

**Post-Construction Eelgrass Survey Report
Year 2 – 2015**

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1) INTRODUCTION

In 2013, the Salt River Ecosystem Restoration Project converted 330 acres of dairy ranch into a salt marsh estuary. 4.02 km of the Salt River channel was excavated, expanded, and deepened. Over 4.8 km of new slough channels were excavated and enhanced. Restoration goals include increased habitat value, long-term sediment management and improved drainage/floodplain functioning.

Rare plant surveys were conducted throughout the project area in 2010. *Zostera marina*, a native species of eelgrass, was found in the Salt River for 2,286 meters, beginning upstream from the confluence with Cutoff Slough. The California Coastal Commission special conditions for CDP 1-10-32 states that within three years of completion of the project, the entire pre-construction eelgrass impact area plus the restored areas suitable for eelgrass recruitment shall have an extent of vegetative cover equal to at least 1.2 times the impacted area and have an average density equal to the pre-construction average density.

Pre-construction *Z. marina* surveys were conducted in 2013 to create a baseline for comparison to three yearly post-construction surveys. This document is the first of the three yearly post-construction *Z. marina* surveys and will be utilized in determining if the California Coastal Commission success criteria have been met.

2) METHODS

The 2015 post-construction *Z. marina* surveys were conducted during Lower Low Water levels on the following dates and tidal heights in 2015:

June 5 / -1.34ft; June 6 / -1.15ft; June 7 / -0.82ft

July 2 / -1.41ft; July 3 / -1.51ft; July 4 / -1.41ft

The field methods utilized at the Salt River project area were duplicated at Morgan Slough, a nearby control site similar to, but not affected by, restoration activities (See Figure 1). Monitoring of the control site will aid in identifying environmental factors not associated with the project activities that potentially influence *Z. marina* recruitment in the Salt River.

2.1) Eelgrass Extent

The 2015 eelgrass survey was initiated at the confluence of the Salt River and Cutoff Slough at the western end of the project area. Extent is defined as the area where *Z. marina* was observed. Discrete patches are separated from adjacent eelgrass patches by at least a meter, whereas, continuous eelgrass beds are less than one meter apart. GPS coordinates were recorded in the center of each discrete patch and assigned a number as indicated on the map (see Figure 2). Length and location of continuous *Z. marina* beds were also recorded and mapped.

2.2) Percent Cover

The percent cover was visually estimated by measuring how much of the substrate was covered by eelgrass within a 0.25-m² quadrat. Percent bottom cover is defined as total plant coverage per total bed area. Cover categories are given as the percentage of substrate covered by eelgrass. For example, if 90% of the substrate is exposed, that represents 10% coverage. If 50% of the substrate is exposed, that represents 50% coverage. See

<http://www.seagrassnet.org/sites/default/files/SeagrassNetManual2006Worldwide.pdf> page 71 for a percent cover photo guide. Percent cover measurements were taken within the same quadrat as the density measurements described below.

2.3) Shoot Density

Shoot density is defined as number of shoots per square meter. *Z. marina* percent cover and shoot density are a function of channel depth; therefore, percent cover and density measurements were spaced evenly across the channel. The entire length of the restored Salt River channel where eelgrass occurred was divided evenly into four cross-sectional zones: 1) north right bank to north mid slope, 2) north mid slope to north low slope, 3) south low slope to south mid slope, 4) south mid slope to south bank. Power analysis recommended a sample size of 10 density measurements for the entire length of the study area yielding 40 total replicates; however, a total of 30 density measurements for the entire length of the study area gave a total of 120 replicates, increasing the accuracy of estimated density. The total length of channel containing *Z. marina* in 2013 was 2,345 m. The total length of channels containing *Z. marina* in 2014 increased by 2,989 m, for a total range of 5,334 meters. Seven additional measurement transects (cross-section of four measurements) were added in the Salt River channel in 2014 due to increased *Z. marina* range (see Table 1). A hand-held GPS unit was used to measure distance along the channel. The first measurement transect was placed at the confluence of Cutoff Slough and Salt River and subsequent measurement occurred every 78 meters throughout the project area.

2.4) Non-Native Eelgrass

Zostera japonica, an invasive species of eelgrass, has been reported in the project area. Location and number of shoots found in the project area was recorded in the 2013 pre-construction survey, and a visual search was completed in 2014 and 2015.

2.5) Photo Documentation

Photographs, location and compass bearings were recorded at each measurement transect to compare with future surveys.

2.6) Control Site

A nearby control site was selected in 2013, with the assistance of staff from CDFW and NOAA Fisheries, which best matches environmental conditions in the project area. Morgan Slough is located about 1 km north east of the project area, experiences a similar amount of freshwater and sediment inundation, and is on easily accessed, public land. The same survey procedures were used at the Morgan Slough control site July 5, 2015.

The Morgan Slough channel was surveyed 1,640 meters upstream from the confluence with Cutoff Slough to the Morgan Slough Road Bridge. A total of 21 transects, 78 meters apart, revealed continuous eelgrass present 1,600 m upstream (see Table 2). A comparison of eelgrass percent cover and shoot density was made between the Salt River and Morgan Slough between pre and post-construction years.

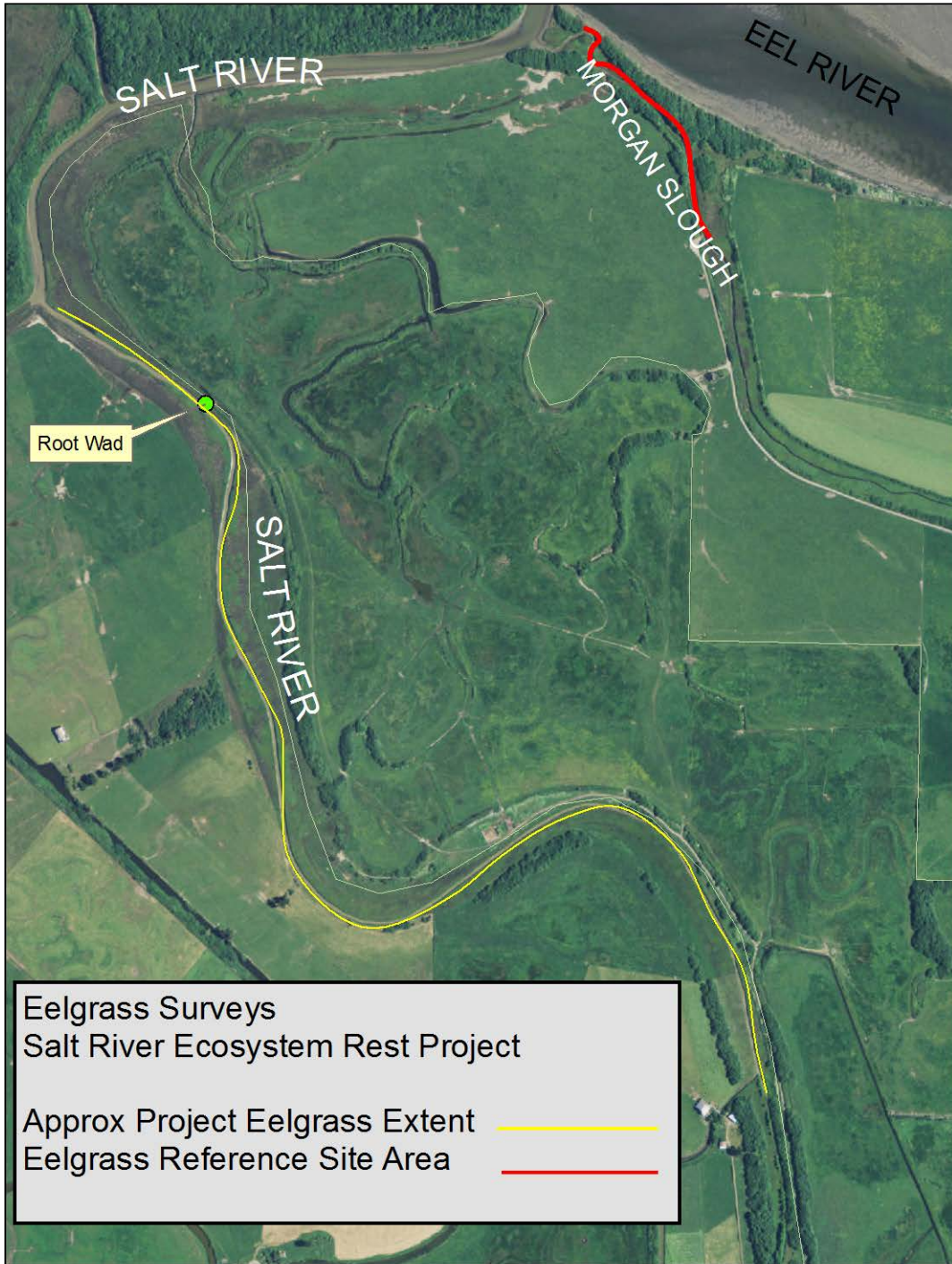


Figure 1: Salt River Ecosystem Restoration Project, pre-construction. *Z. marina* survey area and Morgan Slough reference site.

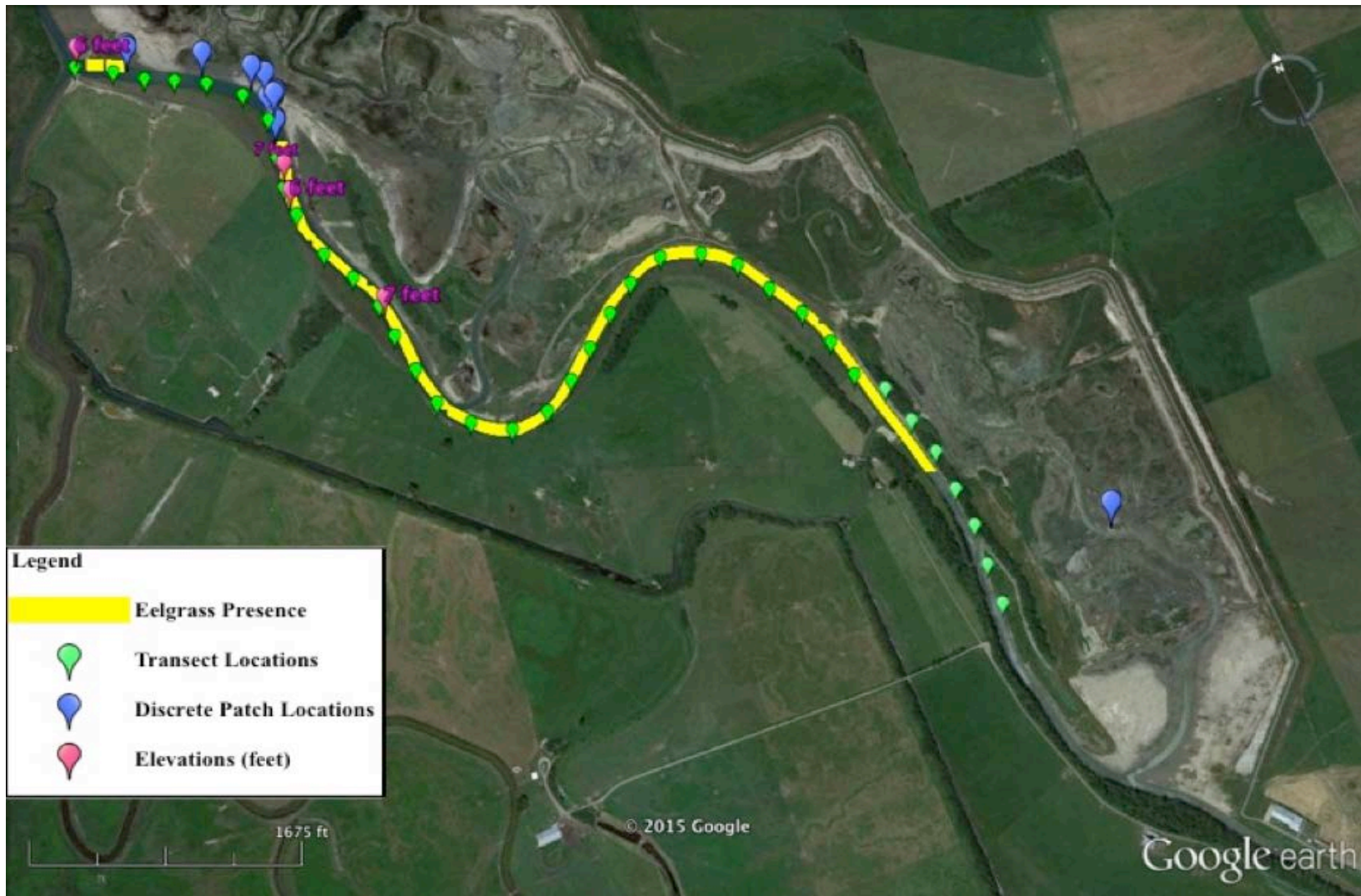


Figure 2: 2015 *Z. marina* extent cover, transect marker locations and channel elevations for Salt River.

Table 1: 2015 locations of Salt River transect markers, including the 7 additional transects.

| Transect | Waypoint | Latitude | Longitude |
|----------|----------|--------------|----------------|
| 1 | 139 | 40°37'8.04" | 124° 18'57.96" |
| 2 | 140 | 40°37'6.66" | 124° 18'54.96" |
| 3 | 141 | 40°37'5.40" | 124° 18'52.62" |
| 4 | 116 | 40°37'4.50" | 124° 18'50.22" |
| 5 | 117 | 40°37'3.48" | 124° 18'47.70" |
| 6 | 118 | 40°37'1.74" | 124° 18'45.12" |
| 7 | 119 | 40°36'59.46" | 124° 18'43.80" |
| 8 | 120 | 40°36'56.94" | 124° 18'44.34" |
| 9 | 121 | 40°36'54.66" | 124° 18'44.64" |
| 10 | 122 | 40°36'52.02" | 124° 18'44.70" |
| 11 | 123 | 40°36'49.38" | 124° 18'43.44" |
| 12 | 124 | 40°36'47.16" | 124° 18'41.82" |
| 13 | 125 | 40°36'44.76" | 124° 18'40.62" |
| 14 | 126 | 40°36'42.54" | 124° 18'40.32" |
| 15 | 127 | 40°36'39.96" | 124° 18'39.72" |
| 16 | 128 | 40°36'36.37" | 124° 18'39.06" |
| 17 | 129 | 40°36'36.35" | 124° 18'37.02" |
| 18 | 130 | 40°36'33.96" | 124° 18'34.02" |
| 19 | 131 | 40°36'34.14" | 124° 18'30.72" |
| 20 | 132 | 40°36'35.40" | 124° 18'27.90" |
| 21 | 133 | 40°36'36.84" | 124° 18'25.38" |
| 22 | 134 | 40°36'38.40" | 124° 18'22.68" |
| 23 | 135 | 40°36'39.72" | 124° 18'20.04" |
| 24 | 136 | 40°36'40.56" | 124° 18'16.80" |
| 25 | 137 | 40°36'39.72" | 124° 18'13.44" |
| 26 | 138 | 40°36'38.10" | 124° 18'10.92" |
| 27 | 142 | 40°36'35.82" | 124° 18'9.24" |
| 28 | 143 | 40°36'33.54" | 124° 18'7.50" |
| 29 | 144 | 40°36'31.08" | 124° 18'6.30" |
| 30 | 145 | 40°36'28.56" | 124° 18'5.58" |
| 31 | 27 | 40°36'26.4" | 124° 18'04.0" |
| 32 | 28 | 40°36'23.9" | 124° 18'03.1" |
| 33 | 29 | 40°36'21.5" | 124° 18'02.3" |
| 34 | 30 | 40°36'18.9" | 124° 18'02.1" |
| 35 | 31 | 40°36'16.4" | 124° 18'01.9" |
| 36 | 32 | 40°36'13.9" | 124° 18'02.3" |
| 37 | 33 | 40°36'11.4" | 124° 18'02.5" |

Table 2: 2015 locations of Morgan Slough transect markers. *Z. marina* shoot density and percent cover measurements were taken in each zone across the channel from each marker.

| Transect | Waypoint | Latitude | Longitude |
|----------|----------|--------------|---------------|
| 1 | 146 | 40°37'22.59" | 124°18'22.36" |
| 2 | 147 | 40°37'23.40" | 124°18'19.13" |
| 3 | 149 | 40°37'21.63" | 124°18'17.53" |
| 4 | 151 | 40°37'20.67" | 124°18'14.63" |
| 5 | 152 | 40°37'15.87" | 124°18'10.54" |
| 6 | 153 | 40°37'12.24" | 124°18'9.49" |
| 7 | 154 | 40°37'10.01" | 124°18'7.59" |
| 8 | 155 | 40°37'7.28" | 124°18'7.44" |
| 9 | 156 | 40°37'4.69" | 124°18'6.63" |
| 10 | 157 | 40°37'2.16" | 124°18'5.63" |
| 11 | 168 | 40°37'0.49" | 124°18'3.01" |
| 12 | 158 | 40°36'59.33" | 124°17'59.88" |
| 13 | 159 | 40°36'58.30" | 124°17'56.20" |
| 14 | 160 | 40°36'57.85" | 124°17'52.86" |
| 15 | 161 | 40°36'57.27" | 124°17'49.63" |
| 16 | 162 | 40°36'56.22" | 124°17'46.27" |
| 17 | 163 | 40°36'54.92" | 124°17'42.95" |
| 18 | 164 | 40°36'53.16" | 124°17'39.91" |
| 19 | 165 | 40°36'52.33" | 124°17'38.28" |
| 20 | 166 | 40°36'51.86" | 124°17'35.83" |
| 21 | 167 | 40°36'51.29" | 124°17'32.40" |

3) RESULTS

3.1) Eelgrass Extent

In 2015, 13 discrete patches of *Z. marina* were observed in the Salt River, and the newly excavated slough channels. The range of *Z. marina* within the main channel of the Salt River, and newly formed slough channels increased by 2,900 meters from the 2013 pre-construction extent survey to the 2014 survey; there was no further increase in *Z. marina* range in 2015. The eelgrass extent discussed below is defined as the length of channel where *Z. marina* was observed within the range of the project area including both continuous, and discrete patches.

3.2) Percent Cover

The 2015 average *Z. marina* percent cover of the Salt River sampled areas was: Zone 1 (Z1) = 5%; Zone 2 (Z2) = 8%; Zone 3 (Z3) = 10%; and Zone 4 (Z4) = 19%. 2015 *Z. marina* percent cover for each zone in the Salt River project area is summarized in Table 3.1. For comparison, 2014 and 2013 *Z. marina* percent cover for each zone in the Salt River are summarized in Tables 3.2 and 3.3. In 2015, *Z. marina* percent cover for the entire population within the project area was 10.5% +/- 1.86. Out of the 37 sample quadrats along the main Salt River channel, 3 plots from Zone 1, and 5 plots from Zone 4, were cut banks, or eroded, so that measurements were impossible. The location of each of the 37 Salt River transect locations where *Z. marina* percent cover and density measurements were measured are shown in Table 1. The same transects were used from the pre-construction 2013 survey, along with the 7 transects added in 2014.

The 2015 average *Z. marina* percent cover of eelgrass at the Morgan Slough control site was: Z1 = 2%; Z2 = 0%; Z3 = 0%; and Z4 = 0%. 2015 *Z. marina* percent cover for each zone in the Morgan Slough project area is summarized in Table 4.1. For comparison, 2014 and 2013 *Z. marina* percent cover for each zone in Morgan Slough are summarized in Tables 4.2 and 4.3. Table 2 lists the locations of each of the 21 Morgan Slough transect locations where *Z. marina* percent cover and density measurements were recorded. These locations were the same as the 2013 pre-construction surveys. Due to the near complete absence of eelgrass presence in Morgan Slough in 2015, statistical comparisons of eelgrass quantity were not made between the two sites. Within the Salt River site the, average percent cover in zones 1 and 2 differed significantly from zone 4 in that there was lower percent cover in the first two zones, and higher percent cover in zone 4 (ANOVA $F = 7.24$, $P < 0.05$). Within the Morgan Slough site, there was not a significant difference in *Z. marina* percent cover between the zones (ANOVA $F = 1.00$, $P = 0.39$).

Salt River *Z. marina* percent cover. Estimated percent cover/m² represents percent cover of the sampled area extrapolated over the total project area. The combined estimated percent cover is a mean of the four zones.

Table 3.1: 2015 *Z. marina* percent cover within the Salt River project area.

| Zone | # of Samples | Sampled Area (m ²) | % Cover | Total Area (m ²) | Estimated Total Cover | Std. Dev. of Total Cover | Est. % Cover/m ² |
|----------|--------------|--------------------------------|---------|------------------------------|-----------------------|--------------------------|-----------------------------|
| 1 | 34 | 2.13 | 10.7 | 23750 | 118997 | 138119 | 5.0 |
| 2 | 37 | 2.31 | 18.5 | 23750 | 190416 | 213842 | 8.0 |
| 3 | 37 | 2.31 | 23.1 | 23750 | 237326 | 260819 | 10.0 |
| 4 | 32 | 2 | 38.3 | 23750 | 454961 | 425574 | 19.2 |
| Combined | 140 | 8.25 | 90.6 | 95000 | 1001700 | 1038354 | 10.5 |

Table 3.2: 2014 *Z. marina* percent cover within the Salt River project area.

| Zone | # of Samples | Sampled Area (m ²) | % Cover | Total Area (m ²) | Estimated Total Cover | Std. Dev. of Total Cover | Est. % Cover/m ² |
|----------|--------------|--------------------------------|---------|------------------------------|-----------------------|--------------------------|-----------------------------|
| 1 | 34 | 2.13 | 1.9 | 23750 | 20709 | 28212 | 0.9 |
| 2 | 37 | 2.31 | 1.8 | 23750 | 18320 | 21534 | 0.8 |
| 3 | 37 | 2.31 | 3.5 | 23750 | 35530 | 51952 | 1.5 |
| 4 | 27 | 1.69 | 6.5 | 23750 | 91742 | 73065 | 3.9 |
| Combined | 135 | 8.44 | 13.6 | 95000 | 166301 | 174764 | 1.8 |

Table 3.3: 2013 *Z. marina* percent cover within the Salt River project area.

| Zone | # of Samples | Sampled Area (m ²) | % Cover | Total Area (m ²) | Estimated Total Cover | Std. Dev. of Total Cover | Est. % Cover/m ² |
|----------|--------------|--------------------------------|---------|------------------------------|-----------------------|--------------------------|-----------------------------|
| 1 | 24 | 1.50 | 4.7 | 4514 | 14044 | 26271 | 3.1 |
| 2 | 30 | 1.88 | 30.8 | 4514 | 74230 | 67096 | 16.4 |
| 3 | 30 | 1.88 | 27.4 | 4514 | 66045 | 69239 | 14.6 |
| 4 | 22 | 1.38 | 4.5 | 4514 | 14624 | 17958 | 3.2 |
| Combined | 106 | 6.63 | 67.4 | 18056 | 168942 | 180564 | 9.4 |

Morgan Slough *Z. marina* percent cover.

Table 4.1: 2015 *Z. marina* percent cover by zone within the Morgan Slough project area.

| Zone | # of Samples | Sampled Area (m ²) | % Cover | Total Area (m ²) | Estimated Total Cover | Std. Dev. of Total Cover | Est. % Cover/m ² |
|----------|--------------|--------------------------------|---------|------------------------------|-----------------------|--------------------------|-----------------------------|
| 1 | 21 | 1.31 | 5 | 2988 | 11382 | 994 | 4 |
| 2 | 21 | 1.31 | 0 | 2988 | 0 | 0 | 0 |
| 3 | 21 | 1.31 | 0 | 2988 | 0 | 0 | 0 |
| 4 | 21 | 1.31 | 0 | 2988 | 0 | 0 | 0 |
| Combined | 84 | 5.25 | 5 | 11952 | 11382 | 994 | 1 |

Table 4.2: 2014 *Z. marina* percent cover by zone within the Morgan Slough project area.

| Zone | # of Samples | Sampled Area (m ²) | % Cover | Total Area (m ²) | Estimated Total Cover | Std. Dev. of Total Cover | Est. % Cover/m ² |
|----------|--------------|--------------------------------|---------|------------------------------|-----------------------|--------------------------|-----------------------------|
| 1 | 18 | 1.13 | 9.4 | 2988 | 25084 | 36236 | 8.4 |
| 2 | 21 | 1.31 | 22.0 | 2988 | 49976 | 38274 | 16.7 |
| 3 | 21 | 1.31 | 22.0 | 2988 | 49976 | 41823 | 16.7 |
| 4 | 18 | 1.13 | 13.6 | 2988 | 36151 | 39269 | 12.1 |
| Combined | 78 | 4.88 | 67.0 | 11952 | 161188 | 155601 | 13.5 |

Table 4.3: 2013 *Z. marina* percent cover by zone within the Morgan Slough project area.

| Zone | # of Samples | Sampled Area (m ²) | % Cover | Total Area (m ²) | Estimated Total Cover | Std. Dev. of Total Cover | Est. % Cover/m ² |
|----------|--------------|--------------------------------|---------|------------------------------|-----------------------|--------------------------|-----------------------------|
| 1 | 14 | 0.88 | 4.1 | 2988 | 13903 | 22094 | 4.7 |
| 2 | 21 | 1.31 | 41.8 | 2988 | 95074 | 69253 | 31.8 |
| 3 | 21 | 1.31 | 55.6 | 2988 | 126512 | 57984 | 42.3 |
| 4 | 11 | 0.69 | 9.8 | 2988 | 42672 | 80752 | 14.3 |
| combined | 67 | 4.19 | 111.2 | 11952 | 278161 | 230084 | 23.3 |

3.3) Shoot Density

The 2015 average *Z. marina* shoot density in the Salt River sampled area was: Z1 = 71; Z2 = 121; Z3 = 140; and Z4 = 230. 2015 *Z. marina* shoot density for each zone in the Salt River project area is summarized in Table 5.1. For comparison, 2014 and 2013 *Z. marina* shoot density for each zone in the Salt River are summarized in Tables 5.2 and 5.3. In 2015, *Z. marina* shoot density for the entire population within the project area was 140 ± 0.67 shoots/m². Within the Salt River site, average shoot density in zones 1 and 2 was significantly lower than average shoot density in zone 4 (ANOVA F = 7.08, P < 0.05).

Within the Morgan Slough site, average density was not significantly different between zones (ANOVA F = 1.00, P = 0.4). The 2015 average shoot density in the Morgan Slough project area/zone was Z1 = 2; Z2 = 0; Z3 = 0; and Z4 = 0. 2015 *Z. marina* shoot density for each zone in the Morgan Slough control area is summarized in Table 6.1. For comparison, 2014 and 2013 *Z. marina* shoot density for each zone in Morgan Slough are summarized in Tables 6.2 and 6.3. 2015 *Z. marina* shoot density for the entire population within the control area was 0.4 ± 0.02 shoots/m².

Salt River *Z. marina* Shoot Density

Table 5.1: 2015 *Z. marina* shoot density within the Salt River project area.

| Zone | # of Samples | Sampled Area (m ²) | Shoot # | Total Area (m ²) | Estimated Shoot # | Std. Dev. of Total Shoots | Est. Density (Shoots/m ²) |
|----------|--------------|--------------------------------|---------|------------------------------|-------------------|---------------------------|---------------------------------------|
| 1 | 34 | 2.13 | 150 | 23750 | 1676471 | 53503 | 71 |
| 2 | 37 | 2.31 | 280 | 23750 | 2875676 | 87131 | 121 |
| 3 | 37 | 2.31 | 324 | 23750 | 3327568 | 87126 | 140 |
| 4 | 32 | 2 | 459 | 23750 | 5450625 | 149163 | 230 |
| Combined | 140 | 8.25 | 1213 | 95000 | 14082247 | 397505 | 140 |

Table 5.2: 2014 *Z. marina* shoot density within the Salt River project area.

| Zone | # of Samples | Sampled Area (m ²) | Shoot # | Total Area (m ²) | Estimated Shoot # | Std. Dev. Of Total Shoots | Est. Density (Shoots/m ²) |
|----------|--------------|--------------------------------|---------|------------------------------|-------------------|---------------------------|---------------------------------------|
| 1 | 34 | 2.13 | 55 | 23750 | 614706 | 6490 | 26 |
| 2 | 37 | 2.31 | 54 | 23750 | 554595 | 5296 | 23 |
| 3 | 37 | 2.31 | 82 | 23750 | 842162 | 7610 | 35 |
| 4 | 27 | 1.69 | 147 | 23750 | 2068889 | 12123 | 87 |
| Combined | 135 | 8.44 | 338 | 95000 | 4080352 | 31520 | 43 |

Table 5.3: 2013 *Z. marina* shoot density within the Salt River project area.

| Zone | # of Samples | Sampled Area (m ²) | Shoot # | Total Area (m ²) | Estimated Shoot # | Std. Dev. Of Total Shoots | Est. Density (Shoots/m ²) |
|----------|--------------|--------------------------------|---------|------------------------------|-------------------|---------------------------|---------------------------------------|
| 1 | 24 | 1.50 | 94 | 4514 | 282877 | 14361 | 63 |
| 2 | 30 | 1.88 | 388 | 4514 | 934097 | 29268 | 207 |
| 3 | 30 | 1.88 | 375 | 4514 | 902800 | 28914 | 200 |
| 4 | 22 | 1.38 | 115 | 4514 | 377535 | 16145 | 84 |
| Combined | 106 | 6.63 | 972 | 18056 | 2497309 | 88687 | 138 |

Morgan Slough *Z. marina* Shoot Density

Table 6.1: 2015 *Z. marina* shoot density within the Morgan Slough control area.

| Zone | # of Samples | Sampled Area (m ²) | Shoot # | Total Area (m ²) | Estimated Shoot # | Std. Dev. of Total Shoots | Est. Density (Shoots/m ²) |
|----------|--------------|--------------------------------|---------|------------------------------|-------------------|---------------------------|---------------------------------------|
| 1 | 21 | 1.31 | 2 | 2988 | 4553 | 994 | 2 |
| 2 | 21 | 1.31 | 0 | 2988 | 0 | 0 | 0 |
| 3 | 21 | 1.31 | 0 | 2988 | 0 | 0 | 0 |
| 4 | 21 | 1.31 | 0 | 2988 | 0 | 0 | 0 |
| Combined | 84 | 5.25 | 2 | 11952 | 4553 | 994 | 0.4 |

Table 6.2: 2014 *Z. marina* shoot density within the Morgan Slough control area.

| Zone | # of Samples | Sampled Area (m ²) | Shoot # | Total Area (m ²) | Estimated Shoot # | Std. Dev. Of Total Shoots | Est. Density (Shoots/m ²) |
|----------|--------------|--------------------------------|---------|------------------------------|-------------------|---------------------------|---------------------------------------|
| 1 | 18 | 1.13 | 148 | 2988 | 393088 | 19700 | 132 |
| 2 | 21 | 1.31 | 317 | 2988 | 721673 | 17823 | 242 |
| 3 | 21 | 1.31 | 316 | 2988 | 719397 | 20596 | 241 |
| 4 | 18 | 1.13 | 187 | 2988 | 496672 | 27378 | 166 |
| Combined | 78 | 4.88 | 968 | 11952 | 2330830 | 85497 | 195 |

Table 6.3: 2013 *Z. marina* shoot density within the Morgan Slough control area.

| Zone | # of Samples | Sampled Area (m ²) | Shoot # | Total Area (m ²) | Estimated Shoot # | Std. Dev. Of Total Shoots | Est. Density (Shoots/m ²) |
|----------|--------------|--------------------------------|---------|------------------------------|-------------------|---------------------------|---------------------------------------|
| 1 | 14 | 0.88 | 62 | 2988 | 211721 | 23528 | 71 |
| 2 | 21 | 1.31 | 387 | 2988 | 881033 | 30483 | 295 |
| 3 | 21 | 1.31 | 485 | 2988 | 1104137 | 25657 | 370 |
| 4 | 11 | 0.69 | 78 | 2988 | 339002 | 54197 | 113 |
| Combined | 67 | 4.19 | 1012 | 11952 | 2535894 | 133866 | 212 |

4) COMPARISONS BETWEEN YEARS

4.1) Eelgrass Extent

In 2013, there were 35 discrete patches of *Z. marina* in the Salt River. Within these patches, there were an approximate total of 388 individual *Z. marina* shoots. In 2015, there were 13 discrete patches of *Z. marina* in the Salt River and the newly formed slough channels. Within these patches, there were an approximate total of 59 individual *Z. marina* shoots. In 2013, the total length of continuous *Z. marina* beds in the Salt River was 2,053 meters. In 2015, the total length of continuous *Z. marina* beds in the Salt River was 2,075 meters.

4.2) Percent Cover

Z. marina percent cover in the Salt River was significantly higher in zones 1, 2 and 4 in 2015 than it was in 2013 ($p = 0.04, 0.05, 0$; $t = 2.16, 2, 5.26$, $df = 56, 53, 33$). Salt River *Z. marina* percent cover in zone 3 did not differ significantly between 2015 and 2013 ($p = 0.52$; $t = 0.64$; $df = 58$).

4.3) Density

Z. marina shoot density in Salt River was significantly higher in zones 2 and 4 in 2015 than it was in 2013 ($p = 0.05, 0.0$; $t = 2.05, 3.71$; $df = 50, 43$). Salt River *Z. marina* shoot density in zones 1 and 3 did not differ significantly between 2015 and 2013 ($p = 0.7, 0.16$; $t = 0.39, 1.44$; $df = 50, 51$).

4.4) Non-Native Eelgrass

In 2013, eight shoots of *Z. japonica*, the non-native eelgrass, were found in one patch in the Salt River. The GPS location of the patch was 40°37'7.20"N, 124°18'56.34"W. *Z. japonica* was not observed in the Morgan Slough control area. *Z. japonica* was not found in the Salt River or Morgan Slough in 2014 or 2015.

4.5) Photo Documentation

Photographs and GPS waypoints were taken at each transect marker every 78 meters along the Salt River project and Morgan Slough control sites. The following sampling of photos was taken at the same locations in the Salt River in 2013 and 2015 and document *Z. marina* coverage pre and post-construction. Photos of each transect were taken in 2014 and have been submitted to Doreen Hansen at the Humboldt County Resource Conservation District. The captions for each photograph include the abbreviations as follows: Salt River (SR), transect number, beginning at the slough entrance and moving upstream, (T#) and compass bearing (#°).

2013 SR, T14, 70°



2015 SR, T14, 260°



2013 SR, T17, 30°



2015 SR, T17, 240°



2013 SR, T18, 6°



2015 SR, T18, 200°



5) DISCUSSION

5.1) Eelgrass Extent

The total combined area of *Z. marina* in both continuous beds, and discrete eelgrass patches in 2013 was 1.06535 acres. Of that total area, 0.53 acres of *Z. marina* were excavated in 2013. The success criterion states that "within three years of completion of the project (both phases), the entire pre-construction eelgrass area plus the restored areas suitable for eelgrass recruitment shall have an extent of vegetative cover equal to at least 1.2 times the impacted area and have an average density equal to the pre-construction average density" (California Coastal Commission special conditions for CDP 1-10-32-Eelgrass). The impacted area was 0.53 acres; 1.2 times 0.53 acres is 0.64 acres. The total combined *Z. marina* extent for 2014 was 1.06899 acres; the total acreage increased by 102% or a 2.02 times increase from the impacted area. Therefore, the success criterion of 1.2 times increase in *Z. marina* coverage was achieved in 2014. The total combined *Z. marina* extent for 2015 increased further to 1.08 acres, yielding a total acreage increase of 104% or a 2.04 times increase from the impacted area. Acreage calculations are based on detailed surveys of previous and existing *Z. marina* continuous beds and discrete patches as described in detail in the methods section.

In 2015, average percent cover and density were both higher in the project area than in 2013 and 2014. When comparing *Z. marina* percent cover and shoot density between years, Zone 4 is the area least affected by excavation activity. All of Salt River eelgrass zones 1 through 4 in the 2013 pre-construction survey are contained within Zone 4 in the 2014 and 2015 surveys. In 2013, Zone 1 was not part of the channel and Zones 2 and 3 were heavily impacted by excavation activities. *Z. marina* occurring in zones 1-3 in 2014 and 2015 are novel recruitment.

5.2) Salt River Percent Cover

Comparing the Salt River *Z. marina* average percent cover between 2013 and 2014 indicates a decrease in percent cover of 81% following excavation activities. Between 2014 and 2015, *Z. marina* percent cover increased by 483%, indicating a substantial recovery in one year. Between 2013 and 2015, *Z. marina* percent cover in the Salt River increased by 11.7%. Therefore, the project has reached the percent cover criteria goal.

5.3) Salt River Shoot Density

Comparing the Salt River *Z. marina* average density between 2013 and 2014 indicates a 69% decrease in shoots/m² following excavation activities. Between 2014 and 2015, *Z. marina* density increased by 226%, indicating a substantial recovery in one year. Between 2013 and 2015, *Z. marina* average density in the Salt River increased by 1.45%. Therefore, the project has reached the shoot density criteria goal.

5.4) Morgan Slough Percent Cover

Comparing the Morgan Slough *Z. marina* average percent cover between 2013 and 2014 indicates a decrease in percent cover of 42%. Between 2014 and 2015, *Z. marina* percent cover in Morgan Slough decreased by 93%. Between 2013 and 2015, *Z. marina* percent cover in Morgan Slough decreased by 96%, indicating a near collapse of the *Z. marina* population.

5.5) Morgan Slough Shoot Density

Comparing the Morgan Slough *Z. marina* average densities between 2013 and 2014 indicates 8% decrease in shoots/m². Between 2014 and 2015, *Z. marina* average density decreased by 99.8%. Between 2013 and 2015, *Z. marina* average density decreased by 99.8%, indicating a collapse of the *Z. marina* population in Morgan Slough.

5.6) Eel River Delta

The drastic decrease in the *Z. marina* population in Morgan Slough was witnessed in other areas of the Eel River Delta system, particularly in the interior marsh channels around Salt River and Cockrobin Island. Within the project area, there was initial *Z. marina* recruitment in the newly created slough channels in 2014, although those recruits were not present in 2015. Abiotic factors such as increased water temperature and drought conditions may be affecting eelgrass in the Eel River Delta. Increase sediment suspension along with chemical loading due to heavy cattle use upstream of the Morgan Slough Bridge could also contribute to the *Z. marina* die-off in the control area. The fact that *Z. marina* is increasing in the project area despite the general decrease in surrounding areas is interesting and may warrant another season of surveys. We would recommend including water temperature/quality measurements in any future *Z. marina* survey work to establish baseline data that could be useful in understanding temporal changes in population size and health.