidal waters entering the site. Reviewing the graph above and data, it appears this site's high tide lag is 1hour and the low tide lag is between 3 and 5 hours (average 4.6 hours) within the two day interval. These lag times indicate that the internal slough network fills quickly, but drains very slowly.

Temperature – Site 4

Temperature readings were collected from the water level recorder. No temperature spikes should have been recorded since the logger was continuously submerged. However, this is a very shallow site and temperatures can rise dramatically during sun exposure. The average temperature during the sampling period is calculated at 66.2 °F. The maximum temperature recorded is 86.1 °F and the minimum temperature is 53.2 °F (Table 4). The Water Temperature graph above shows a decreasing temperature trend from July to October. This is consistent with colder atmospheric and ocean temperatures setting in from summer to fall.

Salinity – Site 4

In 2014, salinity logger sensors proved to foul quickly. This site has slow water movement, and it appears the sensor became fouled. The Salinity graph above shows readings begin to gradually increase after the first week from a minimum of 28.9 (ppt) to an improbable maximum salinity level of 55.7 (ppt). The salinity in the Salton Sea is approximately 44 (ppt). The fouling was caused by detritus and primarily from colonies of bryophytes covering the entire logger.

Therefore, a majority of the data collected is erroneous. The graph indicates that salinity values began to reach normal ocean salinity levels, approximately 35 (ppt), in late September. This decrease may have been due to the site becoming inundated by fresh water from rain fall and increased Eel River levels, thus killing the bryophytes.

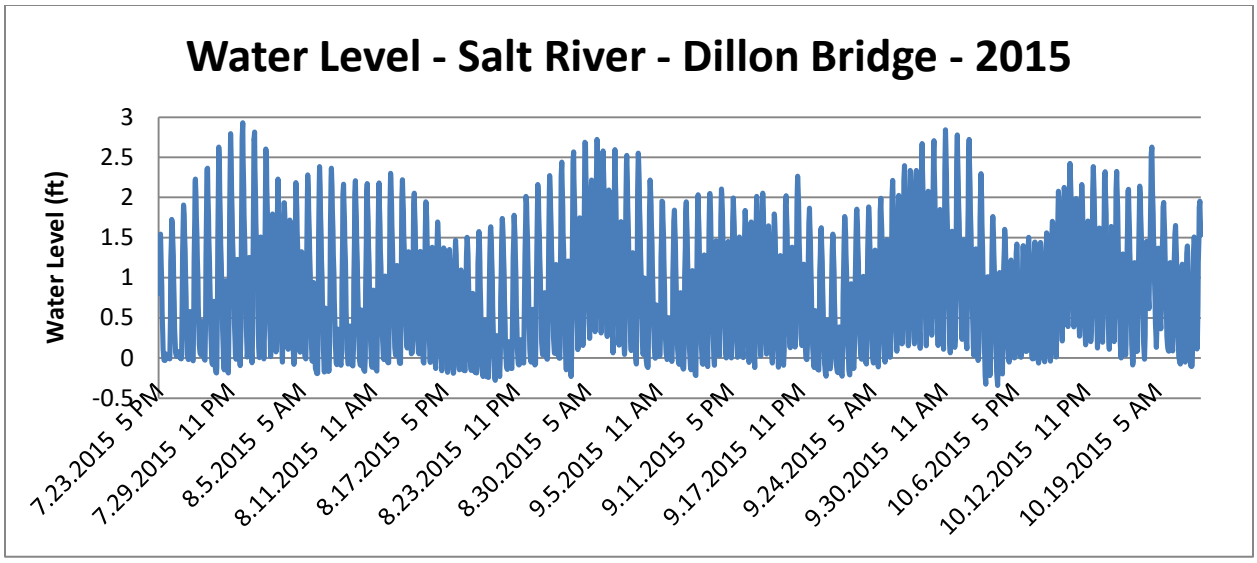
Dissolved Oxygen – Site 4

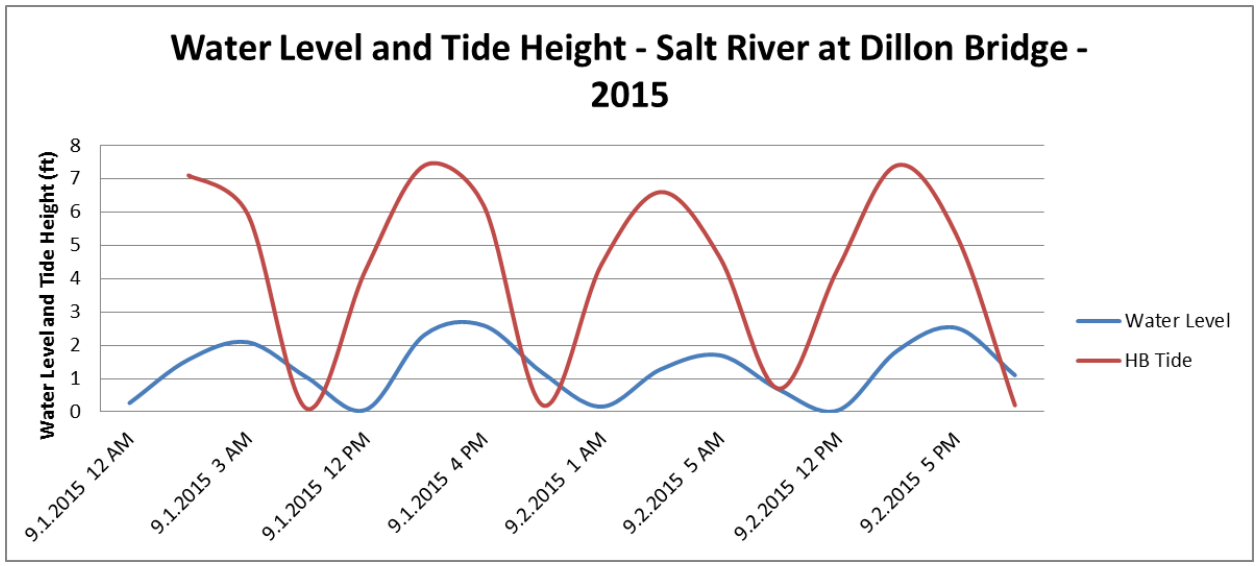
A dissolved oxygen (DO) logger was deployed between July 23rd and August 6th, 2015. The DO levels recorded at this site indicate that DO is positively correlated with temperature. That is, as temperature peaks, DO peaks; as temperatures decrease, DO decreases. This is contrary to the rule that cold water contains higher DO levels than warm water. Analyzing the data, DO is not correlated with high tides or changing tides; unless it is coincides with temperature. After further analysis, DO is directly and positively correlated with daylight, where DO concentrations are highest during midday (thus during the warmest part of the day). This is likely due to the increased photosynthesis of aquatic microbes in the water (e.g. phytoplankton).

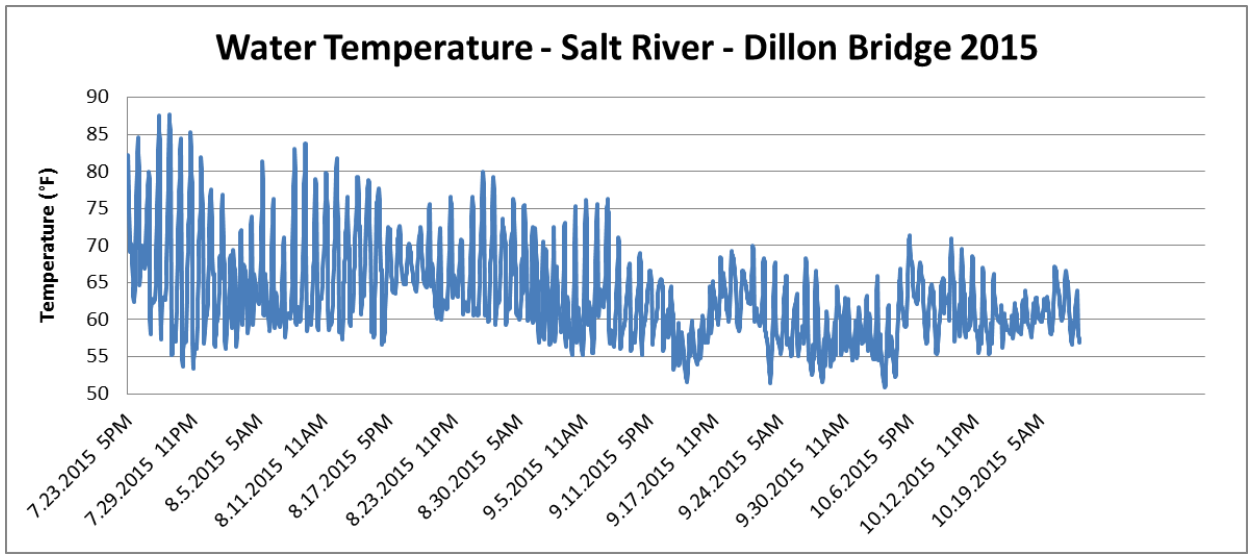
Typically, the amount of dissolved oxygen at 100% saturation is around 10 mg/L. However, water can become supersaturated (>100%) due to the photosynthesis of aquatic microbes. This could explain the maximum DO level of 24.7 mg/L. The recorded minimum DO level is -0.02. It is unknown if these values are indicative of true levels. DO meters tend to read inaccurately. However spot DO measurements during fish surveys in at the same site indicate supersaturated DO concentrations (approximately 14.2 mg/L and 18.5 mg/L in June and July respectively). In the summer months, this site supports a variety of fish species such as sculpin and juvenile top smelt.

Site – Dillon Road Bridge – Salt River Channel

The site at Dillon Road Bridge is located in the constructed Salt River channel, approximately 3.7 miles upstream from the lowest end of the restored portion of the Salt River. This site still receives tidal water at high tide events. No fresh water inputs are currently above the site during the monitoring period. Fresh water inputs are incidental from lower tributaries, and come in with the high tides. The loggers were deployed in a shallow scour pool. The loggers were deployed on July 23rd, 2015. Water level and salinity loggers were retrieved on November 4th, 2015.


Water Level - Salt River - Dillon Bridge - 2015
Water Level (ft)
3
2.5
2
1.5
1
0.5
0
-0.5
7.23.2015 5 PM
7.29.2015 11 PM
8.5.2015 5 AM
8.11.2015 11 AM
8.17.2015 5 PM
8.23.2015 11 PM
8.30.2015 5 AM
9.5.2015 11 AM
9.11.2015 5 PM
9.17.2015 11 PM
9.24.2015 5 AM
9.30.2015 11 AM
10.6.2015 5 PM
10.12.2015 11 PM
10.19.2015 5 AM


Water Level and Tide Height - Salt River at Dillon Bridge - 2015
Water Level and Tide Height (ft)
8
7
6
5
4
3
2
1
0
9.1.2015 12 AM
9.1.2015 3 AM
9.1.2015 12 PM
9.1.2015 4 PM
9.2.2015 1 AM
9.2.2015 5 AM
9.2.2015 12 PM
9.2.2015 5 PM
Water Level
HB Tide


Water Temperature - Salt River - Dillon Bridge 2015
Temperature (°F)
90
85
80
75
70
65
60
55
50
7.23.2015 5PM
7.29.2015 11PM
8.5.2015 5AM
8.11.2015 11AM
8.17.2015 5PM
8.23.2015 11PM
8.30.2015 5AM
9.5.2015 11AM
9.11.2015 5PM
9.17.2015 11PM
9.24.2015 5AM
9.30.2015 11AM
10.6.2015 5PM
10.12.2015 11PM
10.19.2015 5AM

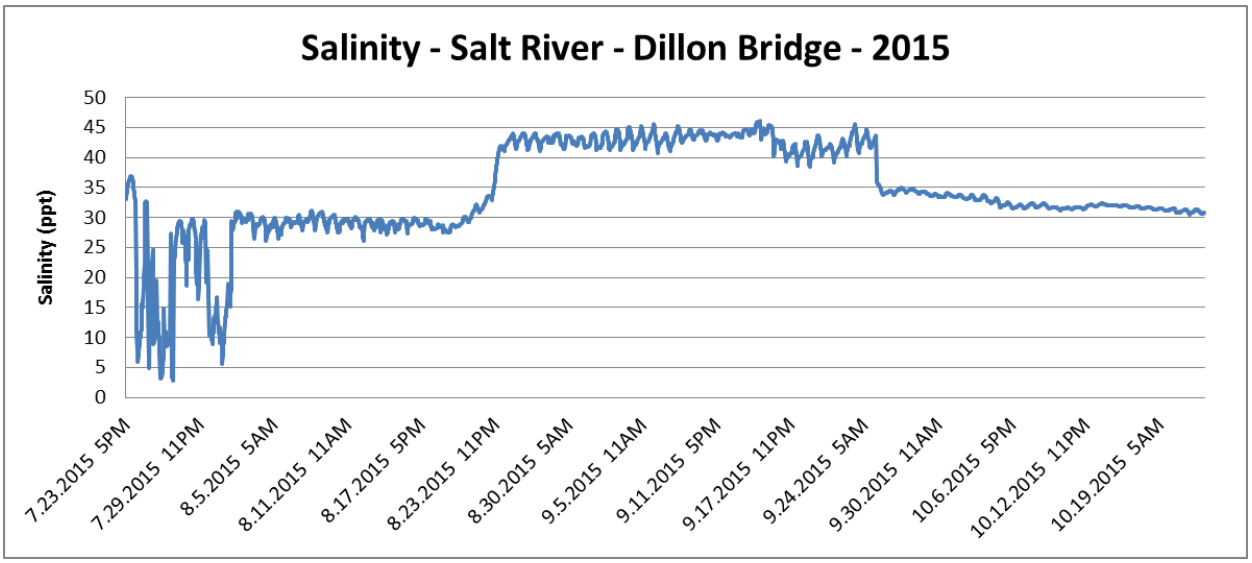


Table 5. Water Parameter Statistics for Site Dillon Road Bridge – Salt River Channel

	Water Parameter - Dillon Bridge			
	Water Level	**Temperature**	**Salinity**	**Dissolved Oxygen**
	(ft)	**(°F)**	**(ppt)**	**(mg/L)**
Maximum	2.9	87.7	46	N/A
Minimum	-0.3	50.8	2.8	N/A
Average	0.8	63.1	34.1	N/A

Water Level – Site - Dillon Road Bridge – Salt River Channel

The site at Dillon Road Bridge is located in the constructed Salt River channel and is directly affected by tidal water inundation. Fluctuations in the water level, as depicted by the data, are due to the diurnal high and low tides. The tides are muted at the site compared to actual ocean conditions. Maximum water level during the sampling period (July through October) reached 2.9 feet and decreased to a minimum of -0.3 feet, with an average 0.8 feet (Table 5).

Water levels at the Dillon Road Bridge site are compared to tide heights at the Humboldt Bay North Spit tide station for two days in September (1st and 2nd). Tides heights in the Humboldt Bay and water levels at this site should not be strictly equated to each other since the site is not at a 0.0 ft elevation. Tides and water levels can be correlated to determine the lag time of tidal waters entering the site. Reviewing the graph above and the associated data, it appears this site's the high tide lag is 1 to 2 hours (average 1.5 hours) and the low tide lag is between 3 and 4 hours

(average 3.6 hours) within the two day interval. These lag times indicate that the Dillon Road Bridge site fills quickly, but drains very slowly.

Temperature – Site - Dillon Road Bridge – Salt River Channel

Temperature readings were collected from the water level recorder. The average temperature during the sampling period is calculated at 63.1 °F. The maximum temperature recorded is 87.7 °F and the minimum temperature is 50.8 °F (Table 5). The Water Temperature graph above shows a decreasing temperature trend from July to October. This is consistent with colder atmospheric and ocean temperatures setting in from summer to fall.

Salinity – Site - Dillon Road Bridge – Salt River Channel

In 2014, salinity logger sensors proved to foul quickly. This site has slow water movement, and it appears the sensor became fouled. The Salinity graph above shows salinity values dramatically fluctuating between 30 (ppt) and 2 (ppt), however the values ranges level off and only fluctuate by 5(ppt). The recorders show that salinity reached a maximum of 46 (ppt) and a minimum of 2.8 (ppt) and had an average of 34.1 (ppt). However, these data are suspect. Observations show that tidal inundation reaches this site at high tides. The purpose of siting this probe at this location is to prove that tidal inundation does reach this far up the channel. Personal observations have noted that the tide extends just over 100' upstream of this site.

Site – Salt River and Eel River Confluence

The site situated at the confluence of the Salt River and Eel River is located very near the mouth of the Eel River, thus at the ocean's edge. This site is has high levels of fresh water from the Eel River and high levels of tidal water from the ocean. The loggers were located close to the right bank of the Salt River. The loggers were deployed on July 23rd, 2015. The loggers were cleaned on August 6th, 2015. Upon retrieval of the loggers on November 4th, the entire station (PVC piping, rebar, and loggers) were missing. They may have gone missing due to high currents or vandalism.

CONCLUSIONS

Water quality parameters measurements were recorded in Year 2 after post restoration activities on Phase 1 (Riverside Ranch) of the Salt River Ecosystem Project. Water quality measurements were also recorded for the first time at an upstream location in the Salt River at the extent of tidal inundation (Phase 2 Dillon Road Bridge). Accurate sampling of the parameters proved challenging due to the tidal environment of the restoration site. The challenges faced during the sampling period include missing equipment and sensors being fouled by suspended sediment, biological marine fauna, and algae production. These impediments render some of the collected data questionable with water level data likely the most robust data recorded. Early ranges of salinity data may be useful for specific sites to track changes as the site evolves.

Although some of the data collected does not provide a clear description of the environment occurring on the current project footprint, it does reflect that water quality parameters reached expected levels at most sites during the sampling period and shows that tidal inundation occurs across all sites. Observations also confirmed that tidal water reaches the upper extents of the newly-created internal slough channels and upstream Salt River channel (Dillon Road Bridge) daily. These results and observations indicate the project is functioning as designed and expected.

Based on this years' experience, the following changes are recommended: 1) Salinity loggers cease to be deployed as sensors foul quickly and easily; 2) Sampling sites should be visited periodically during the sampling period to remove any fouling that occurs on logger sensors; 3) Consider monthly spot salinity measurements; 4) Consider abandoning the site at the confluence of the Salt River and Eel River as exposure to strong currents and public access may cause valuable equipment to go missing.