

Salt Marsh Vegetation

Status Update and Experiments to Inform Adaptive Management



San Dieguito Wetlands
March 2019

- Vegetation development is critically important to the ability of the San Dieguito Wetlands Restoration Project to meet the performance standards required for successful mitigation.
- The project has relied on natural recruitment of vegetation and several planting efforts have been undertaken in the past to facilitate vegetation development, but with generally poor outcomes except for cordgrass.
- We would like to review the current status of vegetation in the restoration site and current planting efforts and experiments underway to facilitate vegetation establishment.

Performance Standards Pertaining to Cover of Vegetation

Absolute Standard: Habitat Areas

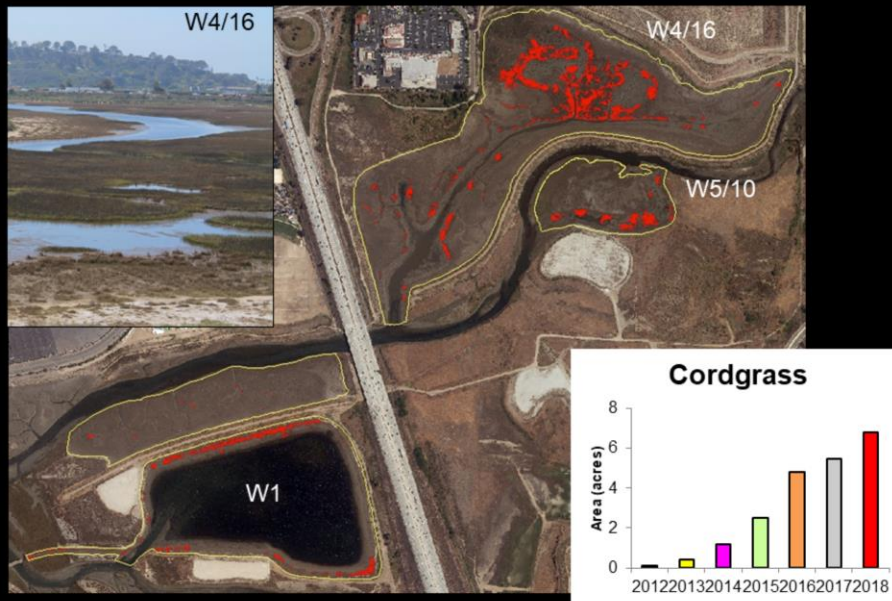
The area of different habitats shall not vary by more than 10% from the areas indicated in the final restoration plan

Relative Standard: Vegetation

The proportion of total vegetation cover in the marsh shall be similar to those proportions found in the reference sites.

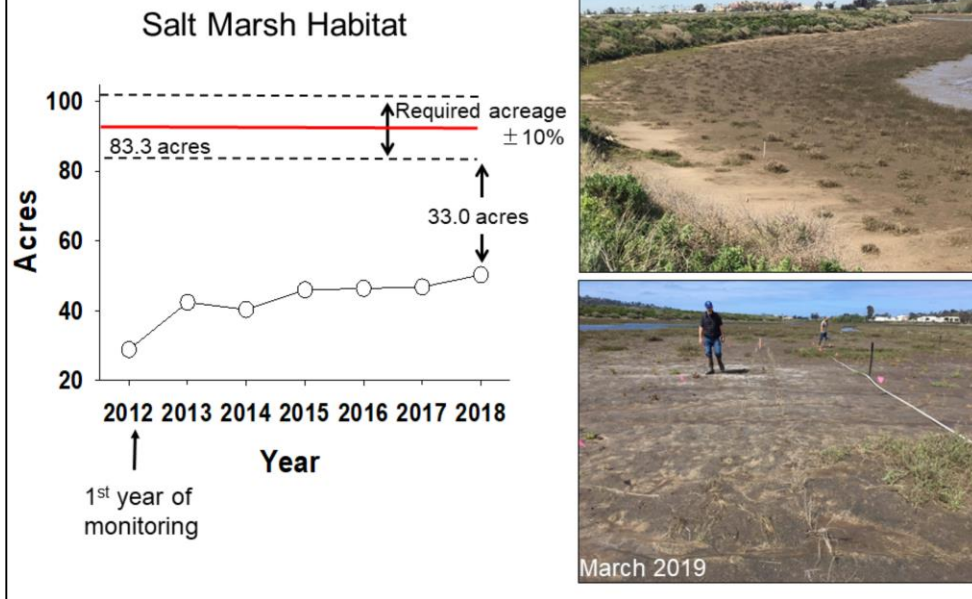
- There are two standards that pertain to the cover of vegetation.
- The first is the Habitat Areas standard. This is an absolute standard, that is evaluated only in San Dieguito Wetlands and specifies that the area of different habitats shall not vary more than 10% from the areas in the final restoration plan.
- To be assessed as salt marsh habitat the cover of vegetation has to be at least 30% and this 30% is evaluated within 10 x 10 m grids covering the entire wetland as discussed by Steve in the Performance talk.
- The second standard that pertains to the cover of vegetation is the Vegetation standard.
- This is a relative standard and requires that the proportion of total vegetation cover in the marsh shall be similar to those proportions found in the reference sites.

Distribution of Cordgrass in San Dieguito Wetlands 2018



- In some areas of the the restoration project, vegetation is becoming well established.
- This includes in particular areas of low marsh planned for cordgrass, *Spartina foliosa*.
- The photo shows cordgrass patches, indicated by the red color, in modules W4/16 and W5 on the east side of the freeway and around the basin module W1 on the west side of the freeway.
- After a slow start following the last planting in 2011 cordgrass now occupies a total of about 6.8 acres an increase of about 1.3 acres from 2017.

Salt Marsh Habitat is Underperforming



- Overall, however, vegetation is still underperforming.
- In this figure we have acres on the y-axis and year on the x-axis.
- The required acres of salt marsh habitat $\pm 10\%$ is also shown together with trend in acres over time.
- San Dieguito Wetlands did pick up about 3.4 acres of salt marsh habitat from 2017 to 2018 but in 2018 the restoration project was still ~33 acres short of the minimum number of required acres of salt marsh habitat , at least 30% cover.
- As mentioned in the Performance talk, San Dieguito Wetlands has yet to met the absolute standard for habitat areas.

Vegetation Cover



Mugu Lagoon



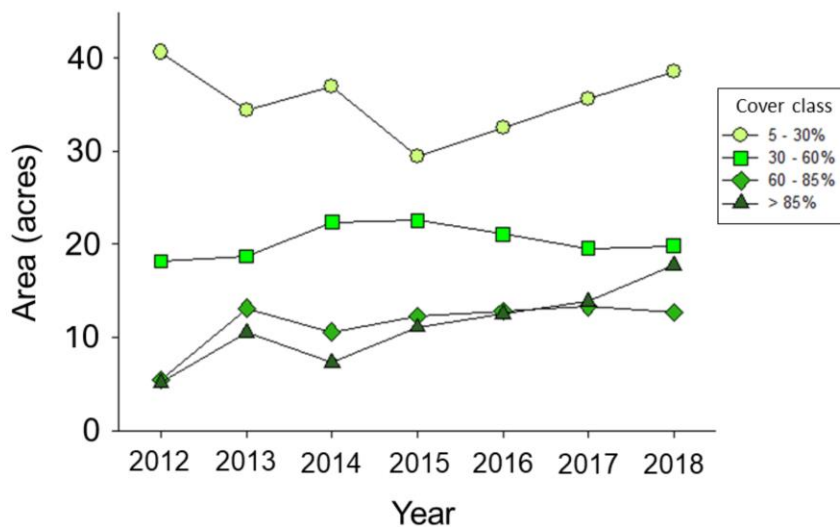
Carpinteria Salt Marsh



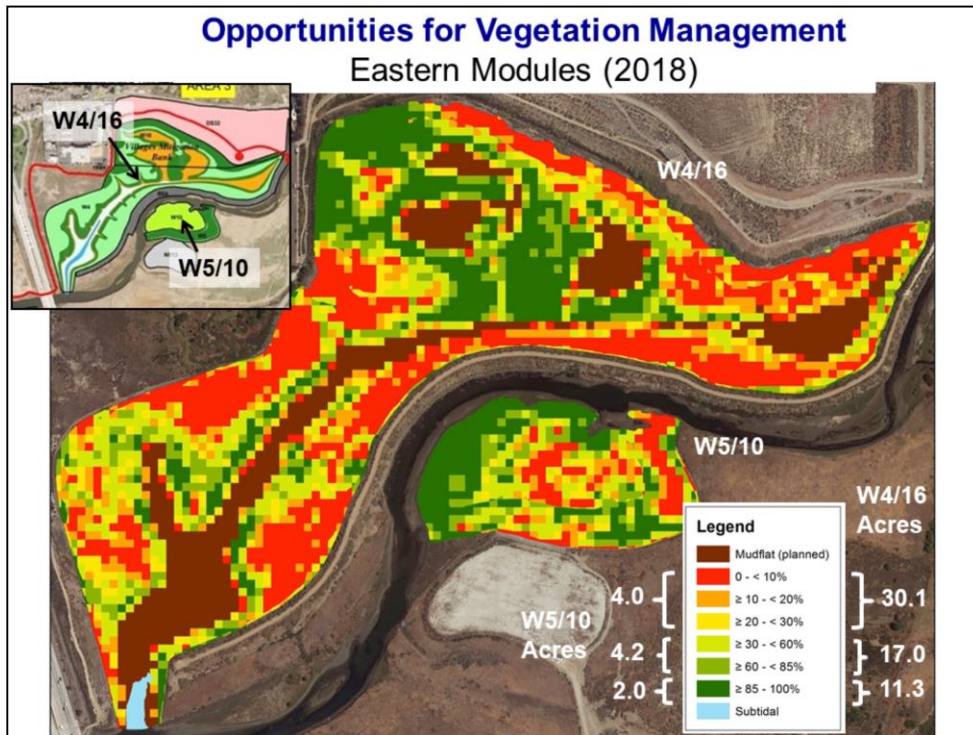
Tijuana Estuary

- In addition to the habitat areas standard, which is an absolute standard, vegetation cover is a relative standard that requires cover in SDW to be similar to that of the reference wetlands.
- Vegetation cover is high in natural wetlands, illustrated here for the reference wetlands, Mugu Lagoon, Carpinteria Salt Marsh, and Tijuana Estuary.

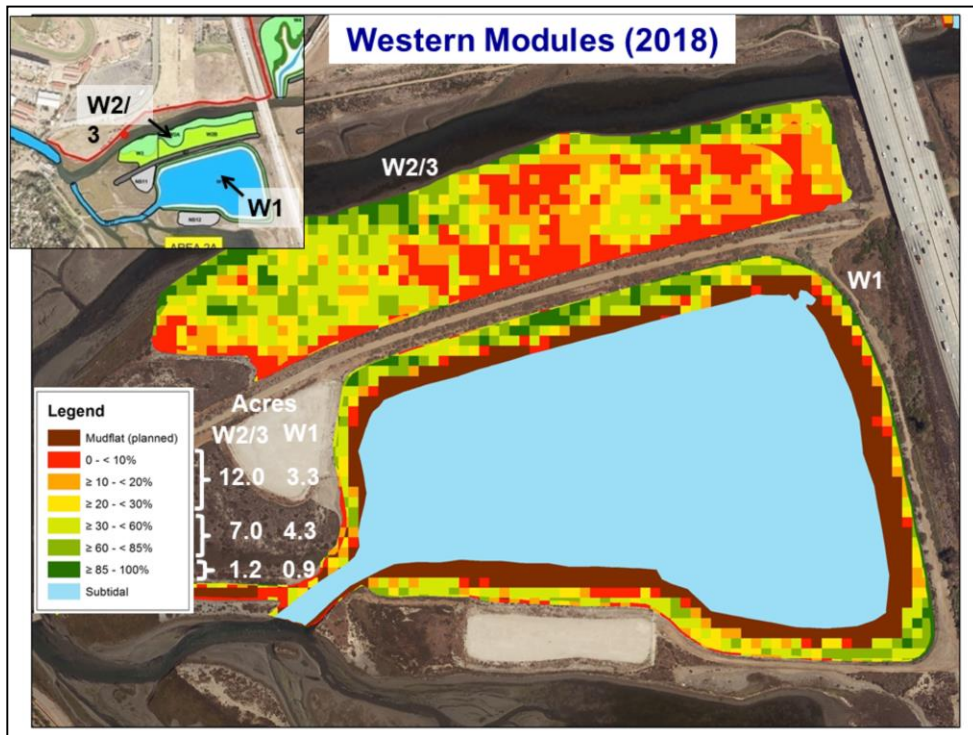
Vegetation Cover in San Dieguito Wetlands



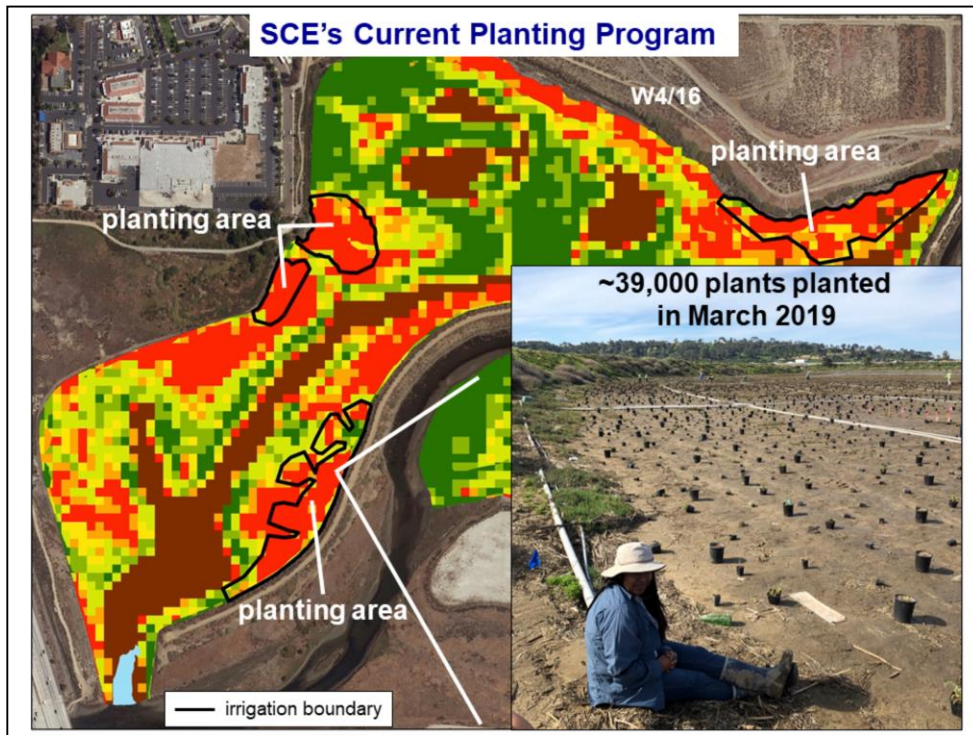
- This figure shows changes in vegetation cover over time by cover classes, 5-30%, 30-60%, 60-85%, and >85% updated for 2018.
- The goal is to achieve not only a minimum of 83.3 acres of salt marsh habitat, but a high cover of vegetation similar to the reference wetlands.
- At present, the increase in cover in the higher classes is very shallow, with ~18 acres of 85% cover in 2018, there was, however, an increase about 5 acres in this cover class over 2017.
- Without adaptive management to increase the cover of vegetation, it is unlikely that the restoration project will meet the habitat areas standard or the relative standard for vegetation cover for many years.



- We can use our monitoring data to identify areas in the wetland where vegetation is underperforming and identify opportunities for adaptive management.
- For orientation, this slide shows the wetland modules on the east side of the freeway.
- The inset is extracted from the Restoration Plan and shows most of these modules were planned vegetated salt marsh habitat indicated as shades of green.
- The brown indicates planned mudflat.
- We have broken down vegetation cover determined using aerial imagery in 2018 into cover classes: Red is 0-10, orange 10-20 and yellow 20 to 30%—these also represent areas that were classified either as other or unplanned mudflat
- Brown is planned mudflat
- Areas that meet the Habitat Areas standard, that is with cover $\geq$ or equal to 30% are indicated by shades of green, with darkest green showing areas that are 85% or greater cover.
- Also provided are the estimated acres for each cover class.
- You can see that as of 2018 there are extensive areas of red and orange that could benefit from some form of intervention to facilitate plant development, including 30 acres in W4/16



- Similarly, we can take a look at the modules on the west side of the freeway, that includes W2/3 and the basin, W1.
- The inset shows that modules W2/3 were planned vegetated salt marsh habitat.
- Module W1 is largely a subtidal basin bordered by mudflat and a strip of vegetated marsh.
- We can see that about 40% of W2/3, 8.2 acres had achieved at least 30% cover in 2018 but that 12 acres of sparse vegetation remain, particularly in the middle and eastern end.



- To facilitate plant development, SCE has undertaken a planting program.
- In 2017, SCE tilled some areas and installed irrigation line in preparation for planting in three areas of W4/W16, indicated by the solid lines that had a very low cover of vegetation.
- In March 2019 they planted about 39,000 plants within these areas.

Experiments to inform SCE planting program (2019)

Overall goal:

Use some of the plants available for 2019 in experiments to investigate factors that could facilitate plant cover and bring the wetland vegetation standards into compliance with the SONGS permit.

Questions:

- Does container size of nursery grown plants affect plant growth and survival in the field? Will this vary among species?
Rationale: Soil salinity decreases with depth. Plants in larger pots may have deeper roots.
- Does planting in clusters affect plant growth and survival in the field? Will this vary among species?
Rationale: Closer spacing of planted plants may improve microhabitat conditions (e.g., salinity, moisture) favorable to plant growth.

- Embedded within this larger planting program are some experiments designed to inform this program moving forward.
- The overall goal of these experiments is to investigate factors that could facilitate plant cover and bring the wetland into compliance with the SONGS permit.
- The specific questions being addressed are:
- Does container size of nursery grown plants affect the development of plant cover?
Rationale: Soil salinity is a stressor, but it decreases with depth. Plants grown in larger pots have deeper roots that may have less exposure to higher salinities.
- Does planting in clusters affect plant cover? Will this vary among species?
Rationale: Clustering of planted plants may reduce time to achieve high cover by improving microhabitat conditions e.g., soil moisture, favorable to plant growth.

Experimental variables

- **Container size (gallon vs. rosepot)**
 - rosepot 2.25 x 3.25" deep
 - gallon 6 x 7" deep



- **Clustering (singletons vs. group of 3)**



- Taking a closer look at the experimental variables.
- This slide shows two of the experimental variables, and the arrangement of the experimental plantings in rows with plants spaced about 2' apart.
- The two container sizes being evaluated are shown on the right: rose pot containers on the left and gallon containers on the right.
- The bottom photo shows examples of the clustering treatments: plants planted as singletons or in clusters of three.

Experiments to Inform Adaptive Management Program (2019)

Experimental variables (con't)

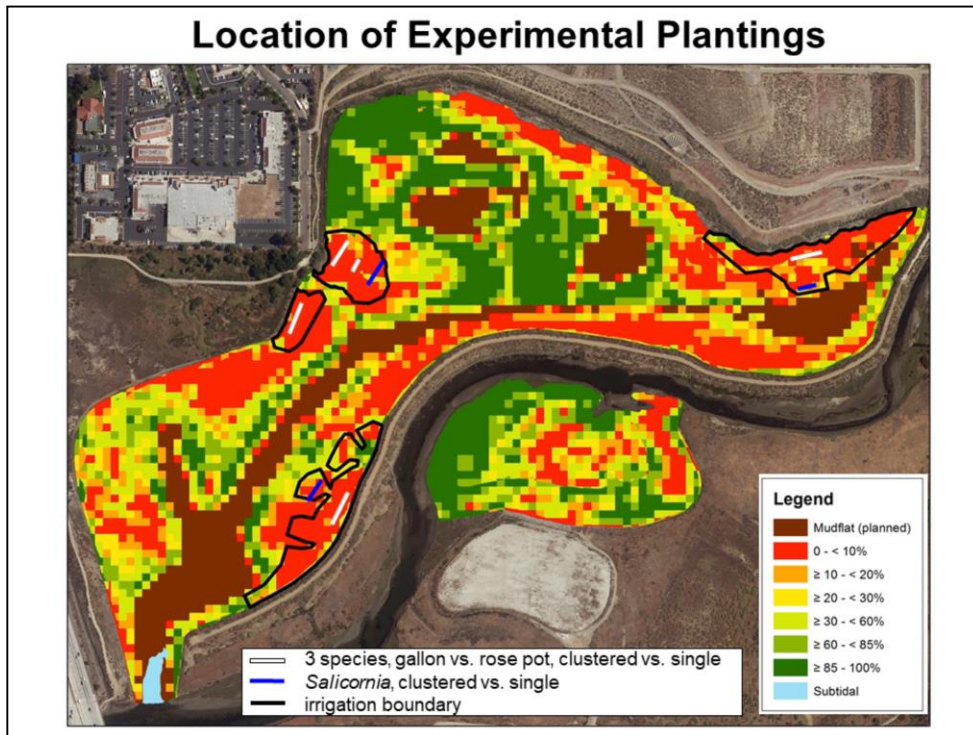
- **Plant species**

- a. *Limonium* – Sea lavender
- b. *Frankenia* – Alkali heath
- c. *Arthrocnemum*–Parish's glasswort
- d. *Salicornia*–Pickleweed



- **Time (initial, mid-point, end of growing season)**

- This slide shows the four plant species being evaluated—they have different growth forms, rooting depths, and tolerances to tidal inundation regime that could affect the rate at which they increase in cover.
- Finally, we are measuring plant responses in the experiment over time.



- The experimental treatments are located in the three areas that are being planted by SCE and that currently have a very low cover of vegetation.

Monitoring of the Experiment

CCC contract scientists will monitor the experiment to evaluate survival and growth of the plantings:

- Measure the cover of plantings at the beginning, mid-point, and end of the growing season.
 - Cover of plants will be determined from *in situ* photographs using point contact methods
 - Larger scale estimates of cover within the experimental areas will be measured using drone imagery
- Measure irrigation water delivery to planted area at intervals throughout the experiment using rain gauges.
- Soil salinity & moisture will be measured within the planted (irrigated) and control (non-irrigated) areas every 2 months.

- CCC contract scientists will monitor the performance of the plantings to determine which experimental treatment best facilitates the development of plant cover.
- This includes measuring the local cover of each planting at the beginning, mid-point, and end of the growing season from *in situ* photographs and over the larger experimental area using drone imagery every 6 months.
- Measure irrigation water delivery to planted area using rain gauges deployed throughout experiment to be able to provide feedback to SCE regarding changes that may need to be made in the irrigation plan to improve plant performance.
- Measure soil salinity & moisture within the planted area and a control areas every 2 months to determine whether the irrigation is affecting those variables.
- Ultimately, we would like to determine if plantings are surviving and growing in a trajectory that will allow for the habitat areas standard to be met within a reasonable amount of time

Other Factors to Consider to Optimize Planting Success

Understanding the factors that affect plant establishment may save money and time in the long run

Factors to consider:

- Irrigation frequency & duration
- Planting density (spacing)
- Plant species
- Planting elevation
- Irrigation withdrawal



- There are other factors to consider that may optimize planting success.
- Conducting experiments in advance of large scale planting to better understand the importance of these factors may save money and time in the long run.
- Factors to consider in a planting program include how frequently to irrigate and for how long, planting density and plant species, and if plants become established with irrigation, how to reduce the stress associated with the withdrawal of irrigation.

Monitoring of SCE's Planting Program

CCC contract scientists will monitor the overall planting program to evaluate whether it achieves the desired goal of increasing vegetation cover, and over what time scale.

- **Measurements of vegetation cover within the planted polygons will be taken from images collected by drone at the beginning and end of the growing season.**

Summary

- **Vegetation is performing well in some areas of the wetland, but underperformance in other areas has lead to a short-fall in salt marsh habitat and vegetation cover.**
- **Absolute standard for habitat areas has not yet been met.**
- **Relative standard for vegetation cover has not yet been met.**
- **SCE is implementing a planting and irrigation program in portions of the wetland to facilitate vegetation development.**
- **An experiment designed to evaluate the effect of plant species, container size, and plant clustering on the development of cover is embedded in the larger planting effort.**
- **CCC contract scientists are monitoring the experiment and the overall planting program to evaluate whether they achieve the desired goal of increasing vegetation cover in a timely manner.**

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