

# **TIDAL EXCHANGE AND WATER QUALITY MONITORING SALT RIVER ECOSYSTEM RESTORATION PROJECT**

## **PHASE 1**

**YEAR 1 – 2014**



Prepared for: Humboldt County  
Resource Conservation District  
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## **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 of a watershed-scale restoration effort known as the Salt River Ecosystem Restoration Project. Presented in this Tidal Exchange and Water Quality Monitoring Report are the results of four months of continuous sampling for water quality parameters including salinity, dissolved oxygen, temperature, and water-level.

## 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 for the purposes of some grant funds secured for the project.

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:

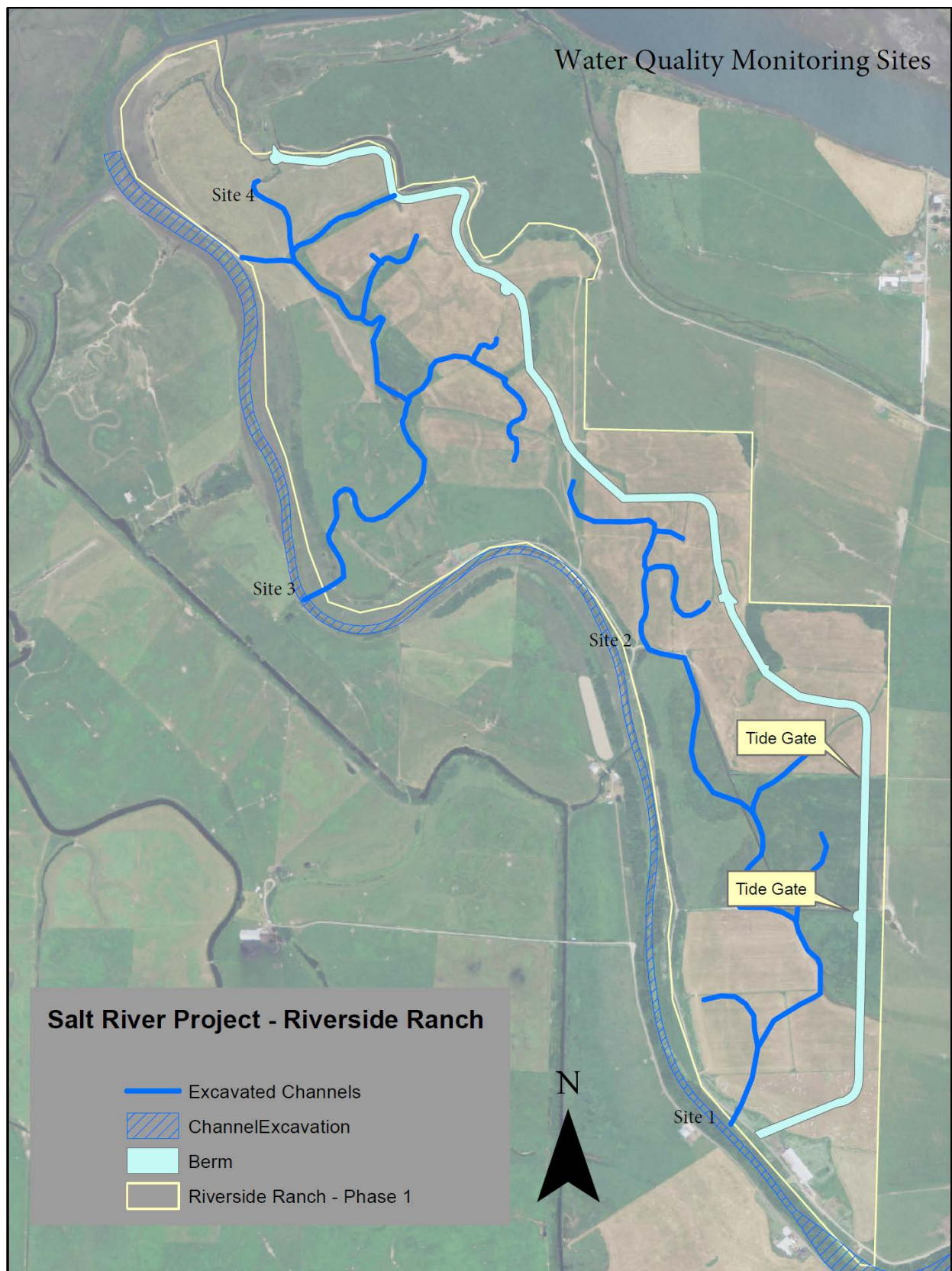
- Use the increase in tidal prism to help maintain the constructed Salt River channel geomorphology and conveyance.
- Improve drainage and water quality in the lower Salt River and Eel/Salt River estuary.
- Restore tidal connectivity to historic tidal wetlands to allow for the natural evolution of diverse 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 redbtail 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 of the SRERP (Riverside Ranch).

To measure tidal prism, multi-parameter recorders were deployed to determine tidal exchange, functional tidal prism, and a healthy salinity structure. Water level, temperature, dissolved oxygen, and salinity levels were also sampled. 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

Recorders were deployed in PVC housings in early July 2014 and left to sample until the end of October. Each recorder was programmed to take samples every two hours, on the hour, each day of deployment. This sampling regimen is a high enough resolution to determine the changing habitat conditions in Phase 1. Dissolved oxygen (DO) recorders are only required to be at two sites on Riverside Ranch. These sites are associated with the two fish sampling sites. DO recorders were originally established to record for only two weeks in July, however, it was determined that the DO recorders should continue to record the remainder of the water quality sampling period. Recorders were retrieved on November 4<sup>th</sup>, 2014.

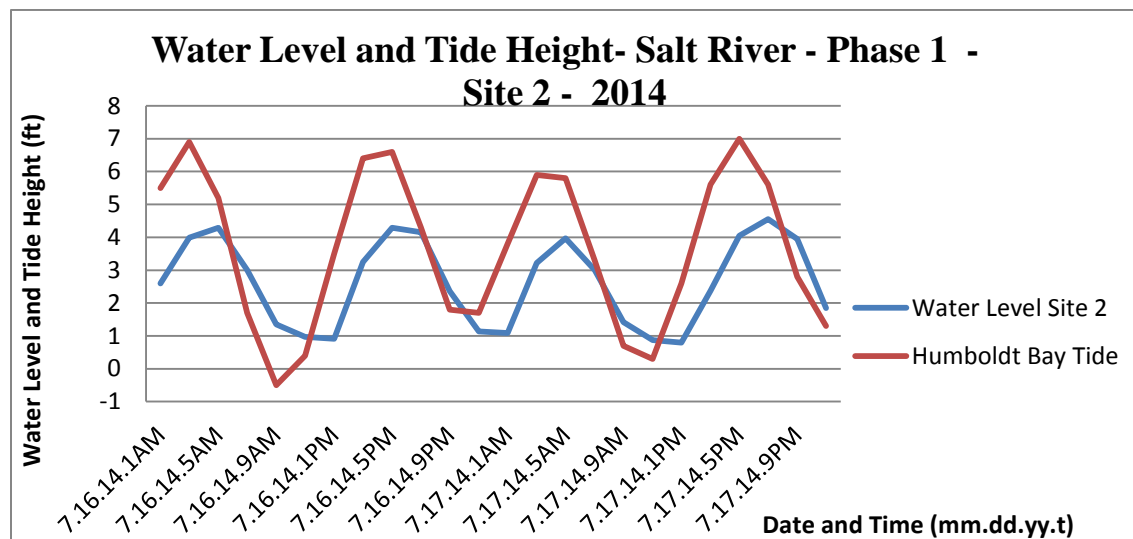
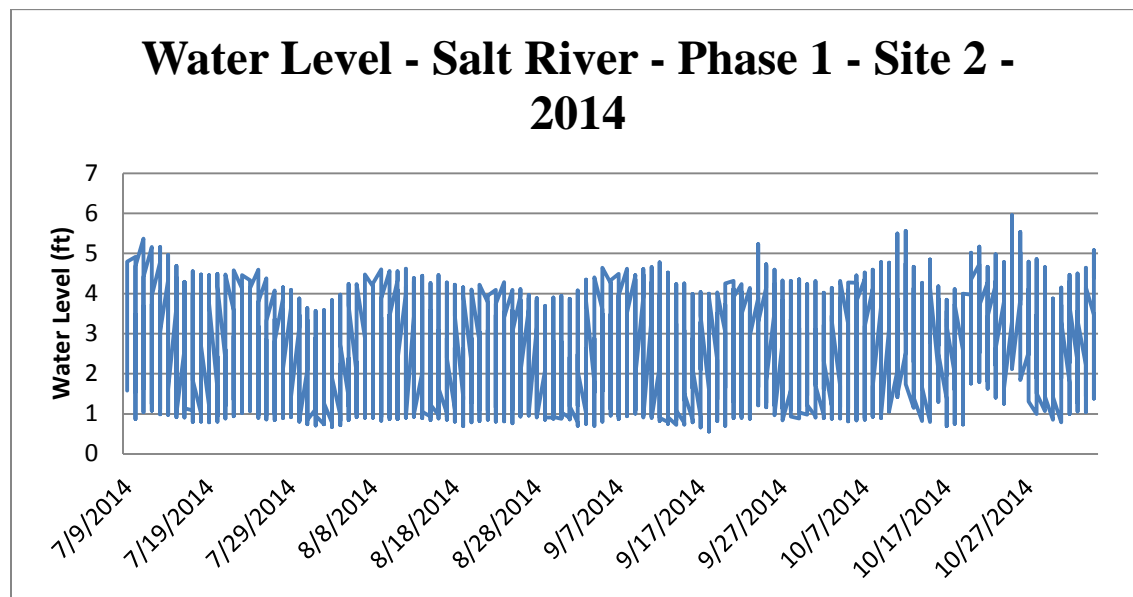


**Figure 1: Water Level and Water Quality Sampling Sites on Phase 1 (Riverside Ranch)**

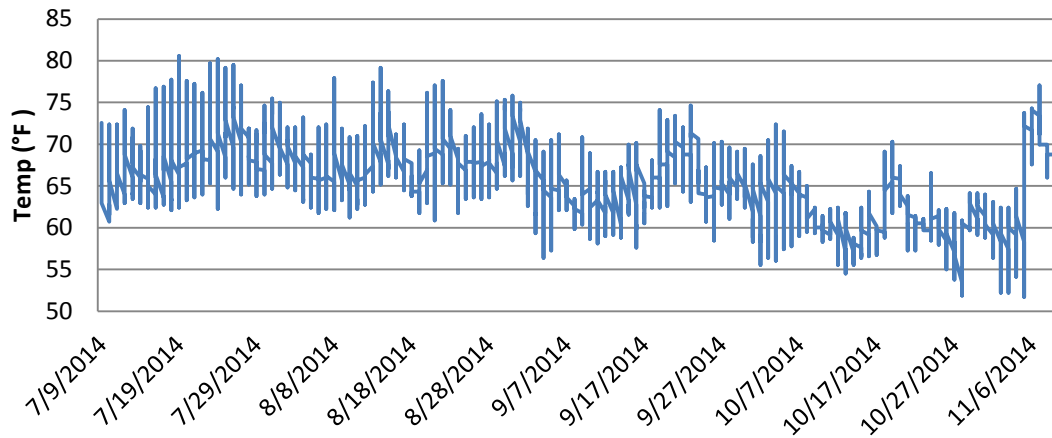
## RESULTS

During the day of retrieval of the data recorders, it was observed that the two sampling sites in the main Salt River (sites #1 and #3) no longer had the PVC housings. Upon inspection all recording devices and housing were missing. A thorough search of the surrounding area was made in hopes of locating the data recorders, with no success. Investigators noted increased boating activity in the Salt River channel and adjacent to Riverside Ranch in mid-October during duck hunting season. Investigators surmise this may have contributed to the disappearance of the data recording equipment. Data recorders at sites #2 and #4 were intact and these data are presented below.

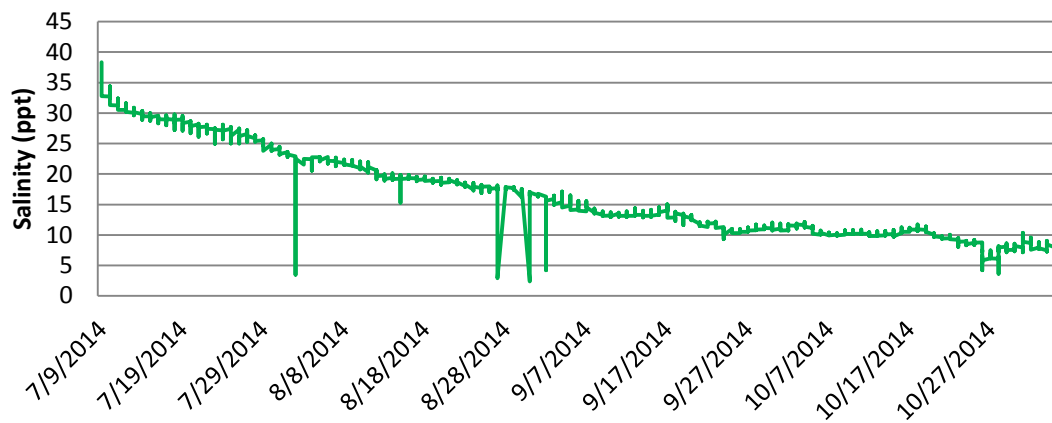
### Site #2 – Southern Slough Channel Site



## Temperature - Salt River - Phase 1 - Site 2 - 2014



## Salinity - Salt River - Phase 1 - Site 2 - 2014



## Dissolved Oxygen Concentration - Salt River - Phase 1 - Site 2 - 2014

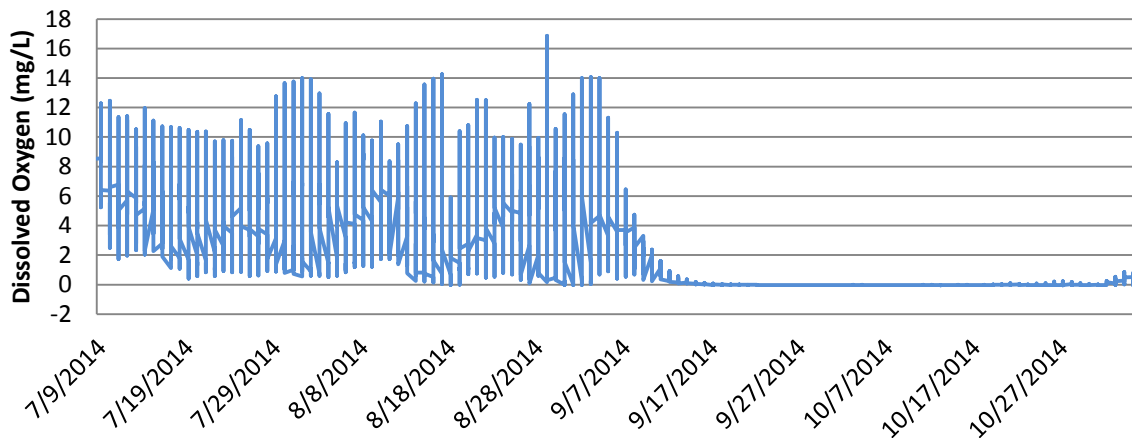


Table #1: Salt River Phase 1 Water Level and Quality Parameters for Site #2 - 2014

	Water Parameters			
	Water Level	Temperature	Salinity	Dissolved Oxygen
	(ft)	(°F)	(ppt)	(mg/L)
<b>Maximum</b>	5.9	80.6	38.3	17.8
<b>Minimum</b>	0.6	51.7	2.4	-0.03
<b>Average</b>	2.6	65.3	16.2	5.0

### Water Level - Site 2

Given that site 2 receives nearly 100 percent tidal water (a small tributary contributes very little fresh water volume) and due to the diurnal tidal inundation of Phase 1 (Riverside Ranch), investigators expected to see large fluctuations in the water level as depicted by the data. The tides are muted at the site compared to actual ocean conditions. Maximum water level during the sampling period (July through October) reached 5.9 feet and decreased to the minimum to 0.6 feet, with an average 2.6 feet (Table 1). Unfortunately, the extreme low water levels also impacted the other water quality parameter recorders as they were more than likely out of the water column.

Water levels at site 2 are compared to tide heights at the Humboldt Bay North Spit tide station for two days in July (16<sup>th</sup> and 17<sup>th</sup>). Though tides heights in the Humboldt Bay and water levels at site 2 should not be strictly equated to each other since the site 2 recorder was not deployed at a 0.0 ft elevation, tides and water levels can be correlated to determine the lag time of tidal waters entering the Phase 1 site. Reviewing the graph above and data, it appears at this site, that a lag of 2 hours is consistent for the two day period for the low and high tides.



### Temperature – Site 2

Temperature readings were collected from the water level recorder. This recording device was likely exposed to air temperature during lower tides. The average temperature during the sampling period is calculated at 65.3 °F. The maximum temperature of 80.6 °F (Table 1) occurred on a July 19<sup>th</sup> 2014; which was a typical daily temperature of 63 °F, however the water level was 0.79 ft. The absence of water around the recorder and the temperature of the PVC housing would have increased temperatures dramatically. Sifting through the data to remove some temperature outliers can be done, though it would be subjective.

### Salinity – Site 2

Viewing the salinity graph above, it appears that salinity began to linearly decrease from the first day deployed. However this is erroneous data. After some consultation with others who have deployed water quality monitoring devices in tidal environments, it is said that the recorder's sensors quickly become fouled, thus not allowing the device to take accurate measurements. This is likely the case for the recorder at this site. The site has a high volume of suspended sediments and is an area with slow water movement, thus sediment and algae progressively collected on the sensor. This was indeed the case as observed when the recorder was retrieved. The salinity of the area is the nearly the same as ocean water (~35 ppt). This is corroborated with spot salinity samples taken during deployment (30.4 ppt) and fish sampling events.

### Dissolved Oxygen – Site 2

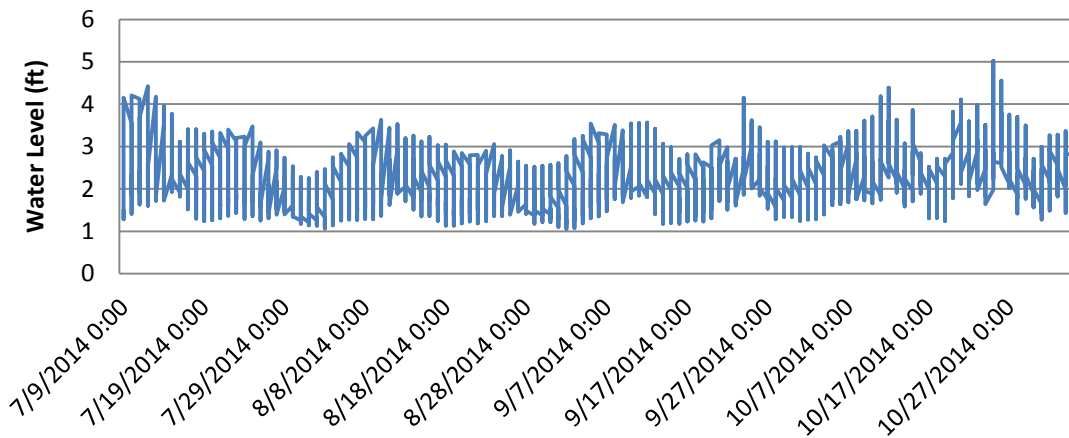
The dissolved oxygen (DO) data fluctuated dramatically between >8.0 mg/L (100% saturation) to just below 0 mg/L (0% saturation). During periods of lower water levels, when the recorder was likely exposed to air, the DO levels primarily reach above >8 mg/L. At times when the device was submerged the recorded data often read between 4.0mg/L to 8 mg/L. However, the longer the recorder was left at the site, the data became erratic. Submerged and exposed DO levels would hover around 1 mg/L and occasionally the exposed device would read close to 8 mg/L. Again, it appears that due to the suspended sediments and algal growth the sensors began to foul after only 5 days of deployment. In fact, after retrieval of the unit, it was observed that a colony of bryophytes grew over the sensor area along with habitation by polychaete worms.

Spot sampling of DO during the June and July fish surveys at this site are 11.8 mg/L and 4.5 mg/L respectively, where hundreds, if not thousands, of stickleback, juvenile smelt, and sculpin were surveyed.

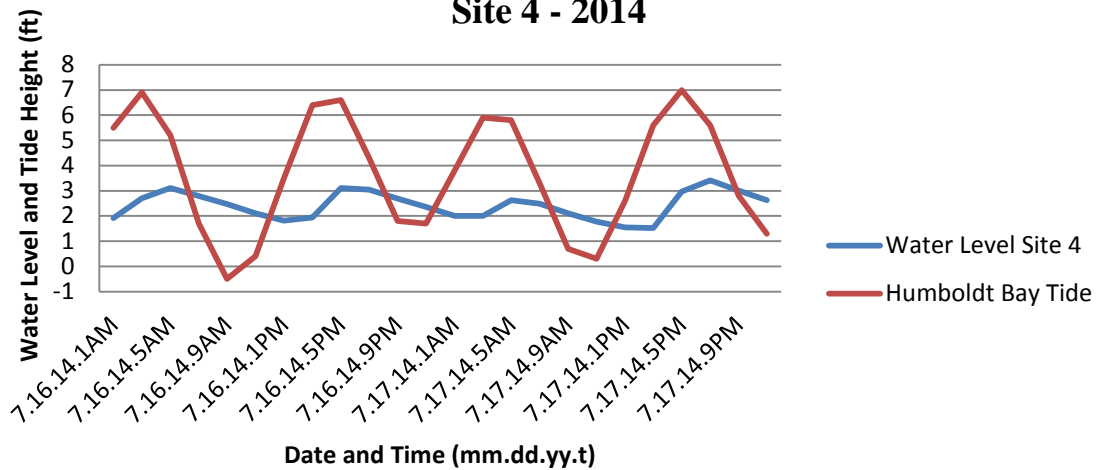


**Site #4 – Northern Slough Channel Site**

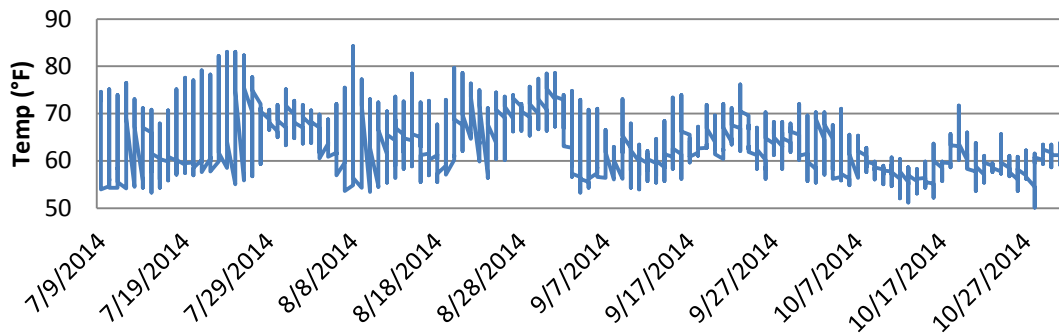
**Water Level Monitoring - Salt River -  
Phase 1 - Site 4 - 2014**



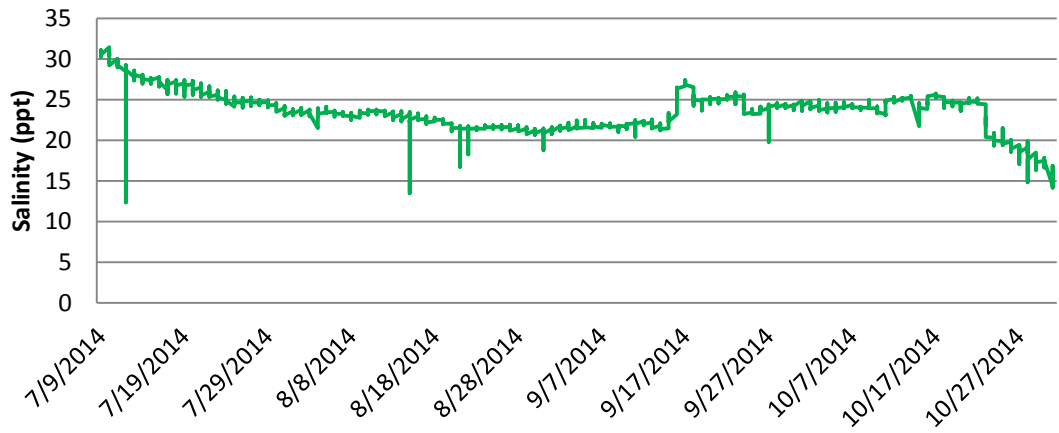
**Water Level and Tide Height - Salt River - Phase 1 -  
Site 4 - 2014**



## Temperature - Salt River - Phase 1 - Site 4 - 2014



## Salinity - Salt River - Phase 1 - Site 4 - 2014



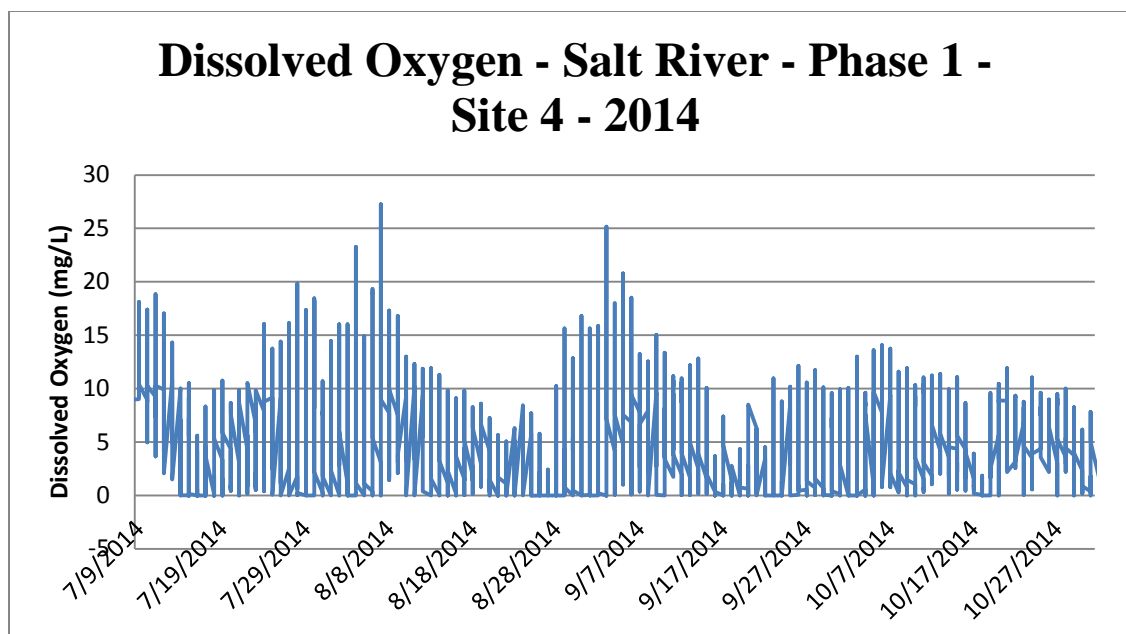


Table #2: Salt River Phase 1 Water Level and Quality Parameters for Site #2 - 2014

	Water Parameters			
	Water Level	Temperature	Salinity	Dissolved Oxygen
	(ft)	(°F)	(ppt)	(mg/L)
<b>Maximum</b>	5.0	84.3	31.4	27.3
<b>Minimum</b>	1.1	50.1	12.4	-0.04
<b>Average</b>	2.2	63.3	23.3	4.7

#### Water Level - Site 4

Due to the diurnal tidal inundation of Phase 1 (Riverside Ranch), and given that the site receives nearly 100 percent of tidal water (a small tributary contributes very little fresh water volume) investigators expected to see large fluctuations in the level of water. The tides are muted at the site compared to actual ocean conditions, and more muted at site 4 than at site 2. The low tide is additionally muted due to a channel feature that retains water in the site area at low tide (this feature was built to enhance tidewater goby habitat). It is observed that the maximum water level during the sampling period (July through October) reached 5.0 feet and the minimum decreased to 1.1 feet, with an average 2.2 feet (Table 2). Unlike Site 2, Site 4 does not completely drain during a low tide.

Water levels at site 4 were compared to tide heights at the Humboldt Bay North Spit tide station for two days in July (16<sup>th</sup> and 17<sup>th</sup>). Though tides heights in the Humboldt Bay and water levels at site 4 should not be strictly equated to each other since the site 4 recorder was not deployed at a 0.0 ft elevation, tides and water levels can be correlated to determine the lag time of tidal waters entering the Phase 1 site. Reviewing the graph above and data, it appears at this site during the two day period, a lag time of 2 hours is found for high tides and a lag time of 2 to 4 hours is observed for low tides.

#### Temperature – Site 4

Temperature readings were collected from the water level recorder. The average calculated temperature for the sampling period was 63.3 °F. The maximum temperature of 84.3 °F (Table 2) occurred on August 9<sup>th</sup> 2014; which had a typical daily temperature of 60 °F, however the water level was 1.51 ft. The low tide and the temperature of the PVC housing would have increased temperatures significantly.

#### Salinity – Site 4

Viewing the salinity graph above, it appears that salinity began to linearly decrease from the first day deployed but began to level off. Again, deploying devices in tidal situations will foul the receiver's sensors, thus not allowing the device to take accurate measurements. This is likely case for this recorder at this site. The site has high suspended sediments and is an area with slow water movement, thus sediment and algae is expected to progressively collect on the sensor. This was indeed the case as observed when the recorder was retrieved. The salinity of the area is nearly the same as ocean water (~35 ppt). It appears that at the beginning of the sampling period that salinities are similar to ocean water (30.0 ppt to 29.0 ppt), though it begins to taper down.

#### Dissolved Oxygen – Site 4

The dissolved oxygen (DO) data fluctuated dramatically between >8.0 mg/L (100% saturation) to just below 0 mg/L (0% saturation). The recorder measured >8.0 mg/L during times when completely submerged and exposed to air. At other times when the device was submerged the recorded data often read between 4.0mg/L to 8.0 mg/L. However, the longer the recorder was left at the site; the more the data became erratic due to being alternately submerged then exposed. DO levels would hover around 0.0 mg/L and occasionally the exposed device would read close to 8.0 mg/L. Again, it appears that due to the suspended sediments and algal growth the sensors began to foul after only 5 days of deployment. Similar to site 2, after retrieval of the unit, it was observed that a colony of bryophytes had grown over the sensor area.

Spot sampling of DO during the June and July fish surveys at this site are 6.2 mg/L and 5.3 mg/L respectively. At this site hundreds, if not thousands, of stickleback and sculpin were sampled.

### **CONCLUSIONS**

The water level and water quality parameters measurements were attempted in Year 1 after post restoration activities on Phase 1 of the Salt River Ecosystem Project. Accurate sampling of the parameters proved challenging due to the tidal environment of the restoration site. The challenges faced during the sampling period included: 1) missing equipment, likely due to human tampering; 2) tidal fluctuations; 3) PVC housing effecting temperature; 4) 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 and DO data may be useful for specific sites to track changes as the site evolves.

Although the data collected does not provide a clear description of the environment occurring on Phase 1 (Riverside Ranch), it does reflect that water quality parameters reached expected levels at the beginning of the sampling period and crudely shows that effective tidal inundation occurs twice a day. Observations confirmed that tidal water reaches the upper extents of the newly-created internal slough channels daily. Additionally, observations at the end of the this year's (2014) construction period noted tidal waters extending up the Salt River channel well past Phase 1 to approximately 1.2 miles upstream (past Dillon Road Bridge). These observations indicate the project is functioning as designed and expected.

During the 2014 monitoring year freshwater inputs were routed around the project site. As a result, the water in the Salt River channel was almost exclusively tidal water. In 2015 an additional monitoring site will be established 1.2 miles further upstream. Data from this site will be utilized in conjunction with conducting spot salinity measurements to create a depth profile of salinity at several locations, thereby determining the upstream limit and approximate shape of the tidal salt water wedge.

Based on this years' experience, the following changes are recommended: 1) modify PVC housings; 2) provide housings for each recording device to help ensure that the recorders are primarily submerged throughout the sampling season; 3) to prevent theft and tampering PVC housings should also be submerged in highly visible areas; and 4) sampling site should be visited periodically during the sampling period to remove any fouling that occurs on the sensors.