

Salt Marsh Vegetation & Biological Standards Status Update



San Dieguito Wetlands
August 2019

Salt Marsh Vegetation & Biological Standards Status Update

Standards that have underperformed in San Dieguito Wetlands:

- Salt marsh vegetation
 - Habitat areas
 - Vegetation cover
- Biological standards
 - Densities of birds and invertebrates
 - Species richness of fish
 - Bird feeding (food chain support)

- This presentation concerns the status of some of the standards that have underperformed in San Dieguito Wetlands.
- The first is salt marsh vegetation, which will be the main focus of the presentation because the habitat areas standard, including the areas of vegetated salt marsh, is an absolute standard that must be met every year, it has not been met, and has been the focus of adaptive management activities over the past several years.
- We will also be focusing more on relative standards that have not been met in the coming year and for today's presentation, we will discuss two of these, densities of birds and invertebrate, in more detail.

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

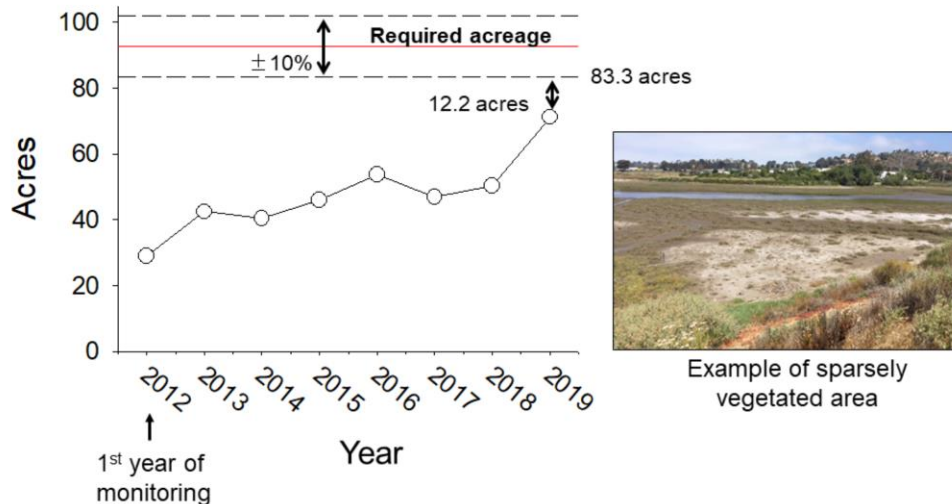
Relative Standard: Vegetation

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 must be at least 30% and this 30% is evaluated within 10 x 10 m grids covering the entire wetland as discussed by Mark 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.
- The project has relied on natural recruitment of vegetation and several planting efforts undertaken in the past to facilitate vegetation development.
- 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.

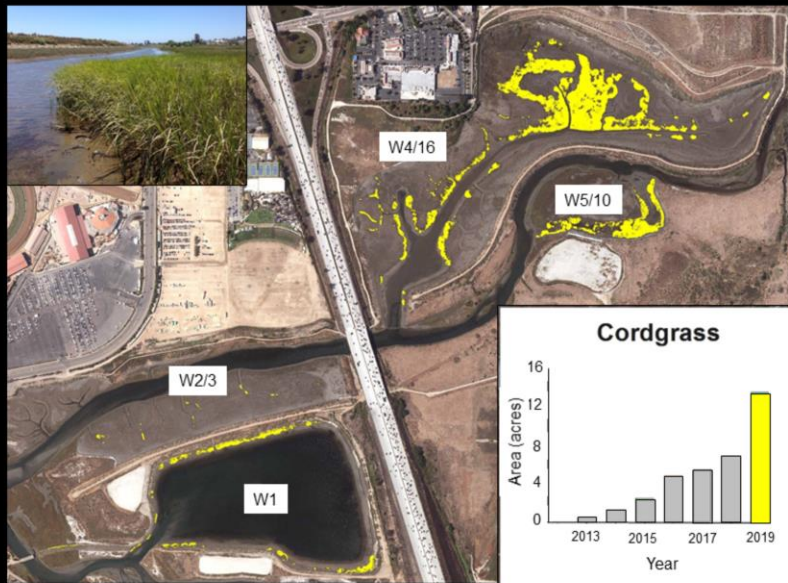
Salt Marsh Habitat is Underperforming

Changes in Acres of Salt Marsh Habitat Over Time



- Overall, after 8 years vegetation is still underperforming although there was an appreciable increase in the acreage of salt marsh habitat during 2019, likely facilitated by the higher levels of rainfall during that year relative to the previous years.
- In this figure we have acres of salt marsh habitat on the y-axis and year on the x-axis.
- The required acres of salt marsh habitat +/-10% is also shown together with trend in acres over time.
- San Dieguito Wetlands picked up ~23 acres of salt marsh habitat from 2018 to 2019 but is still ~12 acres short of the minimum number of required acres of salt marsh habitat , at least 30% cover.
- The photo shows a sparsely vegetated area that would be classified as “other”—not a planned habitat
- As mentioned in the Performance talk, San Dieguito Wetlands has yet to met the absolute standard for habitat areas.

Distribution of Cordgrass in San Dieguito Wetlands 2019



- Cordgrass, *Spartina foliosa*, is becoming well established throughout the lower elevation areas of the restoration project.
- The photo shows cordgrass patches, indicated by the turquoise 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. Note that cordgrass has also colonized some of the tidal creeks in module W2/3..
- After a slow start following the last planting in 2011 cordgrass now occupies a total of about 13 acres, an increase of about 6 acres from 2018.

Vegetation Cover



Mugu Lagoon



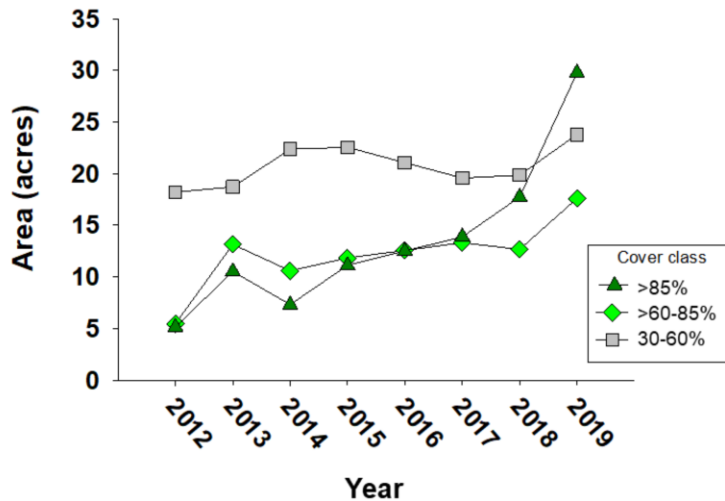
Carpinteria Salt Marsh



Tijuana Estuary

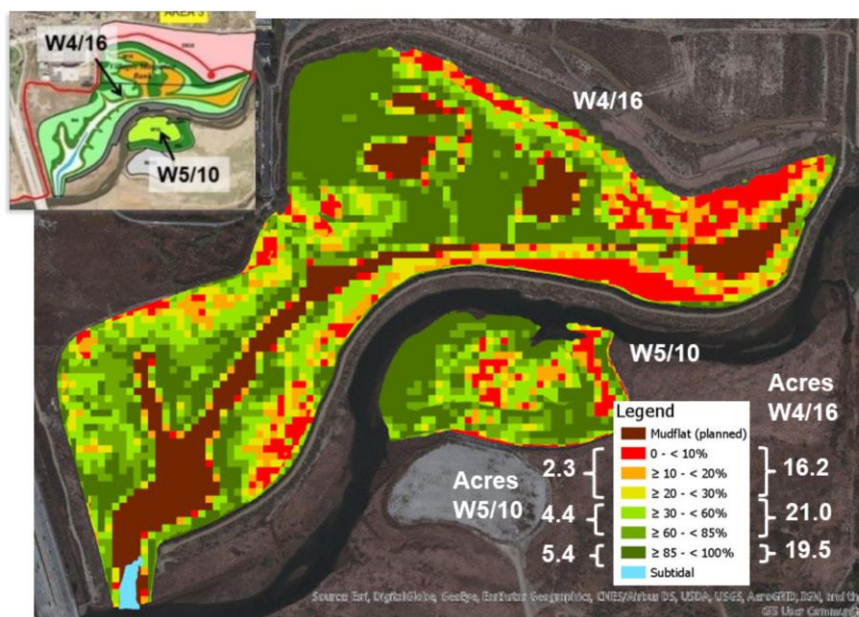
- In addition to the habitat areas standard, which is an absolute standard, vegetation cover is a relative standard that requires cover in SDW to be similar to that of the reference wetlands.
- Vegetation cover is high in natural wetlands, illustrated here for the reference wetlands, Mugu Lagoon, Carpinteria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

Vegetation Cover in San Dieguito Wetlands

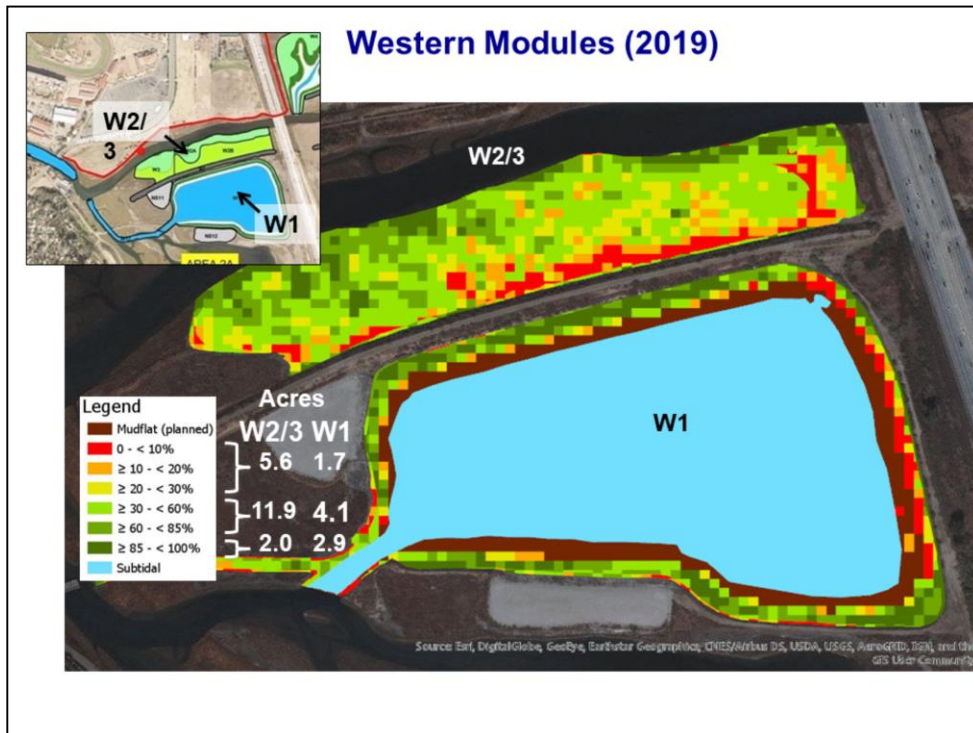


- This figure shows changes in vegetation cover over time for the higher cover classes of vegetation, 60-85%, and >85% and for 30-60% updated for 2019.
- The goal is to achieve not only a minimum of 83.3 acres of salt marsh habitat, but a high cover of vegetation similar to the reference wetlands.
- There was an appreciable increase in the acres of >85% cover to around 30% in 2019, which is encouraging.
- The cover of 30-60% is relatively flat because every year some of the vegetation in cover classes of <30%, or other habitat, grows into the 30-60% cover class, and some of the 30-60% grows into the 85% class.

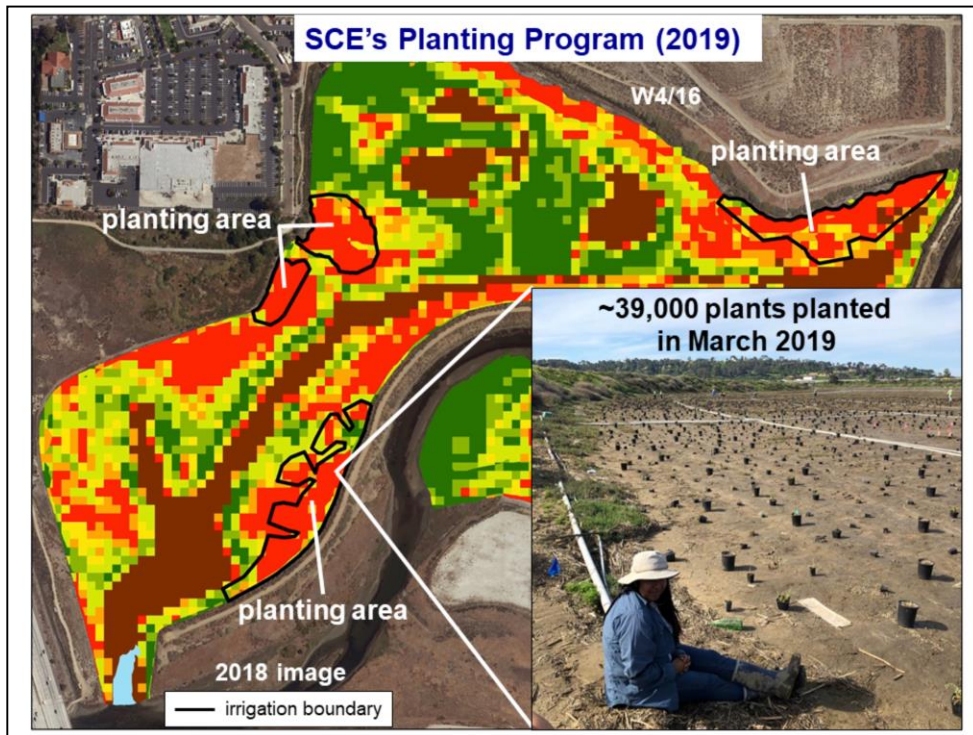
Vegetation Cover - Eastern Modules (2019)



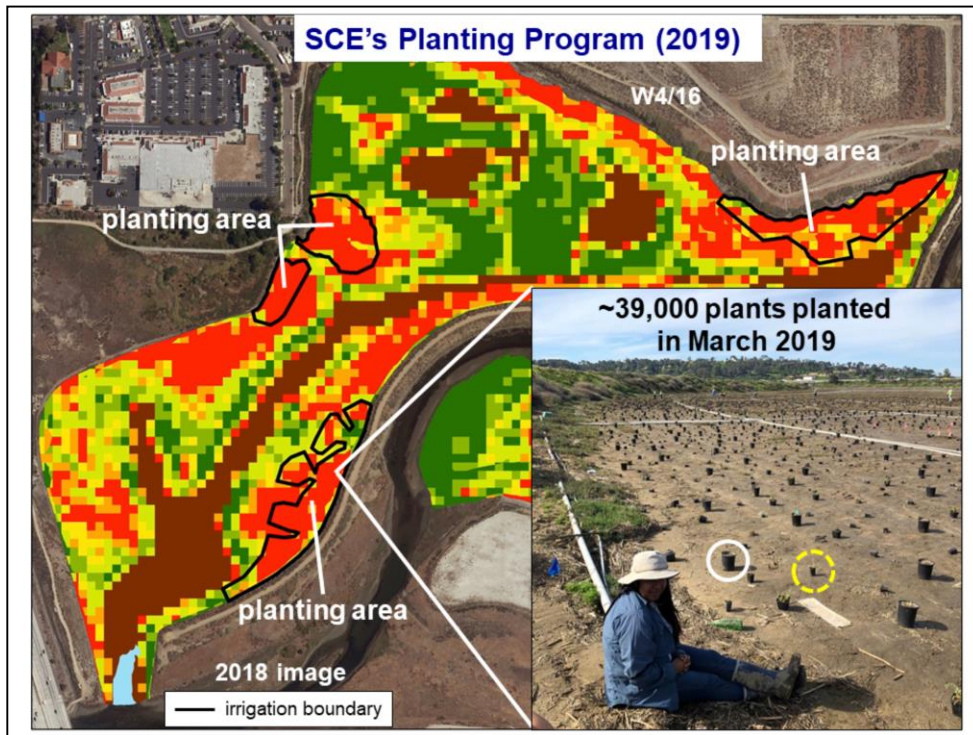
- We can use our monitoring data to help identify areas in the wetland where vegetation is underperforming.
- For orientation, this slide shows the wetland modules on the east side of the freeway.
- The inset is extracted from the Restoration Plan and shows most of these modules were planned vegetated salt marsh habitat indicated as shades of green.
- The brown indicates planned mudflat.
- We have broken down vegetation cover determined using aerial imagery in 2019 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
- Areas that meet the Habitat Areas standard, that is with cover > 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.
- We can see that about 25 acres have achieved at least 85% cover, much of this coming from lower elevation areas vegetated by Spartina with about 50 acres of at least 30% cover
- As of 2019, areas of red and orange that might benefit from some form of intervention to facilitate plant development, are located at the higher elevations and in the eastern portion of 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 14 of 20 acres of W2/3 had achieved at least 30% cover in 2019 and that 5-6 acres of sparse vegetation remain, particularly at the higher elevations and eastern end.
- Only 2 out of the 19.5 acres have achieved at least 85% cover in W2/3.



- 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 in this 2018 image.
- In March 2019 they planted about 39,000 plants within these areas.



- You will notice potted plants for this effort came in two sizes of pots.
- The pot circled on the left is a gallon pot—these are 6" in diameter and 7' deep.
- The pot circled on the right is a rosepot—these are 2.25" in diameter and 3.25" deep.

Experiment to inform SCE planting program (2019)

Goal of the experiment:

- Test the effect of container size and clumping of nursery grown plants on growth and survival in the field.
 - Soil salinity decreases with depth. Plants in larger pots may have deeper roots that extend into the lower salinity soil at depth. More potting soil in larger pots
 - Closer spacing of planted plants may improve microhabitat conditions (e.g., salinity, moisture) favorable to plant growth.

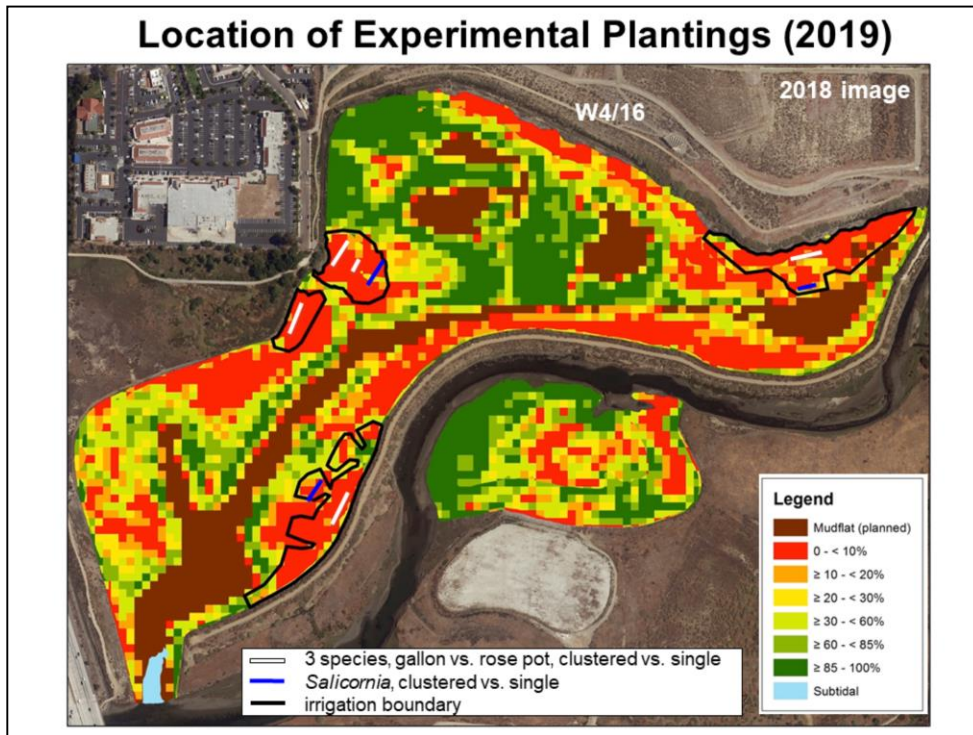


Container size



Clustering

- We have worked with SCE in developing experiments to inform the planting program going forward.
- Embedded within this larger planting program in 2019 was an experiment designed to test the effect of container size of nursery grown plants and plant clumping on plant growth and survival in the field.
- Rationale:
 - Soil salinity decreases with depth. Plants in larger pots may have deeper roots that extend into the lower salinity soil at depth. More potting soil in larger pots
 - Closer spacing of planted plants may improve microhabitat conditions (e.g., salinity, moisture) favorable to plant growth.

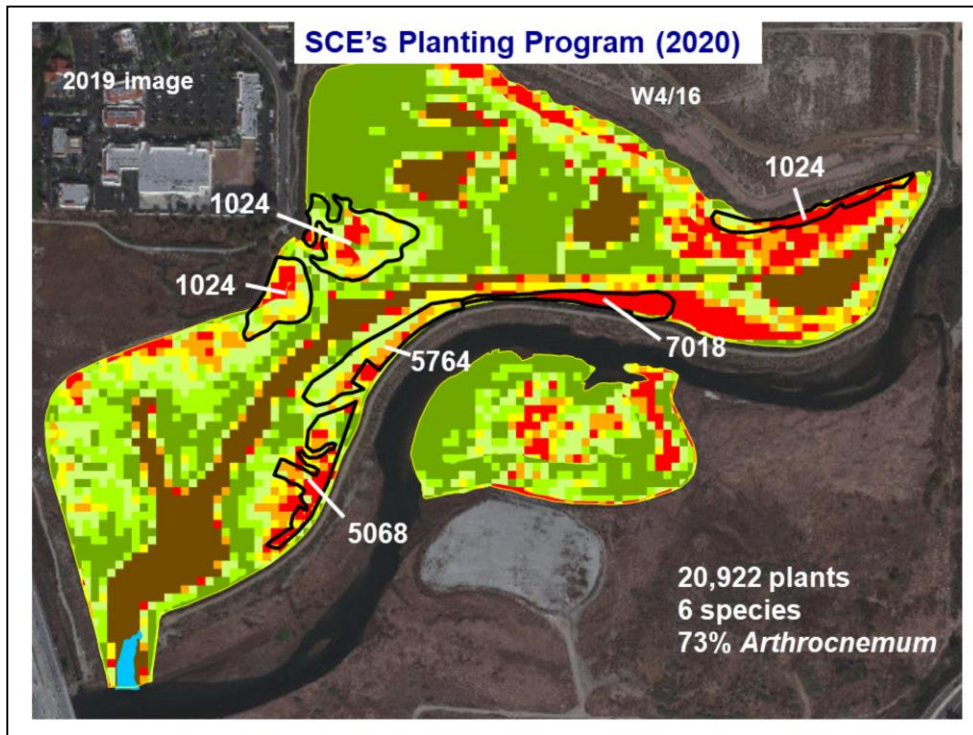


- The experimental treatments were located in the four areas that were planted by SCE in 2017/18 and that had a very low cover of vegetation in 2018.

Summary of Results of Experiment (2019)

- Plants in Gallon containers performed much better than plants in smaller Rosepots
- Clustering conferred no obvious benefit on plant performance
- Results from experiment were used to inform the planting program in 2020

- This slide just summarizes the results of the experiment for Parish's Glasswort, which comprise most the plants planted in 2019.
- Plants in Gallon containers performed much better than plants in smaller Rosepots (~3-fold difference in cover after 6 months)
- There was no effect of clustering on change in plant cover after 6 months.
- Results from experiment were used to inform the planting program in 2020



- SCEs planting program has continued into 2020 with additional plantings, about 21,000 plants, 73% of these plants were *Arthrocnemum*, planted within the areas in module W16/4 delineated by the black polygons that contain sparsely vegetated areas.
- Based on results from the experiment, SCE planted plants grown in gallon containers and as singles spaced 1.5 to 2' apart.

Experiments to inform SCE planting program (2020)

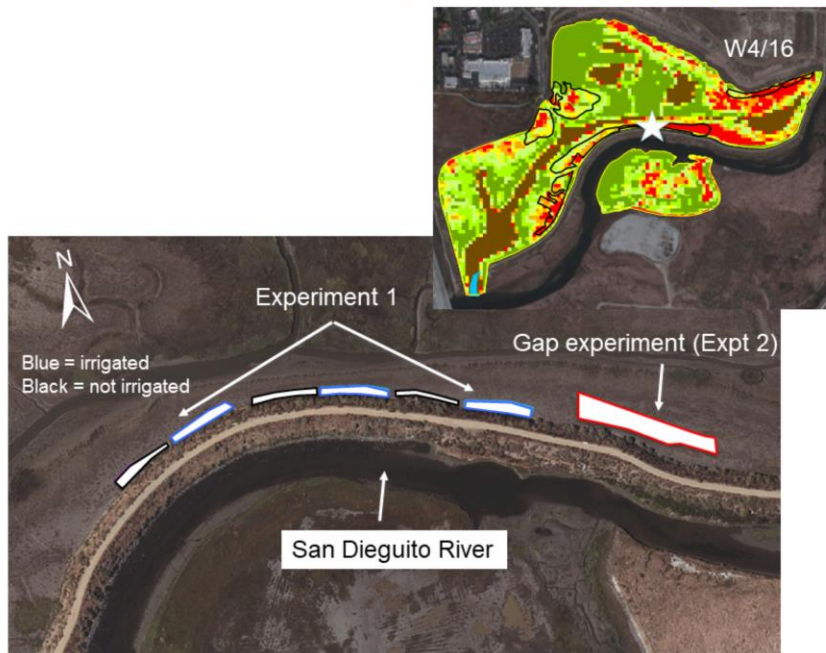
Goal of experiments:

- Test the effect of irrigation, soil decompaction, and soil amendments on the growth and survival of potted plants and of seeds.
- Test the effect of planting versus seeding on filling in gaps in plant cover at lower tidal elevations. No soil treatments or irrigation.



- Two experiments were embedded within 2020 planting program.
- The goal of the first experiment is to test the effect of irrigation, soil decompaction, and soil amendments on the growth and survival of potted plants and of seeds.
- This experiment is being conducted at higher elevations.
- The goal of the second experiment is to test the effect of planting versus seeding on filling in gaps in plant cover at lower elevations.

Location of Experiments (2020)



- This slide shows the location, indicated by the star, and layout of the two experiments: Experiment 1 at high elevation (4.25 – 3.5 feet NGVD) and the gap filling experiment at lower elevation (< 3.5 feet NGVD) in Module W4 east of the I-5 freeway.
- Another gap experiment on west side of freeway.
- The gap experiment is being done at lower tidal elevations that already have approximately 10% cover of plants. No soil treatments or irrigation.
- These experiments are on-going.
- Vegetation cover within the experimental quadrats, and overall SCE planting area, are being measured from images collected by drone quarterly for at least one year beginning in early March 2020.
- We are will also be sampling using 100 uniform points quarterly which will provide ground-truth data for the drone flights and detect effects of seeding.

Vegetation: Summary & Future Directions

- Underperformance of vegetation has led to a short-fall in salt marsh habitat and vegetation cover.
- It appears that favorable conditions, likely rainfall, led to a large increase in both vegetation acreage and cover.
- SCE is implementing a planting and irrigation program in portions of the wetland to facilitate vegetation development.
 - Approximately 60,000 plants planted in 2019-2020.
- An experiment completed in 2019 revealed that plants performed better in Gallon vs. Rosepots with no effect of plant clustering.
- Experiments started in 2020 are currently underway to evaluate the effect of irrigation, decompaction, soil amendments, planting, and of seeding on the development of plant cover.
- 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.

- This slide provides a summary and future directions for the vegetation.
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Performance Standards Pertaining to Biological Communities

Relative Standards:

Require that the measured performance variable be similar in San Dieguito Wetlands to the reference wetlands

For example:

The total densities and number of species of fish, macroinvertebrates and birds shall be similar to the densities and number of species in similar habitats in the reference wetlands.

- Turning to the deficit in standards that pertain to biological communities.
- This slide shows the relative standards for biological communities.

Biological standards not met:

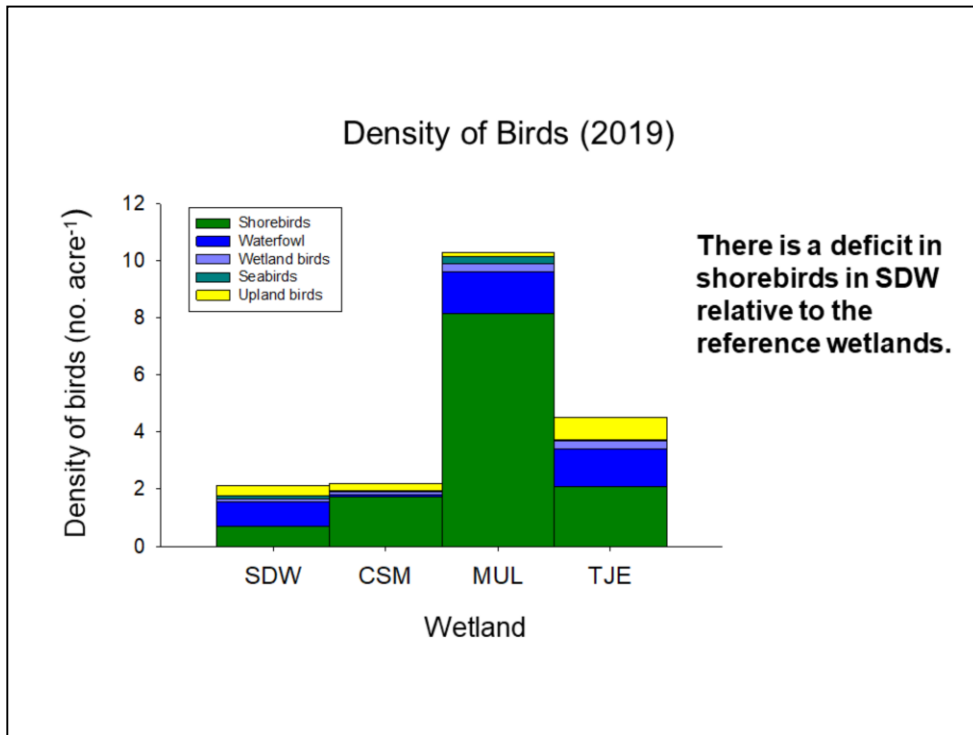
- Birds – density, feeding (food chain support)
- Invertebrates – density in main channel and tidal creeks, species richness in tidal creeks
- Fish – species richness in main channel and tidal creeks

Need to understand the mechanisms behind the underperformance of these groups

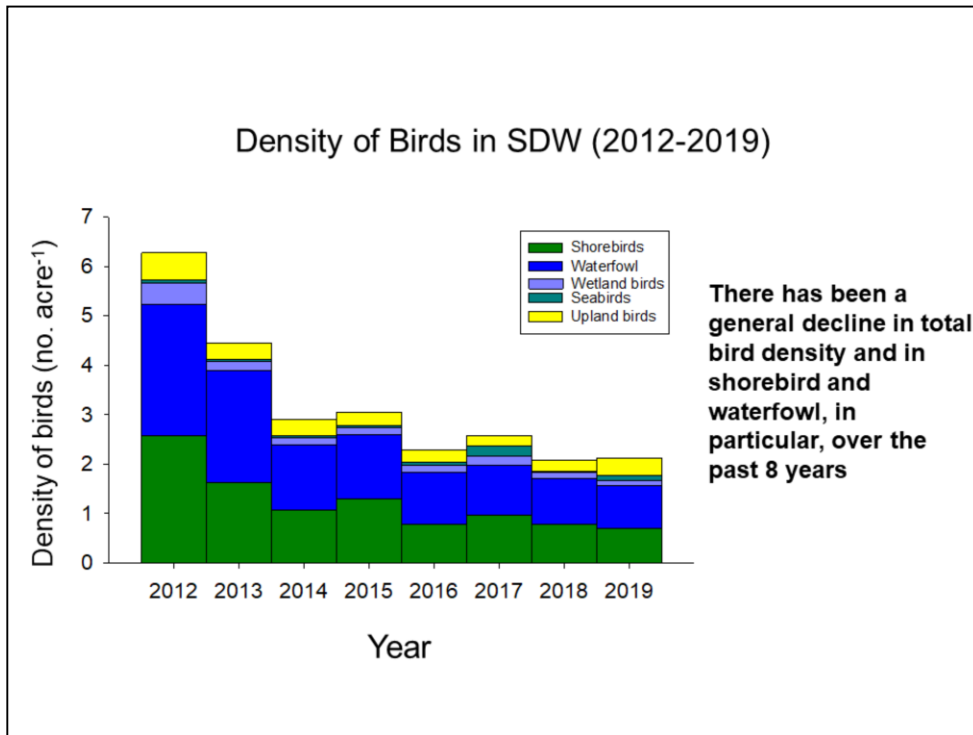
Mechanisms are not obvious

We have started exploring underperformance by looking at patterns in abundance of various groups

- To review from Mark's presentation, the restored wetland did not make the standards relating to the densities of birds, invertebrates in main channel and tidal creek habitat, invertebrate richness in tidal creeks, or fish richness in main channel or tidal creek habitat.
- In order to effectively remediate, we need to understand the mechanisms behind the underperformance,
- Unlike the vegetation, where elevation and soil salinity appear important, the mechanisms behind the underperformance of birds, invertebrates, and fish are less obvious.
- We have started by looking at spatial and temporal patterns in the abundance of various groups



- As an example of the types of analyses we anticipate doing, this figure shows densities of birds in SDW and the reference wetlands broken down by guilds that include shorebirds, waterfowl, wetland birds, seabirds, and upland birds.
- These are the top 5 most abundant groups at SDW.
- SDW and the reference wetlands, CSM, MUL, and TJE are on the x-axis
- You can see that there is a large deficit in shorebirds (green) in SDW relative to the reference wetlands.
- So, there seems to be something about the restored wetland that is affecting shorebird abundance.



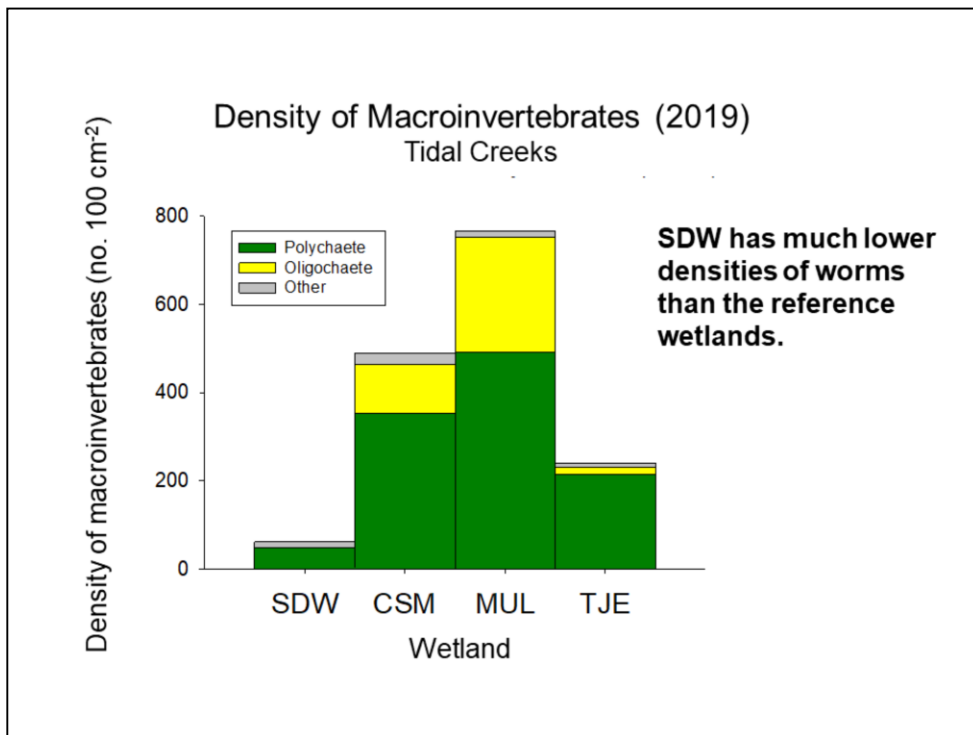
- This figure shows patterns in the abundance of those bird groups over time just at SDW.
- You can see that there has been a general decline in total bird density and in shorebird (green) and waterfowl (blue), in particular, over the past 8 years.

Hypotheses to explain underperformance in bird density and bird feeding include:

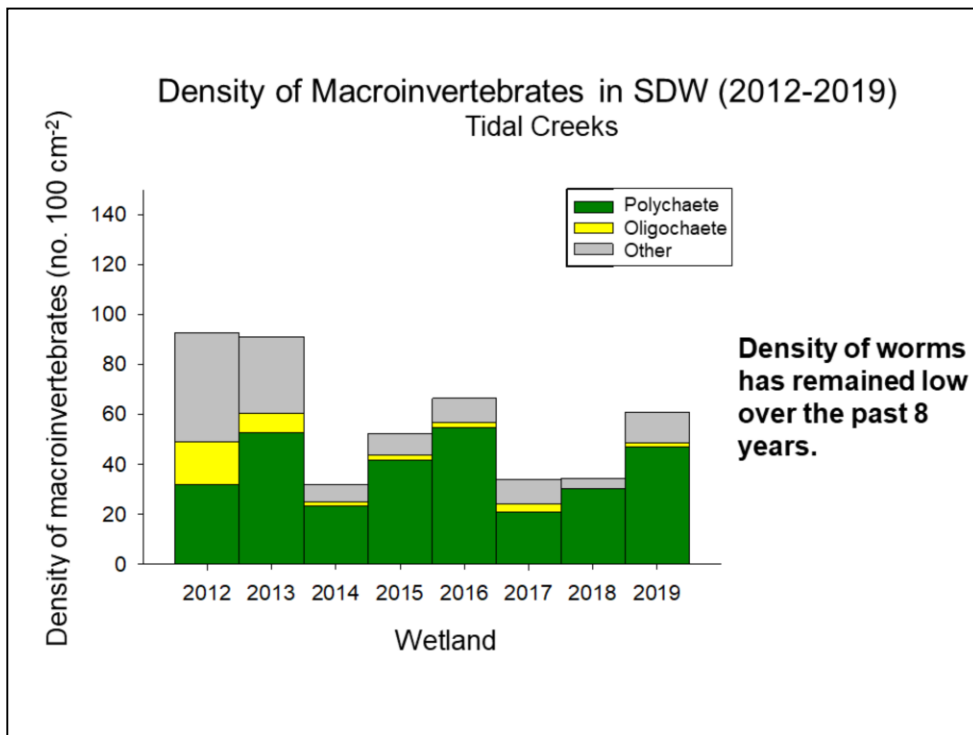
- Insufficient quantity or quality of habitat (e.g., mudflat)
- Insufficient food resources (e.g., worms)



- We don't have an explanation right now for the underperformance of bird density and bird feeding.
- Possible hypotheses for birds include:
 - Insufficient quantity or quality of habitat (e.g., mudflat)
 - Insufficient food resources (e.g., worms)



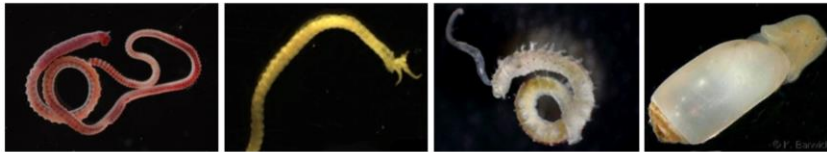
- Similarly, we can take a look at the densities of macro-invertebrates by the 5 most abundant groups in SDW that include polychaete and oligochaete worms (green and yellow), and an other category that includes snails, amphipods and peanut worms (gray).
- We can see that polychaete and oligochaete worms are the most abundant invertebrates in our samples.
- SDW has much lower densities of worms relative to the reference wetlands.
- This is concerning because worms are important source of food for birds, fish, and other invertebrates.



- As with the birds, this figure shows the abundances of worms and other macroinvertebrates over time, just in SDW.
- You can see that the density of worms has remained low, between 20 and 50 and relatively unchanged over the past 8 years.
- This compares to the lowest performing reference wetland where densities are typically around 200.
- This pattern is concerning because we would really expect an increase in the abundance of this group that attain high densities in the reference wetlands.

Hypotheses to explain underperformance of invertebrates include:

- Soil properties (soil texture and soil organic content)
- Channel topography/elevation
- Site history -- SDW historically depauperate?



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- Soil properties (soil texture and soil organic content)
- Channel topography/elevation
- Site history -- SDW historically depauperate?

Biological Standards: Future Directions

To understand mechanisms leading to underperformance, we will:

- Conduct analyses of existing data to explore
 - Spatial and temporal patterns in abundance
 - Differences in taxonomic or functional groups
 - Local and regional context
 - Relationships with physical factors
- Collect new data
 - Soil properties
 - Water quality
 - Channel topography/elevation
 - Targeted experiments

• We don't have an explanation right now for the underperformance of these groups.

• To understand mechanisms leading to underperformance, we will:

• Conduct analyses of existing data to explore

– Spatial and temporal patterns in abundance

– Differences in taxonomic or functional groups

– Regional context

– Relationships with physical factors

• Collect new data

– Soil properties

– Water quality

– Channel topography/elevation

– Targeted experiments

Progress of San Dieguito Wetlands Towards Compliance

- Cover of salt marsh vegetation is increasing and on a promising trajectory
- Densities of birds and bird feeding, invertebrates, and species richness of fish are underperforming relative to the reference wetlands and not on a promising trajectory

Ten year milestone on project compliance¹:

- Performance standards must be met by 10 yrs after initiation of Fully Implemented Monitoring.
- Three consecutive years of compliance must occur by 12 years or remediation will be required at the discretion of the Executive Director.

¹ "The Definition of Compliance in the Context of the SONGS Mitigation Projects",
Monitoring Plan for the SONGS Wetland Mitigation Project

- Looking at the overall progress of SDW towards compliance--
- Cover of salt marsh vegetation is on a promising trajectory
- We have already put a lot of effort into understanding why the vegetation has been underperforming and SCE has already done a lot to try to improve vegetation, from regrading part of the wetland to extensive plantings.
- We are cautiously optimistic that SDW will meet the performance criteria for salt marsh habitat in the near term.
- More concerning is the underperformance in densities of birds and bird feeding, invertebrates, and species richness of fish and how this relates to the 10 year milestone that pertains to project compliance.
- Downward trajectory in some of these standards.
- There is a requirement that Absolute and relative performance standards must be met by 10 years after initiation of Fully Implemented Monitoring.
- Three consecutive years of compliance must occur by 12 years or remediation will be required at the discretion of the Executive Director.
- Given this deadline, there is an urgency to determine the causes for the underperformance of these biological standards.