

**2018**

**Annual Report of the Status of Condition A:  
Wetland Mitigation**

**SAN ONOFRE NUCLEAR GENERATING STATION (SONGS)  
MITIGATION PROGRAM**



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MITIGATION PROGRAM**

*Submitted to the California Coastal Commission  
August 2019*

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## 1.0 Executive Summary

Condition A of the San Onofre Nuclear Generating Station's (SONGS) coastal development permit (CDP) requires Southern California Edison (SCE) and its partners to construct or substantially restore a minimum of 150 acres of tidal wetlands, excluding buffer zone and transition, as partial mitigation for the projected reductions in populations of adult fish throughout the Southern California Bight due to operations of the power plant. San Dieguito Lagoon, located in northern San Diego County was chosen as the wetland mitigation site. Construction of the San Dieguito Wetlands Restoration Project began in September 2006 and was completed in September 2011. The success of the San Dieguito Wetlands Restoration Project in satisfying the mitigation requirements is based on its ability to meet the physical and biological performance standards provided in the SONGS coastal development permit. Annual monitoring is required to determine whether the restoration project has met these standards. Monitoring also tracks ecosystem development and identifies opportunities for adaptive management. The monitoring is overseen by the California Coastal Commission (CCC) and is done independently of SCE. This report summarizes the seventh year of post-construction monitoring done in 2018.

Vegetation development is critically important to the ability of the San Dieguito Wetlands Restoration Project to meet the requirements for successful mitigation. In some areas of the restoration project, vegetation is becoming well established. About 20,000 cordgrass plants were planted widely throughout the restoration site with the latest and largest planting in November 2011, and in 2018 the area of cordgrass covered 6.8 acres, an increase of about 1.3 acres from 2017. Despite the promising expansion of cordgrass and other vegetation in some areas, overall vegetation has under-performed. San Dieguito Wetlands (SDW) has yet to meet the absolute standard for habitat areas and needs about 33 acres of salt marsh habitat to meet the minimum required acreage of this habitat. Salt marsh habitat must have at least 30% cover of vegetation. In addition to the absolute standard for habitat areas, the relative standard for vegetation cover requires that cover in San Dieguito Wetlands to be similar to that of the reference wetlands. Vegetation cover is high in natural wetlands in the region. This is the case for the reference wetlands, Mugu Lagoon, Carpinteria Salt Marsh, and Tijuana Estuary, where coverage averages 85%. Thus, a goal of the restoration project is to not only achieve the required acreage of salt marsh habitat, but also the high cover of vegetation found in the reference wetlands. The monitoring data from 2012 to 2018 reveals that the overall trend of increase in cover in the higher cover classes has been very shallow with only ~18 acres of 85% cover as of 2018. Because of the slow rate of vegetation development, it is unlikely that the restoration project will meet the habitat areas standard or the relative standard for vegetation cover for many years without intervention.

Approximately, 40% of W2/3 or 8.2 acres had achieved at least 30% cover in 2018. However, 12 acres of sparse vegetation remain, particularly in the middle and eastern end of the module. Other areas within the wetland will also require intervention to facilitate vegetation establishment. This includes 30 acres in W4/16, and 4 acres in module W5/10, where cover is less than 30%. To facilitate plant development, SCE had



tilled some areas and installed irrigation line within three areas of W4/W16 in preparation for planting in 2017. In March 2019, SCE planted 39,240 plants within these areas. An experiment designed to evaluate the effect of plant species, container size, and plant clustering on the development of cover and inform SCE's planting effort and any potential remediation moving forward, 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.

The two most abundant bird guilds in SDW in 2018 were shorebirds and waterfowl, followed by lower densities of upland birds, wetland birds, and seabirds. The densities of shorebirds, overall the most abundant group across wetlands, were the lowest in San Dieguito Wetlands compared to the reference wetlands. During monitoring surveys in 2018, the top fish groups included gobies, silversides and killifish. During surveys in 2018, the two most abundant invertebrate groups in the reference wetlands were small worms of the class Polychaeta and subclass Oligochaeta. In contrast, polychaete worms were followed in abundance by snails, rather than oligochaete worms in San Dieguito Wetlands. Overall, densities of small worms were lower in SDW compared with the reference wetlands, contributing to the failure of SDW to meet the relative standard for invertebrate density in both tidal creek and main channel habitats in 2018.

The success of the San Dieguito Wetlands in meeting the mitigation requirement for a given year is based on its ability to meet the physical and biological performance standards provided in the SONGS permit. The San Dieguito Wetlands Restoration Project satisfied four of five of the absolute standards. These included standards pertaining to topography, tidal prism, plant reproductive success, and exotic species. The absolute standard that has not yet been met pertains to Habitat Areas due to the under performance of vegetation cover. The restored wetland did not meet the requirement for the relative standards, which requires that as many of relative standards be met in the San Dieguito Wetlands as are met in the lowest performing reference wetlands. In 2018, 60.0% of the relative standards were met in the San Dieguito Wetlands compared with 85.7% of standards met by Mugu Lagoon, the lowest performing reference wetland. The six relative standards that were not similar in San Dieguito Wetlands compared with the reference wetlands pertained to fish density and species richness in tidal creek habitat, macro-invertebrate density in main channel and tidal creek habitat, vegetation cover, and food chain support. The project has yet to meet the relative standards for invertebrate densities in tidal creeks and vegetation cover. The standard for invertebrate densities in main channel habitat has only been met in 2012.

In order to receive mitigation credit for a given year, the wetland restoration project must meet all of the absolute standards and as many of the relative standards as the poorest performing reference wetland. So far, the San Dieguito Wetlands has yet to meet the absolute standard for Habitat Areas and failed to meet the relative standard requirement. Although the San Dieguito Wetlands is providing habitat for wetland plants and animals, it has not yet satisfied the performance success criteria provided in the SONGS permit and has not yet received mitigation credit.

On-going activities and future plans moving forward include continued performance monitoring in 2019 as required by the SONGS permit, monitoring SCE's adaptive management program for vegetation, further analysis of existing data, and the collection of additional data, if necessary, to assist in determination of the mechanisms underlying the under-performance of macro-invertebrate densities. Coastal Commission staff and SCE will be consulted regarding next steps to address the under-performance of vegetation cover and invertebrate densities with the goal of bringing the project into compliance with the SONGS permit.

## 2.0 Introduction

### 2.1. Purpose of Report

This report focuses on Condition A of the San Onofre Nuclear Generating Station's (SONGS) coastal development permit (6-81-330-A), which pertains to mitigation for SONGS impacts to fish populations in the Southern California Bight. Southern California Edison (SCE) and the California Coastal Commission (CCC) have clear and distinct roles in the implementation of Condition A. Under the condition, SCE is required to construct or substantially restore a minimum of 150 acres of tidal wetlands, excluding the buffer zone and transition habitat. The CCC is to provide scientific oversight and monitoring of the wetland mitigation project that is independent of SCE. This report presents the results from the CCC's monitoring of the SONGS wetland mitigation project (hereafter referred to as the San Dieguito Wetlands) during 2018 (the seventh year following completion of construction of the wetland) and summarizes the status of the project's progress towards compliance with Condition A of the SONGS permit.

### 2.2. Background

SONGS Operations: In 1974, the California Coastal Zone Conservation Commission issued a permit (No. 6-81-330-A, formerly 183-73) to SCE for Units 2 and 3 of the San Onofre Nuclear Generating Station (SONGS). SONGS is located on the coast in north San Diego County. Construction of SONGS Units 2 and 3 was completed in 1981. Operation of Units 2 and 3 began in 1982 and 1983, respectively. The SONGS Unit 2 and 3 reactors are cooled by a single pass seawater system and have separate intake lines, each 18 feet in diameter that are located in about 30 feet of water offshore of the power plant. The volume of water taken in each day by these two intake lines when Units 2 and 3 were fully operational was about 2.4 billion gallons.

The water taken in was heated to approximately 19°F above ambient in the plant and then discharged through an extensive diffuser system designed to dissipate the heat. The discharge pipe for Unit 2 terminates 8,500 feet offshore, while the discharge pipe for Unit 3 terminates 6,150 feet offshore. The last 2,500 feet of the discharge pipes for Units 2 and 3 consist of a multi-port diffuser that rapidly mixes the cooling water with the surrounding water. The heated cooling water and turbulence kills fish eggs, larvae and small immature fish taken into the plant, the mortality of which was responsible for a substantial impact on adult nearshore fish populations in southern California. To cool the discharge water, the diffusers drew in ambient seawater at a rate about ten times the discharge flow and mixed it with the discharge water. The surrounding water was swept up along with sediments and organisms and transported offshore at various distances. Mixing caused by the diffuser system resulted in the formation of a turbid plume in the vicinity of the San Onofre kelp forest, which is located adjacent to the two diffuser lines. These discharge effects were responsible for a substantial impact on kelp forest habitat down coast of the diffusers.

Units 2 and 3 of SONGS are not currently producing power. Unit 2 was shut down in early January 2012 for routine refueling and replacement of the reactor vessel head. On January 31, 2012, Unit 3 suffered a small radioactive leak largely inside the containment

shell, with a release to the environment below allowable limits, and the reactor was shut down per standard procedure. On investigation, both units were found to show premature wear in 15,000 places on over 3,000 tubes in the replacement steam generators that were installed in 2010 and 2011. A decision to shutdown the reactors was made on June 7, 2013 and a certification of permanent cessation of power operations was issued on July 22, 2013. The operating license was modified to “possession” only and SCE is no longer authorized to operate or place fuel in the reactors. Since the shutdown, the flow in each unit has been reduced to about 42 million gallons per day or roughly 3% of the normal operating flow. In March 2019, the Commission determined that the magnitude of the reduction in discharge makes it unlikely that this level of flow contributes to significant adverse ecological impacts and based on this determination they defined the end of the operating life of SONGS as the end of 2013, and set the full operating life of SONGS at 32 years.

SONGS Impacts: A condition of the SONGS Coastal Development permit required study of the impacts of the operation of Units 2 and 3 on the marine environment offshore from the San Onofre power plant, and mitigation of any adverse impacts. The impact assessment studies found that the SONGS cooling water system for Units 2 and 3 had major adverse impacts to living marine resources, which included:

- Projected reductions in populations of adult fish throughout the Southern California Bight based on losses of fish eggs, larvae, and immature fish entrained by the cooling water intakes and killed inside the power plant.
- Measured reductions in local populations of adult fishes caused by the mortality of fish impinged against the cooling water screens inside the power plant.
- A substantial reduction in the size of the giant kelp forest and its associated community adjacent to the SONGS diffusers.

Mitigation Requirements: As a result of the impact studies, the CCC added new conditions in 1991 requiring SCE and its partners to mitigate the adverse impacts of the power plant on the marine environment. These measures include: (1) create or substantially restore at least 150 acres of southern California wetlands as out-of-kind mitigation for the losses of immature fish (Condition A), (2) install fish barrier devices at the power plant to reduce the losses of adult fish impinged and killed in the plant (Condition B), and (3) construct a 300-acre kelp reef as in-kind mitigation for the loss of giant kelp forest habitat (Conditions C). The 1991 conditions also required SCE to provide the funds necessary for CCC to contract marine scientists to perform technical oversight and independent monitoring of the mitigation projects (Condition D). In 1993, the CCC added a requirement for SCE to partially fund construction of an experimental white sea bass hatchery. Due to the experimental nature of the hatchery, the CCC did not assign mitigation credit to its operation.

In April 1997, the Commission revised Condition A to allow the permittee to meet its 150-acre wetland acreage requirement by receiving up to 35 acres enhancement credit for the permittee’s permanent maintenance of an open inlet that will produce continuous tidal flushing at San Dieguito Lagoon. The CCC also confirmed in April 1997 its previous finding that independent monitoring and technical oversight was required in Condition D to ensure full mitigation under the permit. Condition D requires SCE and its partners to fund scientific and support staff retained by the CCC to oversee the site assessments,

project design and implementation, and monitoring activities for the mitigation projects. Scientific expertise is provided to the CCC by a small technical oversight team hired under contract. The technical oversight team members include three Research Biologists from UC Santa Barbara: Steve Schroeter, Ph.D., marine ecologist, Mark Page, Ph.D., wetlands ecologist (half time), and Dan Reed, Ph.D., kelp forest ecologist (half-time). In addition, a science advisory panel advises the CCC on the design, implementation, monitoring, and remediation of the mitigation projects. Current science advisory panel members include Richard Ambrose, Ph.D., Professor, UCLA, Peter Raimondi, Ph.D., Professor, UC Santa Cruz, and Russell Schmitt, Ph.D., Professor, UC Santa Barbara. In addition to the science advisors, the contract program staff is aided by a team of field assistants hired under a contract with the University of California, Santa Barbara to collect and assemble the monitoring data. Independent consultants and contractors also assist the contract program's staff when expertise for specific tasks is needed. The CCC's permanent staff also spends a portion of their time on this program, but their costs are paid by the CCC and are not included in the SONGS budget.

### 3.0 Project Description

The CCC decided that the goal of out-of-kind compensation for adverse effects on fish populations in the Southern California Bight due to SONGS operations will most likely be met if the wetland mitigation project: (1) is located near SONGS, but outside its influence to ensure that the compensation for lost resources will occur locally rather than at a distant location (Fig. 3.0.1), (2) creates or substantially restores 150 acres of wetlands, and (3) performs for a period of time equal to the operating life of SONGS Units 2 & 3, including the decommissioning period to the extent that there are continuing discharges.



Figure 3.0.1. Locations of SONGS, the impact site, San Dieguito Lagoon, site of the San Dieguito Wetlands Restoration Project, and three wetlands used as reference sites to evaluate the performance of the restoration project: Carpinteria Salt Marsh, Mugu Lagoon, and Tijuana Estuary.

#### 3.1. Wetland Restoration Construction and Timetable

The restoration project included excavation and grading to create intertidal salt marsh, mudflat, and subtidal basin habitats (Fig. 3.1.1). In addition, four Least Tern nesting sites were constructed, which were not part of the SONGS mitigation requirement. Disposal sites to the northeast and southeast of the project site received most of the over 2 million cubic yards of material excavated during construction of the wetland.



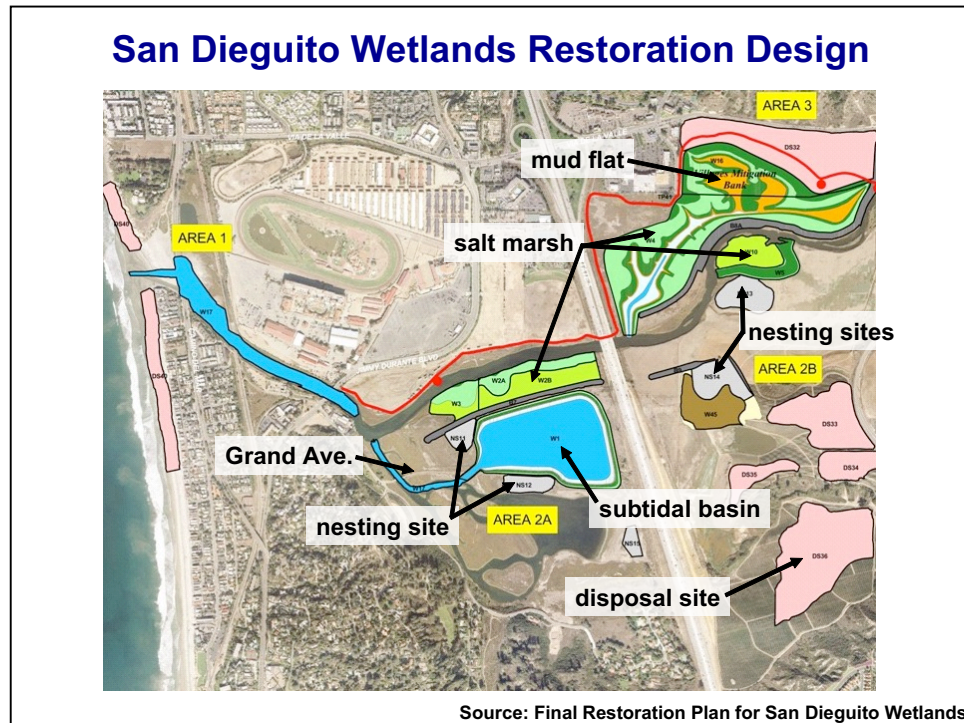


Figure 3.1.1. The design plan view of the restoration project that was approved by the CCC. The project included the creation of tidal salt marsh, indicated by shades of green, mudflat, indicated by the light brown, and subtidal basin, indicated by blue. In addition, four nesting sites, shown in gray, were constructed, which were not part of the SONGS mitigation requirement. The areas in pink are disposal sites. Dark gray linear features are berms along the effective flow area of the San Dieguito River. The yellow boxes that indicate Areas 1, 2a, 2b, and 3 pertain to the staging of construction activities.

Construction began in September of 2006 with most excavation and grading completed by the end of 2008 (Fig. 3.1.2, 3.1.3ab). Construction of the large subtidal and intertidal basin (44 acres) in Area 2A west of Interstate 5 commenced in December 2006 and was completed with the opening to tidal exchange in January 2008. Construction of wetland habitat commenced in other areas within the restoration site in April 2007. This included modules on the east side of Interstate 5, both north (Area 3) and south (Area 2B) of the San Dieguito River that were graded to create high and middle salt marsh and intertidal mud flat habitat. Excavation and grading, including the construction of tidal creek networks, was completed in Area 3 and these areas were opened to tidal exchange in December 2008. Excavation and grading of Area 2B was also completed in December 2008. Initial grading of Modules W2/3 (Fig. 3.1.2) in Area 2A were completed in November 2010 to the originally constructed linear channels.

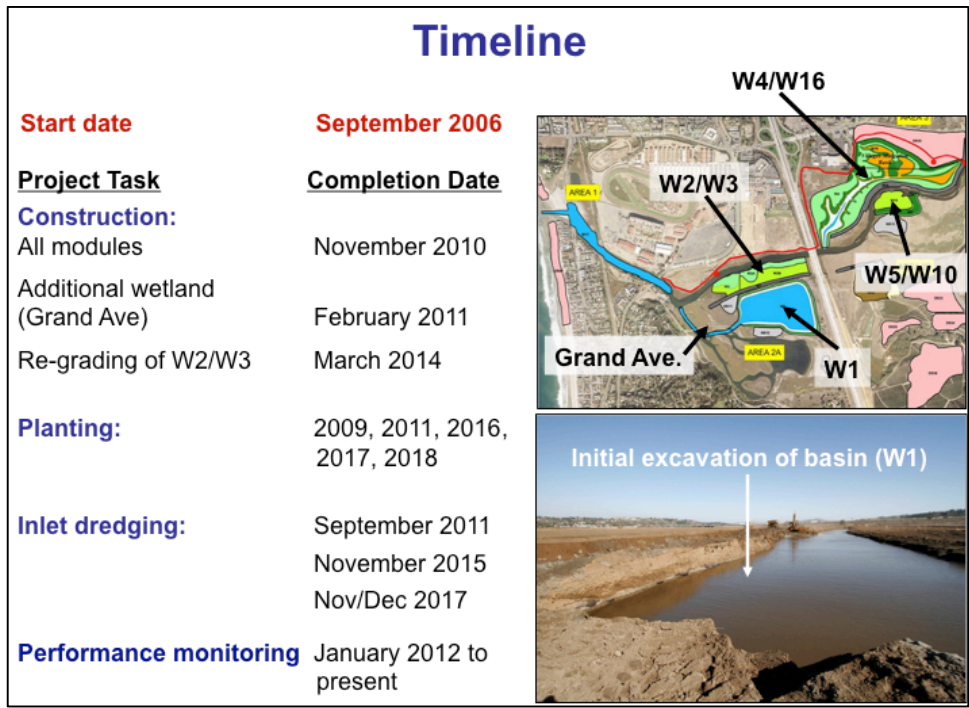


Figure 3.1.2. Timeline for the San Dieguito Wetlands Restoration Project.

This area was re-graded again in March 2014 to lower the elevation of the marsh plain and improve drainage to facilitate the development of marsh vegetation. The construction of additional wetland acreage (“Grand Avenue”) was completed in February 2011.

Following excavation and grading, portions of the restoration project were planted with salt marsh plants. Planting of selected species (largely pickleweed) in high marsh habitat occurred in 2009. Test planting of cordgrass occurred in 2009. The largest planting of cordgrass throughout the restoration was done in November 2011 following initial post-construction inlet channel dredging, which was completed in September 2011. Some additional planting at high marsh tidal elevations occurred in 2016, 2017, and 2018.

Material excavated from the construction site was deposited in upland disposal sites within the project area. Berms designed to constrain storm runoff were completed in February 2009 along the boundary of the effective flow area of the San Dieguito River (Fig. 3.1.1). Maintenance dredging of the inlet was conducted in November 2015 and November-December 2017. Performance monitoring began in January 2012, following the initial dredging in September 2011.

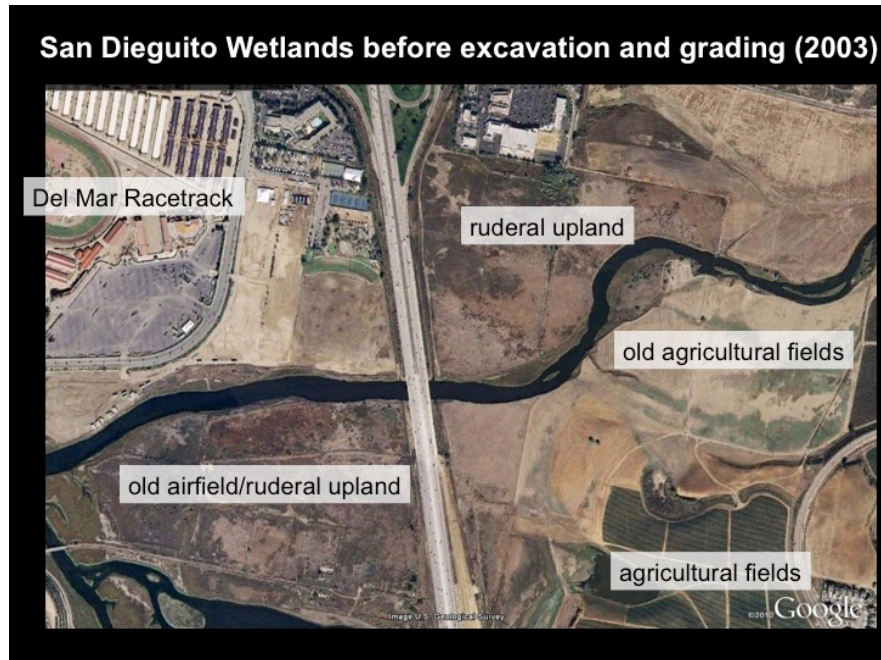


Figure 3.1.3a. Satellite view of the project site in 2003 before excavation and grading. Highlighted are the San Dieguito River and adjoining ruderal upland, including the site of an old WWII dirigible airfield, old agricultural fields, and visible at the bottom of the image, a portion of the Fish and Game Basin constructed in 1978.



Figure 3.1.3b. During construction, the ruderal areas and old agricultural fields were excavated and graded to create the planned intertidal and subtidal wetland habitats of the restoration project visible in this image taken in 2016.

Following construction, annual monitoring independent of SCE is required to evaluate the physical and biological performance standards provided in the SONGS coastal



development permit. Monitoring also tracks ecosystem development and identifies adaptive management opportunities pertaining to the physical and biological functioning of the wetland. Scientists from UCSB with advice from the Science Advisory Panel (SAP) conduct the independent monitoring.

### **3.2. Salt Marsh Vegetation: Status update, SCE's current planting program, and experiments to inform the planting program**

The seventh year of monitoring of the San Dieguito Wetlands Restoration project was completed in 2018 and found that the project has yet to meet the performance standards required for successful mitigation. Failure to meet the performance standards is due, in part, to the slow rate of vegetation development, which affects the ability of the restored wetland to meet the standard for Habitat Areas. The Habitat Areas standard is an absolute standard that must be met every year for the project to receive mitigation credit. It requires that the area of different habitats (subtidal, mudflat, salt marsh) 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% as evaluated within 10 x 10 m grids covering the entire wetland (see Section 5.1.2). A second standard pertaining to the cover of vegetation is the Vegetation standard. This is a relative standard that requires the proportion of total vegetation cover in the marsh be similar to those proportions found in the reference wetlands. Relative standards are assessed by comparing the performance variable of interest, in this case average percent cover of vegetation in salt marsh habitat (i.e., cover at least 30%) between San Dieguito Wetlands and the reference wetlands (see Section 5.2.6). Vegetation cover is high in natural wetlands, typically >85% and a goal of the restoration project is to achieve not only the required acreage of salt marsh habitat, but to attain a high cover of vegetation similar to the reference wetlands.

As of 2018, large areas of the restoration project remained sparsely vegetated with cover less than the 30% minimum cover required for salt marsh habitat. The project has relied on the natural recruitment of vegetation and several planting efforts undertaken in the past to facilitate vegetation development resulted in generally poor outcomes except for cordgrass. This section reviews the current status of vegetation in the San Dieguito Wetlands restoration site and current planting efforts and experiments underway to facilitate vegetation establishment.

#### *Current status of vegetation*

In some areas of the restoration project, vegetation is becoming well established. These areas include, in particular, lower tidal elevations planned for cordgrass, *Spartina foliosa*. Figure 3.2.1 shows that cordgrass patches, indicated by the red color, are located primarily in modules W4/16 and W5 on the east side of the I5 freeway, with additional occurrence around the basin module W1 on the west side of the I5 freeway. After a period of slow establishment following its last planting in 2011, cordgrass now occupies a total of about 6.8 acres, an increase of about 1.3 acres from 2017.

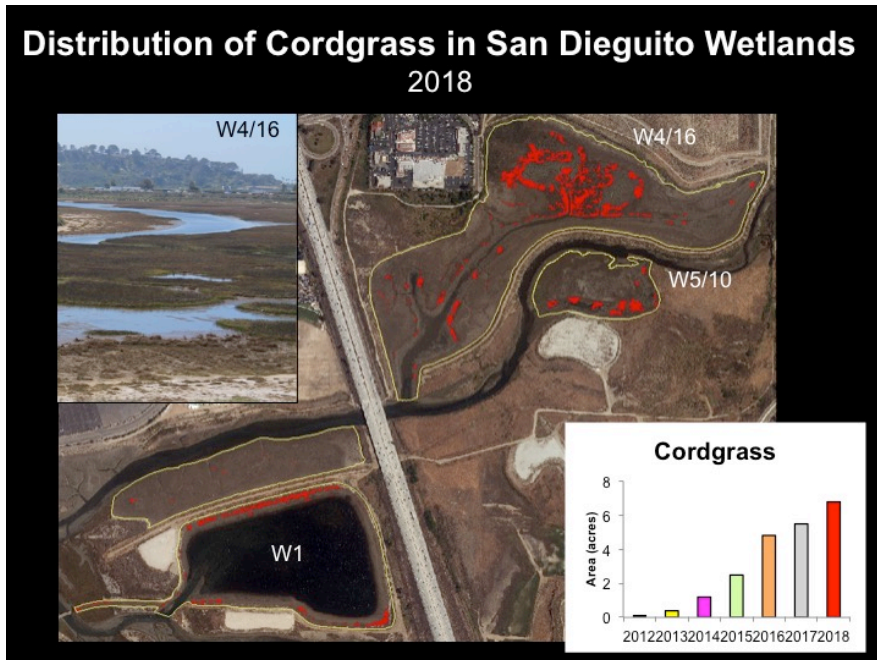


Figure 3.2.1. Distribution of cordgrass *Spartina foliosa* in San Dieguito Wetlands in 2018 (red) and increase in acres of cordgrass over time.

Overall, however, vegetation is underperforming in the restoration site as shown in Figure 3.2.2. This figure shows the required acres of salt marsh habitat  $\pm 10\%$  together with the trend in acres of salt marsh habitat over time. The minimum required acreage of salt marsh habitat is 83.3 acres (10% lower than the design acreage of 92.6 acres). While salt marsh habitat increased by 3.4 acres from 2017 to 2018, the rate of increase for the past seven years has been very slow and in 2018 the restoration project was still 33 acres short of the minimum number of required acres of this habitat.

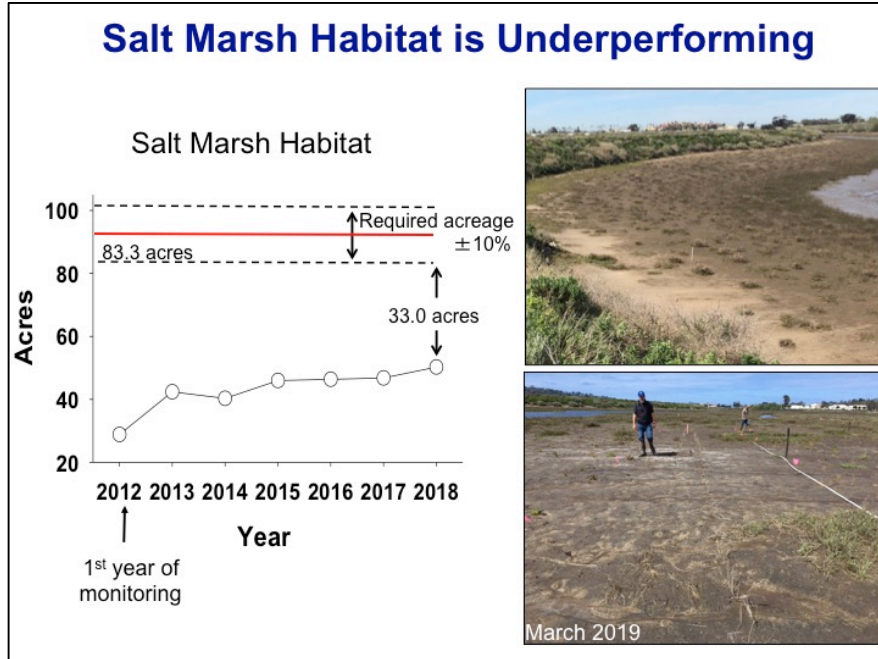


Figure 3.2.2. Change in acres of salt marsh habitat over time and required acreage  $\pm 10\%$  in San Dieguito Wetlands. San Dieguito Wetlands had a deficit of 33 acres of salt marsh habitat in 2018.

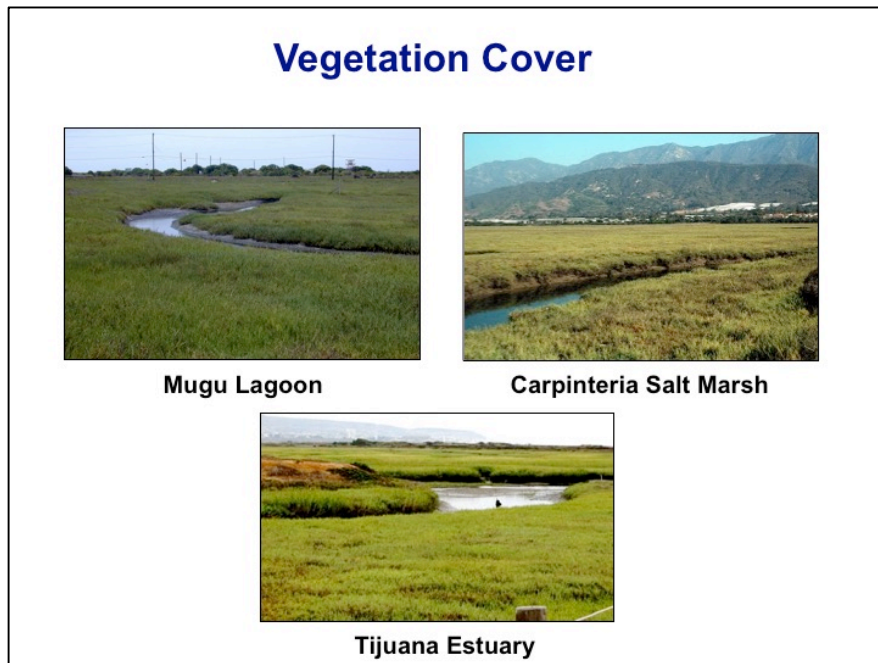


Figure 3.2.3. Photographs showing the high cover of vegetation in the reference sites, which is typical of southern California wetlands.

In addition to the absolute standard for habitat areas, the relative standard for vegetation cover requires that cover in San Dieguito Wetlands to be similar to that of the reference wetlands. Vegetation cover is high in natural wetlands, typically  $>85\%$ , as



illustrated in Figure 3.2.3 for the reference wetlands, Mugu Lagoon, Carpinteria Salt Marsh, and Tijuana Estuary.

The goal of the restoration project is to achieve not only a minimum of 83.3 acres of salt marsh habitat, but to attain a high cover of vegetation similar to the reference wetlands. Figure 3.2.4 shows the change in vegetation cover over time in San Dieguito Wetlands by cover classes. The monitoring data from 2012 to 2018 reveal that there was an increase of about 5 acres in the 85% cover class from 2017 to 2018 (Fig. 3.2.4). However, the overall rate of increase in cover in the higher cover classes has been very low with only approximately 18 acres of 85% cover as of 2018. Due to this slow rate of increase of vegetation development, it is unlikely that the restoration project will meet the habitat areas standard or the relative standard for vegetation cover for many years without intervention to facilitate vegetation development.

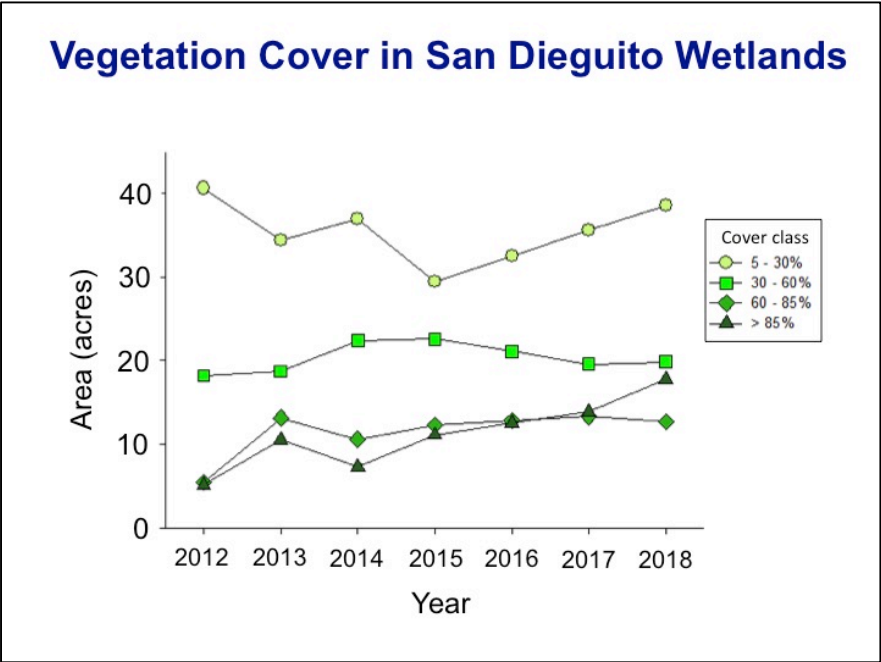


Figure 3.2.4. Change in acres of vegetation as a function of cover class over time.

Data collected to evaluate the performance standards for habitat areas and vegetation cover can be used to identify specific areas in the wetland where vegetation is underperforming and in need of intervention to facilitate plant establishment. Figure 3.2.5 shows vegetation cover in 2018, as assessed within 10 x 10 m grids using aerial imagery (Section 5.1.2), for the wetland modules on the east side of the freeway (W4/16, W5/10). The inset in this figure, extracted from the San Dieguito Wetlands Final Restoration Plan (2005), illustrates that most of these modules are planned vegetated salt marsh habitat, (shades of green) together with some planned mudflat (brown). Vegetation cover in 2018 determined using aerial imagery is binned into cover classes with warm colors (red, orange, yellow) showing areas that were classified either as other (i.e. habitat with insufficient cover to be considered salt marsh) or unplanned mudflat. Brown is planned mudflat. Areas of the restoration site that meet the Habitat Areas standard (i.e., cover  $\geq 30\%$ ) are indicated by shades of green, with darkest green

showing areas that are  $\geq 85\%$  cover. Also provided are the estimated acres of these cover classes. As of 2018 there were extensive areas of red, orange, and yellow that will require some form of intervention to facilitate plant development, including 30 acres in W4/16.

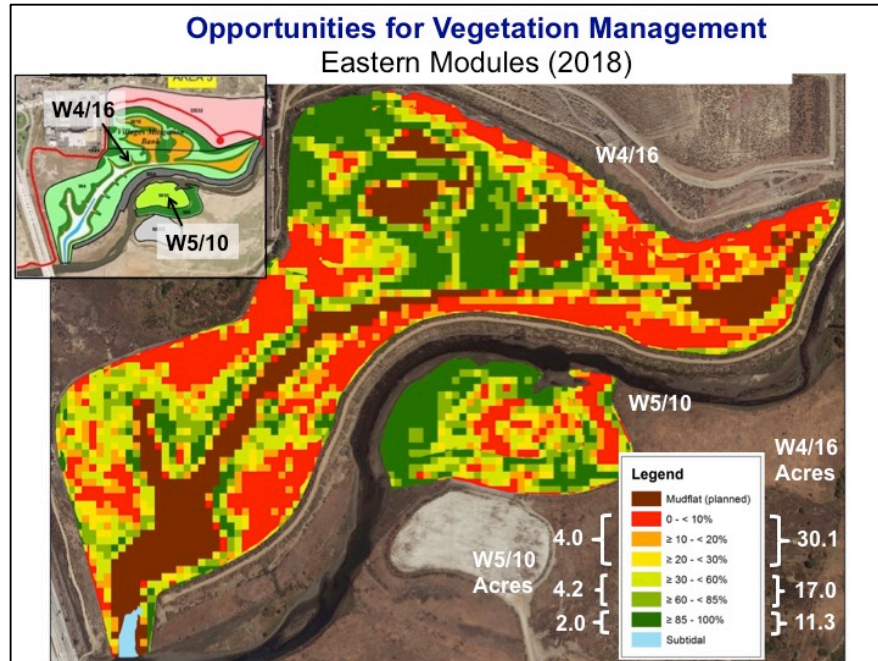


Figure 3.2.5. Cover of vegetation in the eastern modules of San Dieguito Wetlands in 2018 binned into cover classes, and the acres of each class by module. Inset in upper right shows planned habitats from the Final Restoration Plan.

Similarly, Figure 3.2.6 shows the modules on the west side of the freeway, which consists of W2/3 and the basin, W1. The inset shows that modules W2/3 are planned vegetated salt marsh habitat, whereas module W1 is a planned subtidal basin bordered by a narrow strip of mudflat and vegetated marsh. Approximately, 40% of W2/3 or 8.2 acres had achieved at least 30% cover in 2018. However, 12 acres of sparse vegetation remain, particularly in the middle and eastern end of the module.

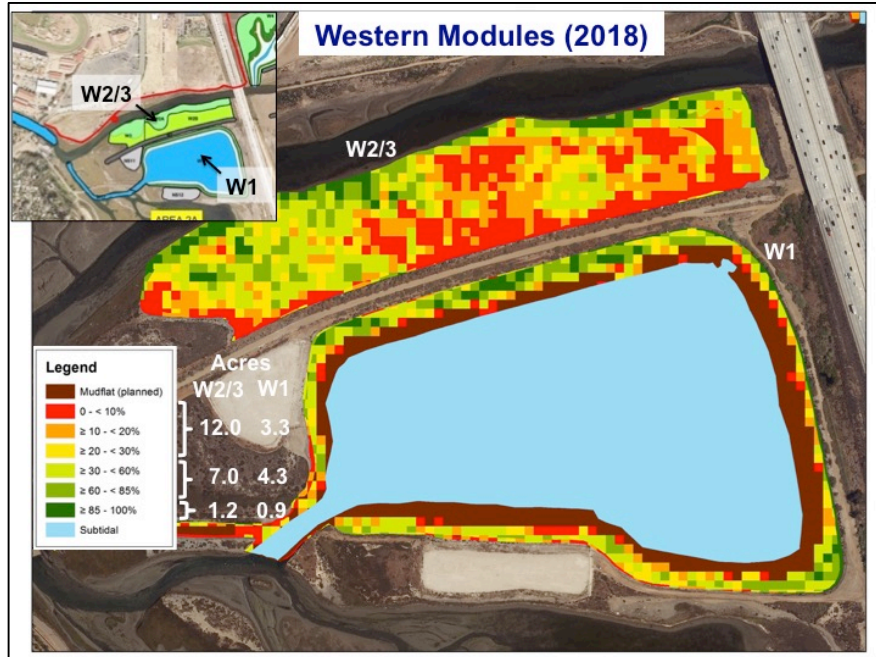


Figure 3.2.6. Cover of vegetation in the western modules of San Dieguito Wetlands in 2018 binned into cover classes. Inset in upper right shows planned habitats from the Final Restoration Plan.

### *SCE's planting program*

Without vigorous intervention to facilitate vegetation development, it is unlikely that the restoration project will meet the habitat areas standard in the foreseeable future. Performance monitoring findings have suggested that the underperformance of vegetation is due largely to very high soil salinities, particularly at higher tidal elevations, but other factors including other soil properties may also be important.

To facilitate plant development, SCE has undertaken a planting program. In 2017, SCE tilled some areas and installed irrigation lines in preparation for planting within three areas of W4/W16, indicated by the solid lines in Figure 3.2.7, which had a very low cover of vegetation. In March 2019, SCE planted 39,240 plants within these areas.

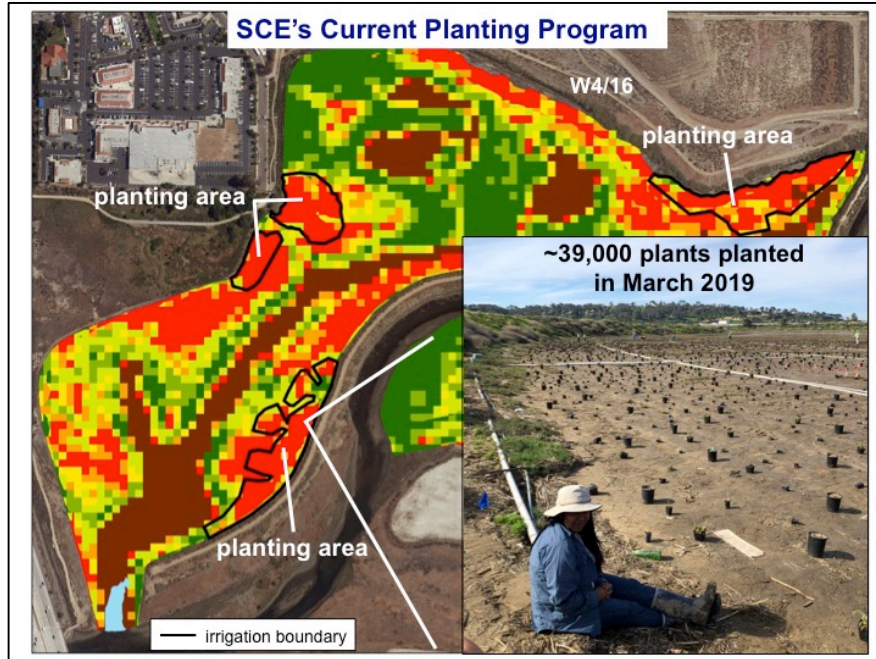


Figure 3.2.7. Location of SCE's current planting program within module W4/16. Approximately 39,000 plants were planted within the areas defined by black lines. These areas also receive irrigation.

#### *Experiments to inform the planting program*

Embedded within the larger planting program are some small-scale experiments designed to inform this program moving forward. The overall goal of these experiments is to investigate factors that could facilitate the successful establishment and growth of planted plants, leading to an increase in plant cover that will bring the wetland into compliance with the SONGS permit. The specific plant species used in the experiment, number of replicates, configuration of the planting, and location of the experiments is constrained by the species and number of plants that were available, location of the irrigation system, and logistics of the planting process. The experimental design was developed in consultation with the SAP and SCE. SCE provided the plants and their contractors planted them in March 2019.

The specific questions being addressed in the experiments (Fig. 3.2.8) are: 1) Does container size of nursery-grown plants affect plant survival and growth and thus the development of vegetation cover? The motivation behind this question is that high soil porewater salinity is a stressor that adversely affects the growth and survival of planted plants. Monitoring has revealed that soil salinity decreases with depth. It follows that plants grown in larger pots may have deeper roots that have less exposure to higher salinities near the soil surface. 2) Does planting in clusters affect plant cover? The motivation behind this question is that the clustering of planted plants, rather than planting plants as singletons, better ameliorates physical stress and provides microhabitat conditions more favorable to plant survival and growth. Plant responses to both container size and clustering are being evaluated at higher tidal elevations (4.0-4.5' NGVD) for four species (*Arthrocnemum subterminale*, *Limonium californicum*, *Frankenia salina*, *Salicornia virginica*) (Fig. 3.2.9). These species have different growth



forms, rooting depths, and tolerances to tidal inundation regime that could affect the rate at which they increase in cover. At lower elevations (<3.5' NGVD), only the effect of clustering is being evaluated (i.e. only plants grown in rosepots are being used) and only for *Salicornia*.

Figure 3.2.8 shows the arrangement of the experimental plantings in rows with plants spaced about 2' apart along a transect line. Examples of two of the experimental variables are also shown. The two container sizes being evaluated are rosepot and one-gallon containers. The gallon containers are over twice as deep and much wider than the rosepot containers. In the clustering experiment, plants are planted either as singletons or in groups of three. The experimental treatments are located in the three areas of the restoration site that are being planted by SCE and that currently have a sparse cover of vegetation (Fig. 3.2.10).

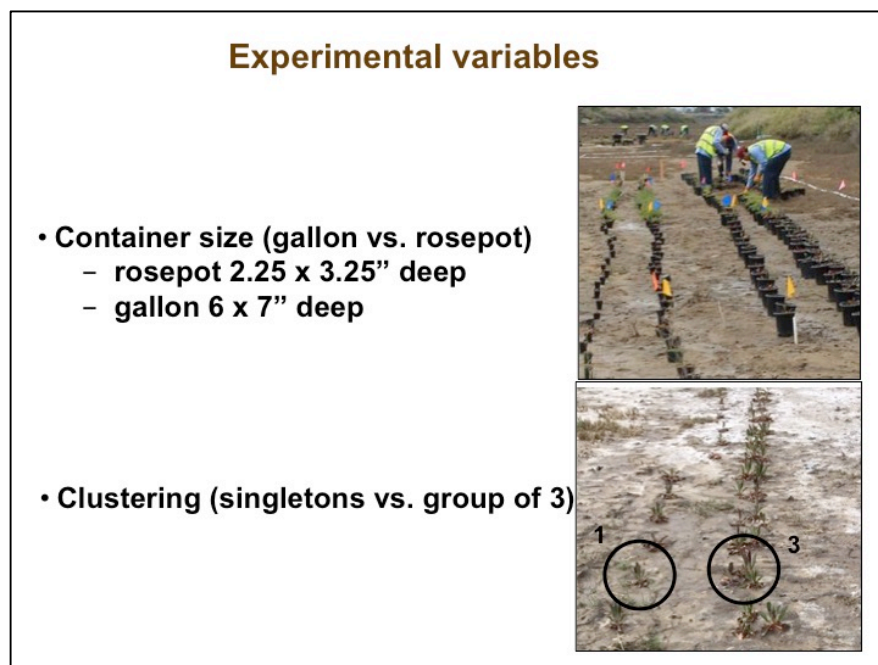


Figure 3.2.8. Images showing the experimental layout, differences in size between rosepot and one-gallon containers, and three-plant clustering versus single plants.

Plant responses to the experimental treatments will be assessed over time (see below).

## 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)**

Figure 3.2.9. The survival and growth of three plant species, *Limonium californicum*, *Frankenia salina*, and *Arthrocnemum subterminale* are being evaluated in the container size and clustering experiments at high tidal elevation. A fourth species, *Salicornia virginica*, was planted in rosepots only so the effect of container size is not being evaluated for this species. The effect of clustering versus non-clustering on *Salicornia* is being evaluated at higher elevations in addition to the lower elevations in all locations except W4.2 (San Andres South). Data are being collected on the performance of the plantings initially, and mid-point and end of the growing season (fall).

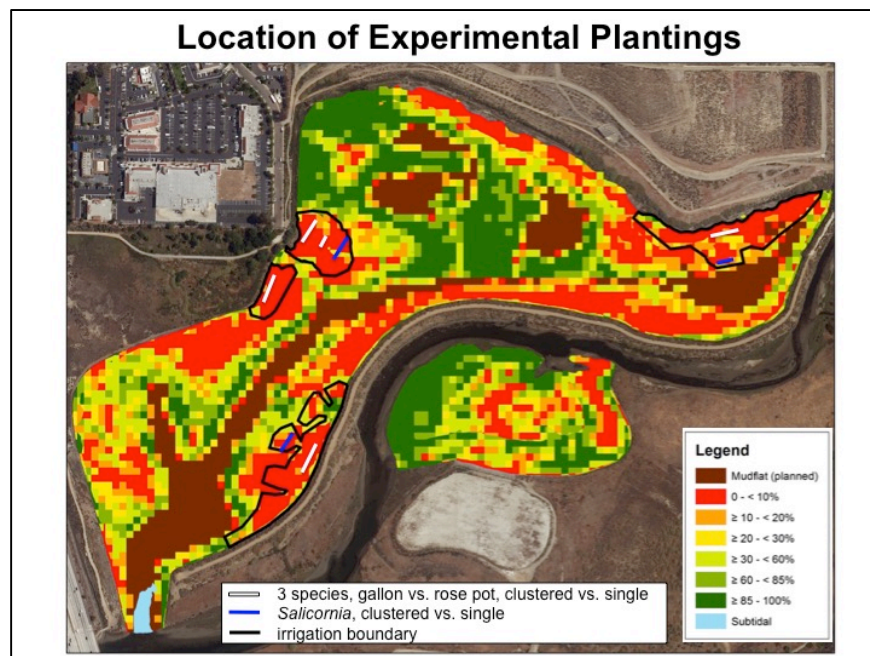


Figure 3.2.10. Location of the experimental treatments in the three areas of the restoration site that are being planted by SCE and that currently have a sparse cover of vegetation.



CCC contract scientists will monitor the performance of the plantings to determine which experimental treatment(s) 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, and perhaps longer, from in situ photographs, and over the larger experimental area using drone imagery. This will provide information on overall growth and survival as a function of experimental treatment. In addition, the delivery of irrigation water to the planted area will be assessed periodically using rain gauges deployed throughout the experiment to be able to provide feedback to SCE regarding changes that may need to be made to ensure that the planted area receives the planned amount of irrigation. The frequency of this measurement may depend on initial assessments of the uniformity of irrigation water delivery across the site. In addition, measurements of soil pore water salinity will be made within the experimental and control areas at the beginning, mid-point, and end of the growing season to determine whether the irrigation is maintaining soil salinities below values ( $70^{\circ}/_{\infty}$ ) considered stressful to plant establishment. Finally, 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. This will be accomplished by measuring vegetation cover within the planted polygons using images collected by drone at the beginning, mid-point, and end of the growing season. The overall goal of the monitoring is 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.

### *Summary*

- Vegetation is performing well in some areas of the wetland, but under performance in other areas has led to a shortfall of 33 acres in salt marsh habitat and in 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.

## **3.3. Status of Birds, Fish, and Macro-invertebrates**

### **3.3.1 Birds.**

During monitoring surveys in 2018, the two most abundant bird guilds in SDW were shorebirds (e.g., Willets, Godwits, plovers, sandpipers, dowitchers) and waterfowl (e.g., ducks, grebes, mergansers, coots), followed by lower densities of upland birds (e.g., sparrows, larks, flycatchers), wetland birds (e.g., rails, soras, egrets, herons), and seabirds (e.g., terns, seagulls, pelicans). Notably, the densities of shorebirds, overall the most abundant group across wetlands, were the lowest in San Dieguito Wetlands

compared to the reference wetlands (Fig. 3.3.1).

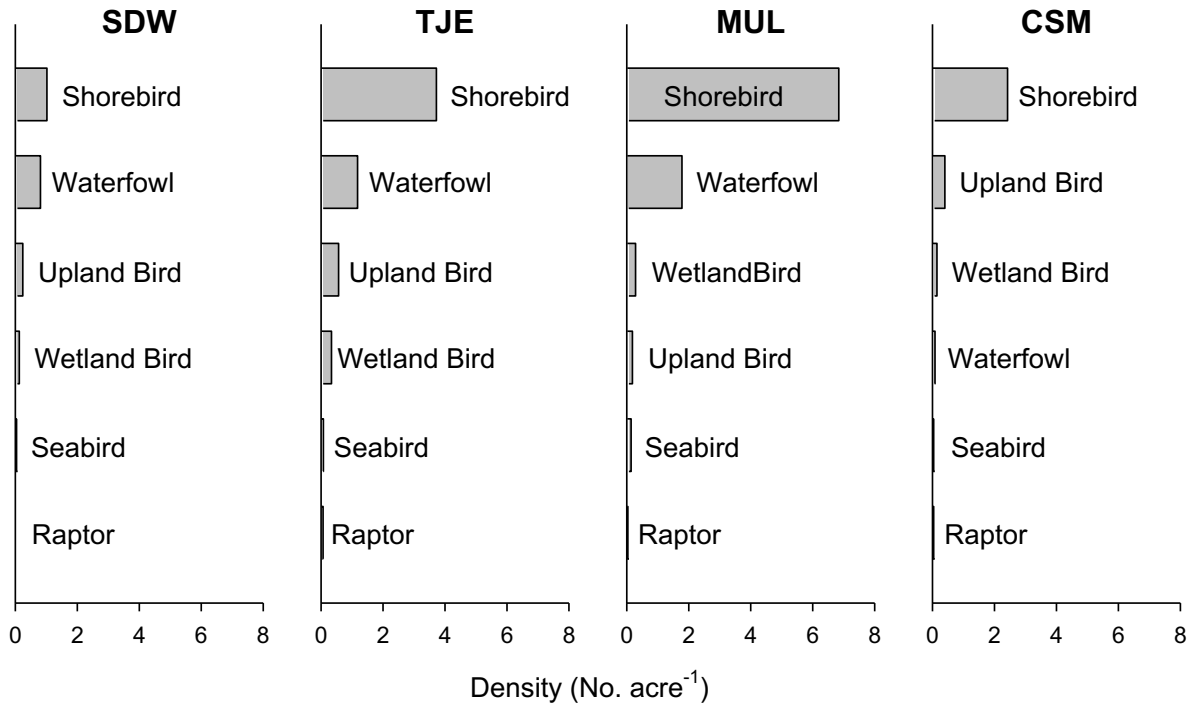


Figure 3.3.1. The six most abundant bird groups in SDW and the reference wetlands, Tijuana Estuary (TJE), Mugu Lagoon (MUL), and Carpinteria Salt Marsh (CSM) in 2018.

### 3.3.2 Fish.

During monitoring surveys in 2018, the top three fish groups included gobies (Arrow Goby, Shadow Goby), silversides (topsmelt, grunion) and killifish (Fig. 3.3.2). Gobies were very abundant in CSM and TJE in 2018 due to large numbers of newly recruited individuals.

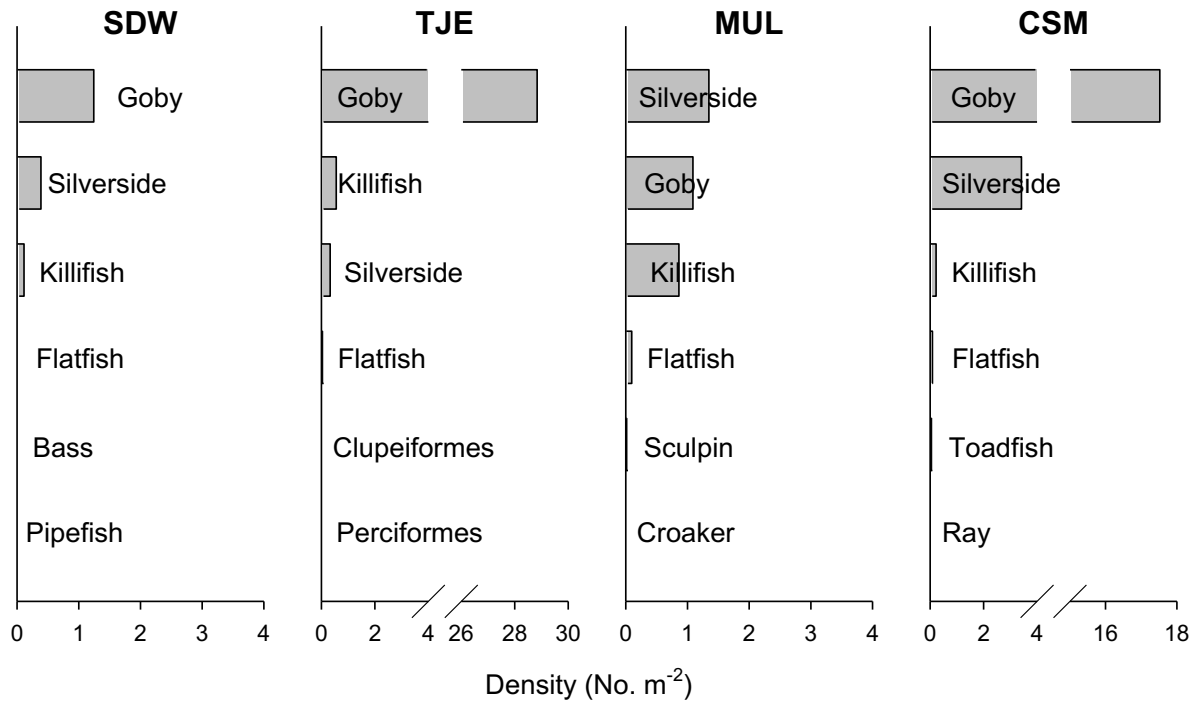


Figure 3.3.2. The six most abundant fish in SDW and the reference wetlands in 2018.

### 3.3.3. Macro-invertebrates.

During surveys in 2018, the two most abundant invertebrate groups in the reference wetlands were small worms in the class Polychaeta and subclass Oligochaeta (Fig. 3.3.3). In contrast, polychaete worms were followed in abundance by snails in San Dieguito Wetlands and, whereas oligochaetes were the next most abundant group in the three reference wetlands, amphipods were the next most abundant group in SDW. Overall, densities of small worms (Spionidae, Capitellidae, Oligochaetes) were lower in SDW compared with the reference wetlands (Fig. 3.3.4), contributing to the failure of SDW to meet the relative standard for invertebrate density in both tidal creek and main channel habitats in 2018 (see section 5.2.4 Macro-invertebrates). Members of the Polychaete families Spionidae and Capitellidae were present in much lower densities in SDW compared with the reference wetlands, and Oligochaetes were nearly absent from SDW, whereas this group comprises a significant component of the annelid fauna in the reference wetlands (Fig. 3.3.4).

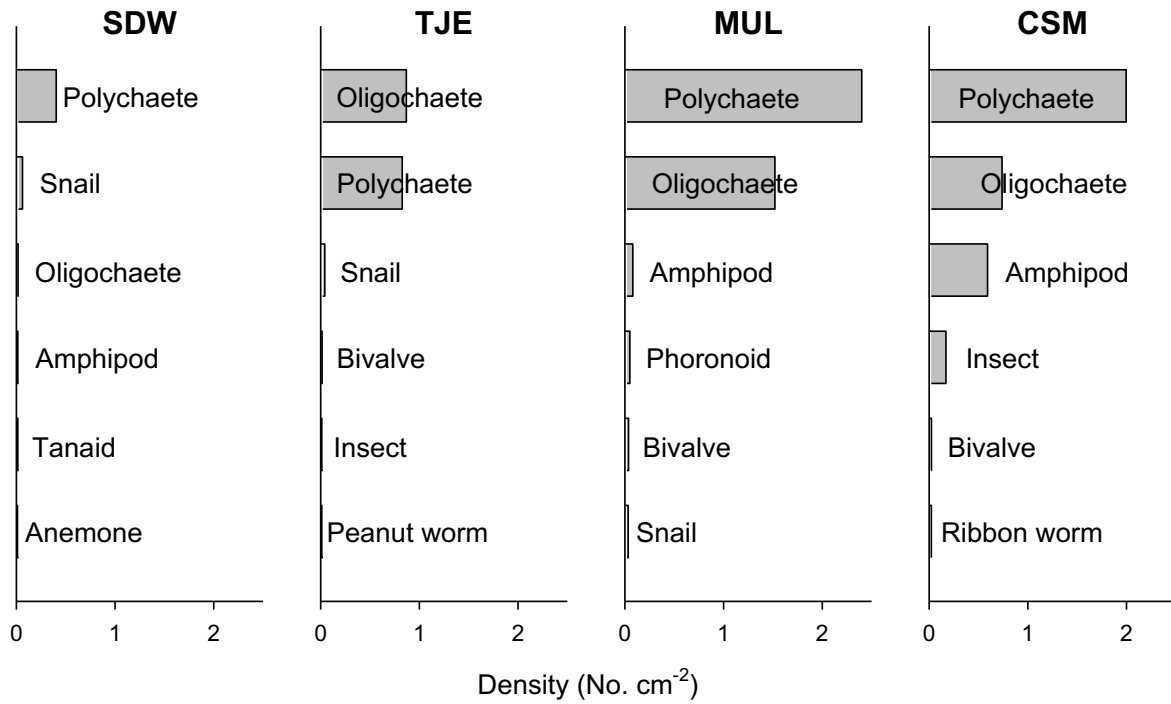


Figure 3.3.3. The six most abundant invertebrate taxa in the restored wetland and reference wetlands in 2018.

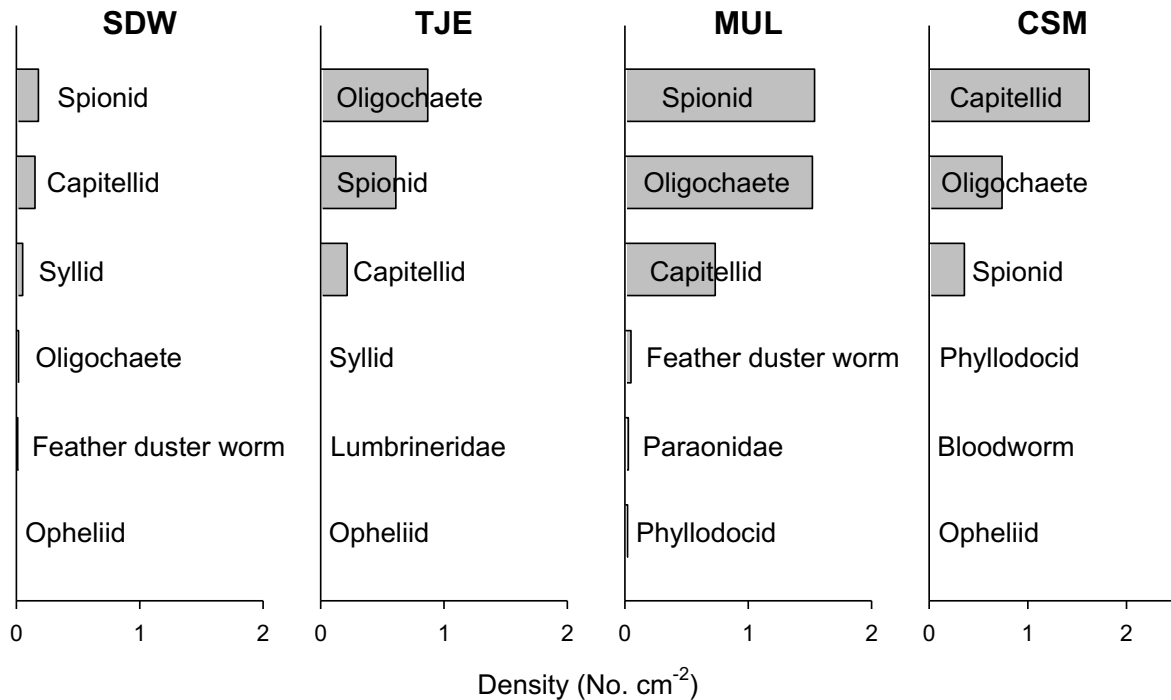


Figure 3.3.4. The six most abundant Oligochaete and Polychaete groups in the restored wetland and reference wetlands in 2018.

### **3.4. On-going Management Tasks**

There are important on-going management tasks associated with ensuring that the restoration project is successful. One task concerns inlet maintenance. Inlet closure interrupts tidal flushing and can adversely affect dissolved oxygen concentration in the lagoon. Low dissolved oxygen concentrations can lead to invertebrate and fish kills. In addition, partial blockage of the inlet by sand can affect drainage during low tides, resulting in adverse effects to cordgrass, which requires good tidal flushing and cannot tolerate continued submergence. SCE has an inlet maintenance plan that will keep the inlet open to avoid degradation in water quality, ponding, and loss of biological resources (Elwany et al. 1998). The inlet was dredged in November 2015 and again in November/December 2017 to remove built-up sand that could impede tidal flushing and reduce the tidal prism. The expansion of cordgrass in the restored wetland is a sign that tidal flushing has been maintained.

Another on-going management task pertains to the control of non-native plants, which are present around the edges of the restoration site. Some non-native species such as tamarisk and crystalline Iceplant can tolerate high soil salinity and could move into the restoration site. Continued vigilance is necessary to ensure that non-native species do not invade tidally influenced habitat.

## 4.0 Methods of Project Evaluation

### 4.1. Monitoring Plan

Condition A of the SONGS permit requires that monitoring of the wetland restoration be done to ensure compliance of mitigation measures over the full operating life of SONGS Units 2 and 3, which encompasses past and future years of operation of SONGS units 2 and 3 as well as the decommissioning period to the extent there are continuing circulating pump discharges. This monitoring measures compliance of the mitigation project with the performance standards specified in the SONGS permit. In accordance with Condition D (Administrative Structure) of the permit, contract scientists retained by the Executive Director developed the Monitoring Plan to guide the monitoring work and oversee the monitoring studies outlined in the plan. The SONGS permit provides a general description of the performance standards and monitoring required for the wetland mitigation project. The Monitoring Plan includes detailed descriptions of each performance standard and the methods that will be used to determine whether they have been met.

A draft Monitoring Plan for the SONGS Wetland Mitigation Program was reviewed by State and Federal agencies and SCE in May 2005. A revised Monitoring Plan was part of the coastal development permit (No. 6-04-88) for the wetland restoration project considered and approved by the Commission on October 12, 2005. The Monitoring Plan was subsequently updated in June and October 2011, July 2014, 2016, August 2017, and August 2018, and will continue to be updated as more information becomes available pertaining to the logistics of sampling and methods of evaluating the performance standards.

### 4.2. Performance Standards

Performance standards specified in Condition A of the SONGS permit are used to evaluate the success of the San Dieguito Wetlands Restoration Project in meeting the intended out-of-kind compensation for impacts to fish populations in the Southern California Bight due to SONGS operations. Monitoring independent of the permittee is done in accordance with Condition D of the SONGS permit to: (1) determine whether the performance standards established for Condition A are met, (2) determine, if necessary, the reasons why any performance standard has not been met, and (3) develop recommendations for appropriate remedial measures that may be required. The performance standards that will be used to measure the success of the wetland restoration project fall into two categories: absolute standards that are evaluated only in the San Dieguito Wetlands, and relative standards, which require that the value of the variable of interest be similar to that measured in reference wetlands in the region. The performance standards include long-term physical standards pertaining to topography (e.g., erosion, sedimentation), water quality (e.g., oxygen concentration), tidal prism (which affects tidal flushing), habitat areas, biological performance standards pertaining to biological communities (e.g., fish, invertebrates, and birds), marsh vegetation, *Spartina* canopy architecture, reproductive success of marsh plants, food chain support functions, and exotic species.



The evaluation of each absolute performance standard in any given year is assessed by 1) a comparison of the value obtained from monitoring to a fixed value (i.e., for Habitat Areas, Tidal Prism, Plant Reproduction) or 2) using best professional judgment (Topography). All absolute standards must be met in a year in order for that year to count towards compliance with Condition A.

The evaluation of each relative performance standard is based on a four-year running average calculated from data collected at the San Dieguito Wetlands and the reference wetlands for that year and the previous three years, similar in approach to that used to evaluate the success of the Wheeler North Artificial Reef. Use of a short-term (4-year) running average accounts for natural variation over time that could affect compliance of the restoration site relative to the reference wetlands. For example, invertebrate, fish, and bird populations can vary in their species composition and abundance from year to year and given this variation it is likely that the reference wetlands (much like the San Dieguito Wetlands) would not consistently meet all the relative standards in a given year.

### **4.3. Reference Wetlands**

The SONGS permit specifies that successful achievement of the relative performance standards will be measured in comparison to reference wetlands. Ideally, the biological assemblages in a successfully restored wetland should vary in a manner similar to those in the natural wetlands used for reference. Temporal variability, especially of the sort associated with weather (e.g., air temperature, rainfall) or oceanographic conditions (e.g., swell height, water temperature, sea level) can be accounted for by sampling the restored and natural reference wetlands concurrently. Concurrent monitoring of the restored and natural wetlands will help ensure that regional changes in weather and oceanographic conditions affecting the restored wetland will be reflected in the performance standards, since the reference wetlands should be subjected to similar conditions.

The permit requires that the wetlands chosen for reference be relatively undisturbed, natural tidal wetlands within the Southern California Bight. Relatively undisturbed wetlands have minimal human disturbance to habitats (e.g., trampling of vegetation, boating, fishing). Natural tidal wetlands appropriate as reference sites are not constructed or substantially restored, continuously open to the ocean, and receive regular tidal inundation. The Southern California Bight extends from Pt Conception to the US/Mexico border. After evaluating more than 40 wetlands within the Southern California Bight, three wetlands, Tijuana River Estuary, Mugu Lagoon, and Carpinteria Salt Marsh were chosen as reference wetlands that best met the criteria of undisturbed, natural tidal wetlands within the Southern California Bight.

### **4.4. Determination of Similarity**

A requirement of the SONGS permit is that the response variables used to assess the relative performance standards of the San Dieguito Wetlands Restoration Project (hereafter referred to as “relative performance variables”) be “similar” to those of the reference wetlands. Evaluating whether a particular relative performance variable at the San Dieguito Wetlands Restoration Project is similar to the reference wetlands requires that two conditions be met. The first condition requires that the mean value for the

performance variable at San Dieguito Wetlands not be significantly worse than the mean value for the worse performing of the three reference wetlands. A one sample, one tailed statistical test is used to evaluate all such comparisons. Significance is determined using an approach that utilizes both a formal probability value and an effect size. Generally, this is done by means of a t-test except in the case of the performance standards pertaining to vegetation and algae. For these standards, only the mean values are compared because the values are wetland wide censuses made using aerial imagery and thus there is no variability around a mean value. The performance for a particular relative performance variable at San Dieguito Wetlands is considered to be worse than the lower of the three reference wetlands if the p-value for the comparison is less than or equal to the proportional effect size (i.e., the proportional difference between San Dieguito Wetlands and the lowest performing reference wetland). The only exception to this rule is when the p-value and the proportional effect size are both greater than 0.5 in which case assessment for the period is considered inconclusive and additional studies will be done. As an example, if the proportional effect size for a given performance variable was 0.25 (i.e., the mean value at San Dieguito Wetlands was 75% of the mean value at the worst of the three reference wetlands), then a t-test yielding a p-value  $\leq 0.25$  would indicate the San Dieguito Wetlands Restoration did not meet the performance standard, whereas p-values  $> 0.25$  would indicate that it did meet the performance standard. More details concerning the approach and the rationale for determining similarity are provided in the Monitoring Plan for the SONGS Wetland Mitigation Project (Page et al. 2018, [http://marinemitigation.msi.ucsb.edu/documents/wetland/ucsb\\_mm\\_reports/wetland\\_mitigation\\_monitoring\\_plan\\_updated\\_august2018.pdf](http://marinemitigation.msi.ucsb.edu/documents/wetland/ucsb_mm_reports/wetland_mitigation_monitoring_plan_updated_august2018.pdf).)

The rationale for using the mean value of the worst performing of the reference wetlands is that the reference wetlands are considered to be acceptable standards of comparison for the San Dieguito Wetlands. Hence, if the San Dieguito Wetlands Restoration is performing at least as well as one of the reference wetlands, then it should be judged successful. The scaling of the p-value ( $\alpha$ ) to the effect size recognizes sampling error when estimating mean values and balances the probability of falsely concluding that the San Dieguito Wetlands Restoration is not similar to the reference wetlands when it is (Type I error) with the probability of falsely concluding that the San Dieguito Wetlands Restoration is similar to the reference wetlands when it is not (Type II error).

To ensure that the San Dieguito Wetlands are not held to a higher standard than the reference wetlands, the above procedure is also applied to the three reference wetlands (Tijuana Estuary, Mugu Lagoon, and Carpinteria Salt Marsh) to evaluate whether they would have met the relative performance standards. This is done by treating each reference wetland as the mitigation wetland and using the other wetlands as the three reference wetlands. The San Dieguito Wetlands are considered similar to the reference wetlands if the proportion of relative standards met by the San Dieguito Wetlands is equal to or greater than the proportion of relative standards met by any of the reference wetlands. The above approach ensures that the assessment of similarity is consistent with the SONGS permit requirement that the performance standards be met without the unreasonable requirement that the San Dieguito Wetlands outperform the reference wetlands (Tijuana Estuary, Mugu Lagoon, and Carpinteria Salt Marsh) for every

performance standard. Importantly, this approach deals realistically with the inherent variability of nature in a manner that best serves the interests of both the public and SCE.

## 5.0 Performance Assessment of the San Dieguito Wetlands Restoration Project

Listed below are the performance standards that are used to evaluate whether the San Dieguito Wetlands Restoration meets the goals and objectives of the wetland mitigation set forth in Condition A of the SONGS coastal development permit; the methods used to evaluate each performance standard; and the results from the seventh year of monitoring. More detailed methods can be found in the updated Monitoring Plan for the SONGS Wetland Mitigation Project ([http://marinemitigation.msi.ucsb.edu/documents/wetland/ucsb\\_mm\\_reports/wetland\\_mitigation\\_monitoring\\_plan\\_updated\\_august2018.pdf](http://marinemitigation.msi.ucsb.edu/documents/wetland/ucsb_mm_reports/wetland_mitigation_monitoring_plan_updated_august2018.pdf)).

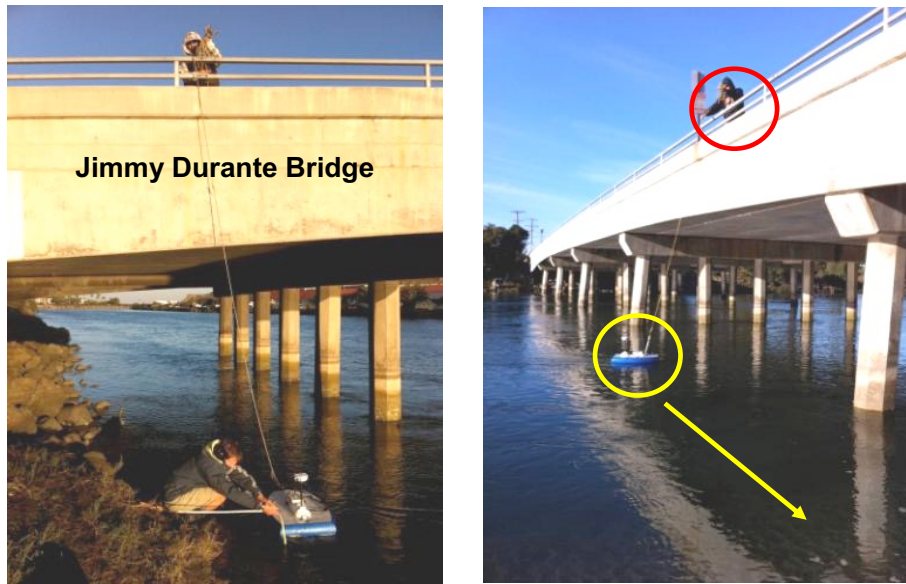
### 5.1. Absolute Performance Standards

#### 5.1.1. Tidal Prism

*THE DESIGNED TIDAL PRISM SHALL BE MAINTAINED, AND TIDAL FLUSHING SHALL NOT BE INTERRUPTED.*

Approach: The tidal prism standard, as an absolute standard, is applied only to the San Dieguito Wetlands restoration. The tidal prism is the amount of water that flows into and out of an estuary with the flood and ebb of the tide, excluding any contribution from freshwater inflows (Hume 2005). Numerical modeling suggested that after restoration, the tidal prism in the lagoon would increase. However, predictions of tidal prism from this modeling are likely to differ from actual values for the as-built wetland since they do not include the effects of friction, which could contribute to a smaller than predicted tidal prism and are not based on the actual as-built topography. Therefore, the tidal prism of the restored wetland was measured on completion of construction in July 2012 and used as the standard of comparison to detect changes in this performance variable during subsequent monitoring.

Since tidal prism can influence the area of wetland habitat inundated by the tides, the tidal prism standard is evaluated, in part, using criteria set forth in the habitat areas standard, which provide that the areas of the different habitats (subtidal, intertidal mudflat, vegetated salt marsh) shall not vary by more than 10%. The planned tidal volume-elevation relationship indicated that a decrease in tidal prism of greater than 12% could result in a reduction in the area of tidally inundated planned salt marsh habitat (1.3 to 4.5' NGVD) of greater than 10%. Since the area of planned intertidal salt marsh habitat may not differ by more than 10% from the as-built area (see section 5.1.1.2, Habitat Areas), the tidal prism cannot be less than 88% of the as-built prism to ensure no more than 10% of planned salt marsh habitat remains exposed during a 4.5' tide. However, since a larger than planned tidal prism could potentially increase erosion within the restored wetland, the prism shall also not be larger than 112% of the as-built prism.



### River Surveyor--Acoustic Doppler Current Profiler (ADCP)

Figure 5.1.1.1. Measurements of tidal flows are taken at Jimmy Durante Bridge (0.9 km from the inlet) using a portable Acoustic Doppler Profiler/discharge measurement system (yellow circle) that is towed back and forth across the width of the channel by monitoring staff (red circle) every 15 minutes during an incoming tide.

Tidal prism is calculated by cumulating values of tidal flow volumes measured over an entire incoming (flood) tide for a range of maximum high tides using a portable Acoustic Doppler Current Profiler (ADCP) system (SonTek River Surveyor, Fig. 5.1.1.1). The performance standard is met if the regression line fit through the prism measurements taken during the monitoring year falls within 12% of the as-built prism value. The 22<sup>nd</sup> Agricultural District completed the final phase of a restoration project within a parcel adjacent to the Grand Avenue Bridge in 2017. Excavation completed as part of this restoration project added approximately 45 acre-feet to the as-built tidal prism. Tidal prism measurements for 2018 were adjusted downward to take into consideration the increase in prism resulting from the 22<sup>nd</sup> Agricultural District restoration project, and then evaluated against the as-built prism measured in 2012.

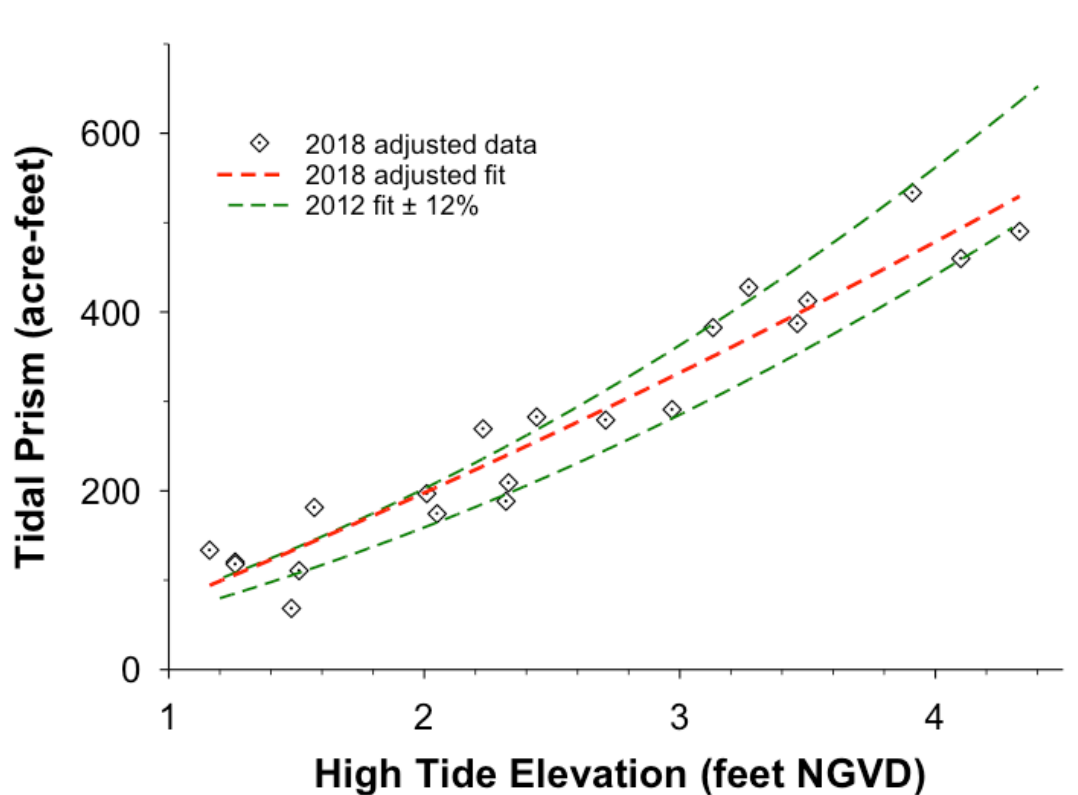


Figure 5.1.1.2. The regression fit to the tidal prism measurements taken January-December 2018 (red dashed line) must fall within the two dashed green lines, which represent 88% and 112% of the as-built prism, for the tidal prism to be maintained. Tidal prism measurements for 2018 were adjusted for the excavation of additional wetland by the 22<sup>nd</sup> Agricultural District adjacent to the Grand Avenue Bridge.

Results: The regression fit to the adjusted tidal prism measurements for 2018 falls between the dashed green lines, indicating that the tidal prism at the San Dieguito Wetlands was maintained in 2018 (Fig. 5.1.1.2). Therefore, this performance standard is met for 2018.

### 5.1.2. Habitat area

*THE AREAS OF DIFFERENT HABITATS SHALL NOT VARY BY MORE THAN 10% FROM THE AREAS INDICATED IN THE FINAL RESTORATION PLAN.*

Approach: The habitat areas standard, as an absolute standard, is applied only to the San Dieguito Wetlands restoration. This performance standard is designed to preserve the mix of habitats specified in the Final Restoration Plan (SCE 2005) and to guard against large scale conversions of one habitat type to another, for example of vegetated marsh to mudflat. The Final Restoration Plan indicates that subtidal habitat will occur at elevations of < -0.9' NGVD, intertidal mudflat will occur from -0.9 to 1.3' NGVD, and intertidal salt marsh will extend from 1.3 to 4.5' NGVD and specifies acreages of the different habitats (Fig. 5.1.2.1). While this is useful for planning the acreages and distributions of the proposed habitats, salt marsh and mudflat habitats may not be constrained by these elevation boundaries. As a result, areas of the three habitats will be assessed using criteria based on inundation, elevation, and cover of vegetation.

Subtidal habitat is defined as continuously submerged. Mudflat habitat is defined as intertidal, occurring lower than 3.5' NGVD to provide for frequent tidal inundation, and as sparsely vegetated (< 5% cover of vegetation) since mudflats are by definition unvegetated (Fig. 5.1.2.2).

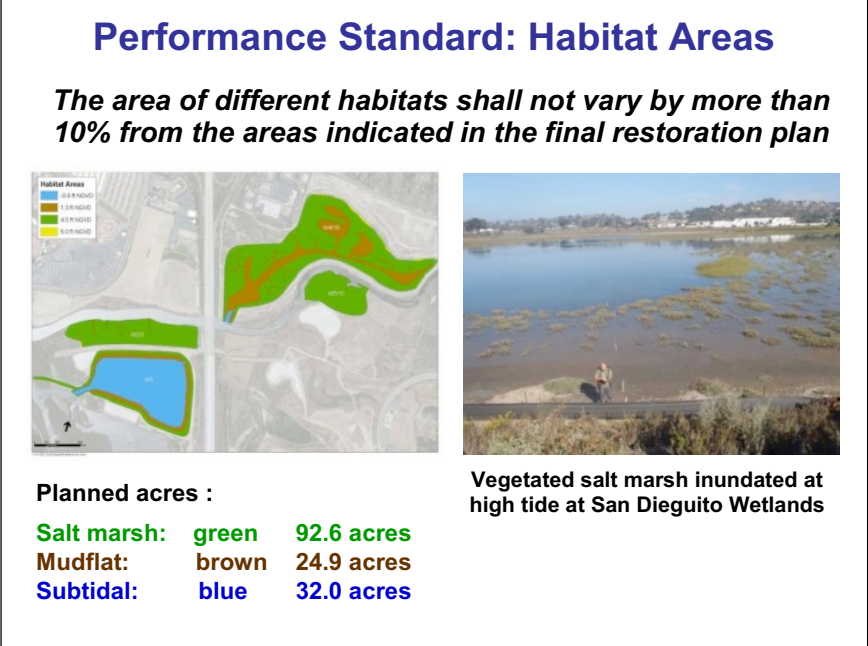


Figure 5.1.2.1. Panel on the left shows areas of planned salt marsh (green), mudflat (brown), and subtidal (blue) habitats as provided in the Final Plan for the restoration project. The photo on the right shows marsh vegetation inundated during a high tide.

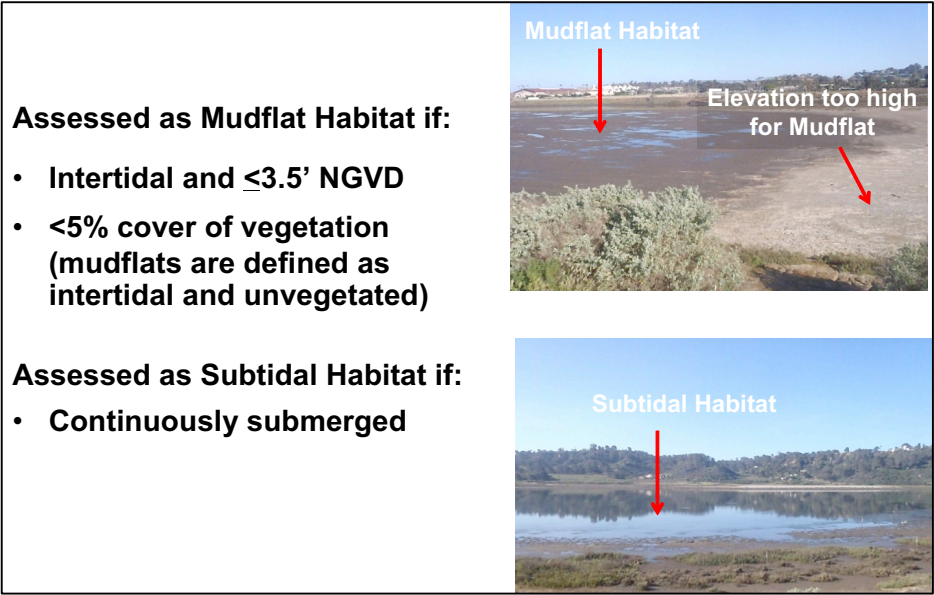


Figure 5.1.2.2. Criteria used to classify areas of the restoration project as mudflat and subtidal habitat.



The upper elevation limit for mudflat was based on the observation of surface salt deposits above this level in some areas of San Dieguito Wetlands indicating infrequent tidal inundation. The upper elevational boundary of subtidal habitat is determined using continuously recording data loggers that measure water level height. Salt marsh habitat is defined as intertidal, occurring at or below 4.5' NGVD, the upper elevation limit of tidally influenced habitat for this project, and as vegetated by at least 30% cover of salt marsh plants (Figs. 5.1.2.3, 5.1.2.4). This minimal cover of vegetation will provide perches and bare space for foraging of the State listed endangered Belding's Savannah Sparrow and other species. Elevation contours at 3.5' and 4.5' NGVD are determined using a Real Time Kinematic (RTK) global positioning system (GPS) with a vertical and horizontal accuracy of a few centimeters (typically <3 cm). Habitats are assessed within 10 x 10 m plots superimposed on multispectral aerial images of the restoration site taken annually in late spring to early summer. The acreages of subtidal, mudflat, and salt marsh habitats are computed with the aid of ArcMap and ArcGIS software and compared to the planned acreages in the Final Plan to determine whether they are within 10% of planned values.

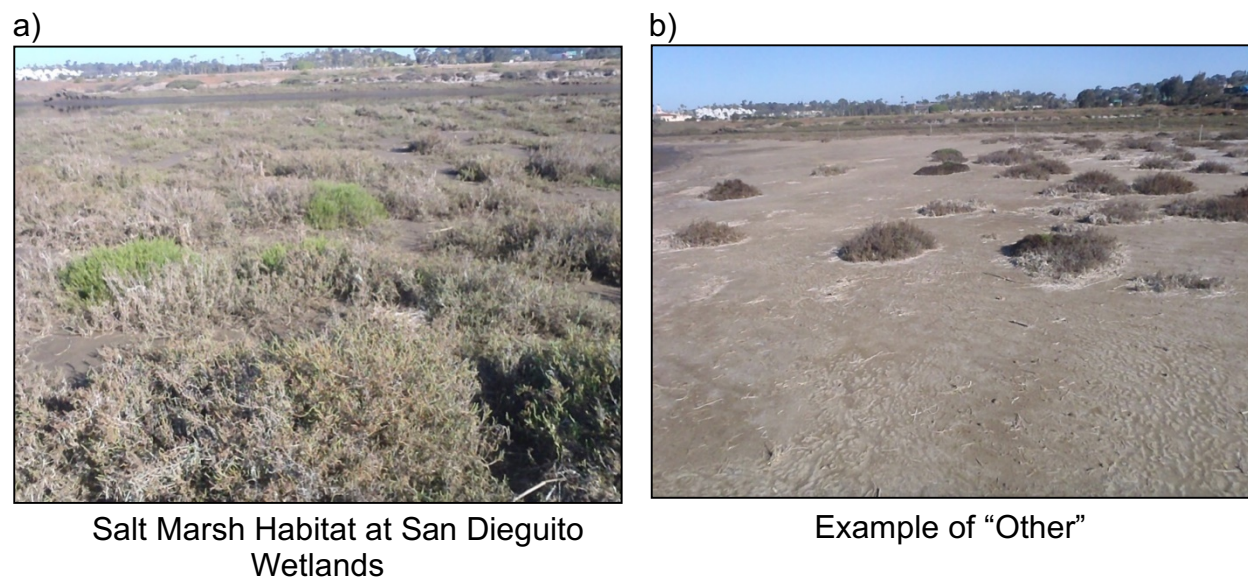
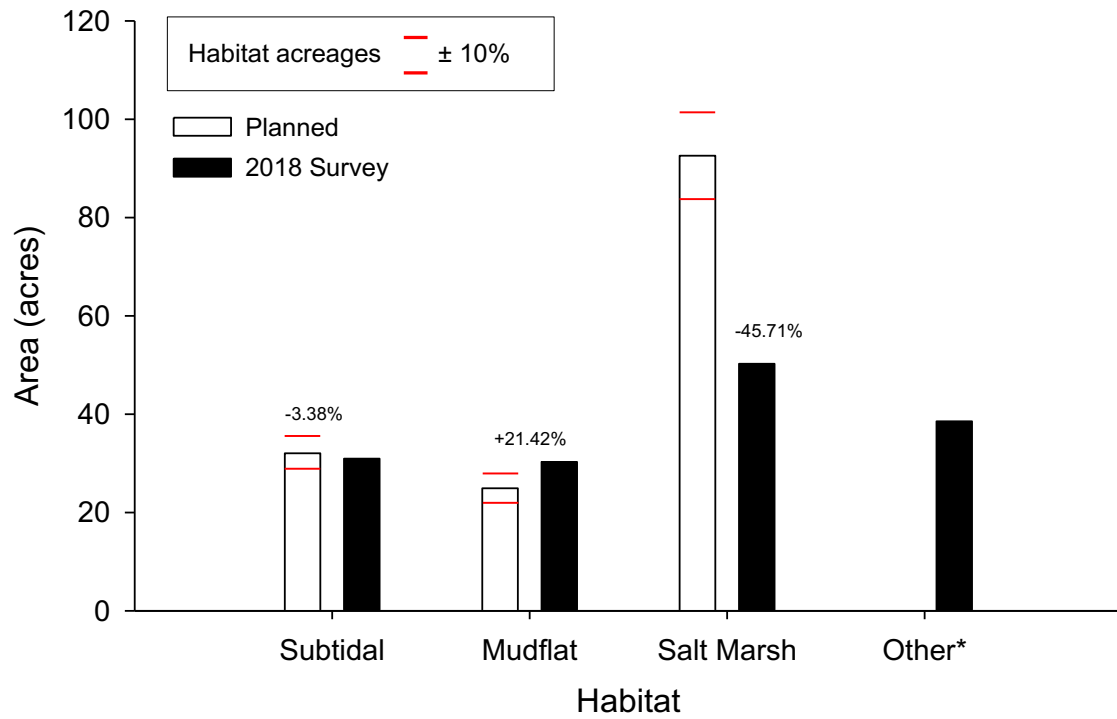


Figure 5.1.2.3. Examples of an area assessed as a) salt marsh habitat, where cover of salt marsh vegetation was  $\geq 30\%$ , and b) an area assessed as "Other", too high in elevation to be assessed as mudflat and too sparsely vegetated to be assessed as salt marsh.

**Results:** The solid bars indicate the acreages determined in our 2018 survey (Fig. 5.1.2.4). While the area of subtidal habitat was within 10% of the planned acreage in 2018, the area of mudflat was greater than 10%, and there was a deficit in salt marsh habitat (of ~33 acres), which was also not within  $\pm 10\%$  of the planned acreages. Salt marsh acreage in 2018 was about 50 acres, 33 acres below the lower 10% limit of the designed acreage. As a result, the San Dieguito Wetlands did not meet the performance standard for Habitat Areas in 2018.





\* not a planned salt marsh habitat

Figure 5.1.2.4. Comparison of the areas of subtidal, mudflat, and salt marsh habitat in the Final Restoration Plan to the 2018 survey. Areas assessed as “Other” were not assessed as one of the planned habitats provided in the Final Restoration Plan.

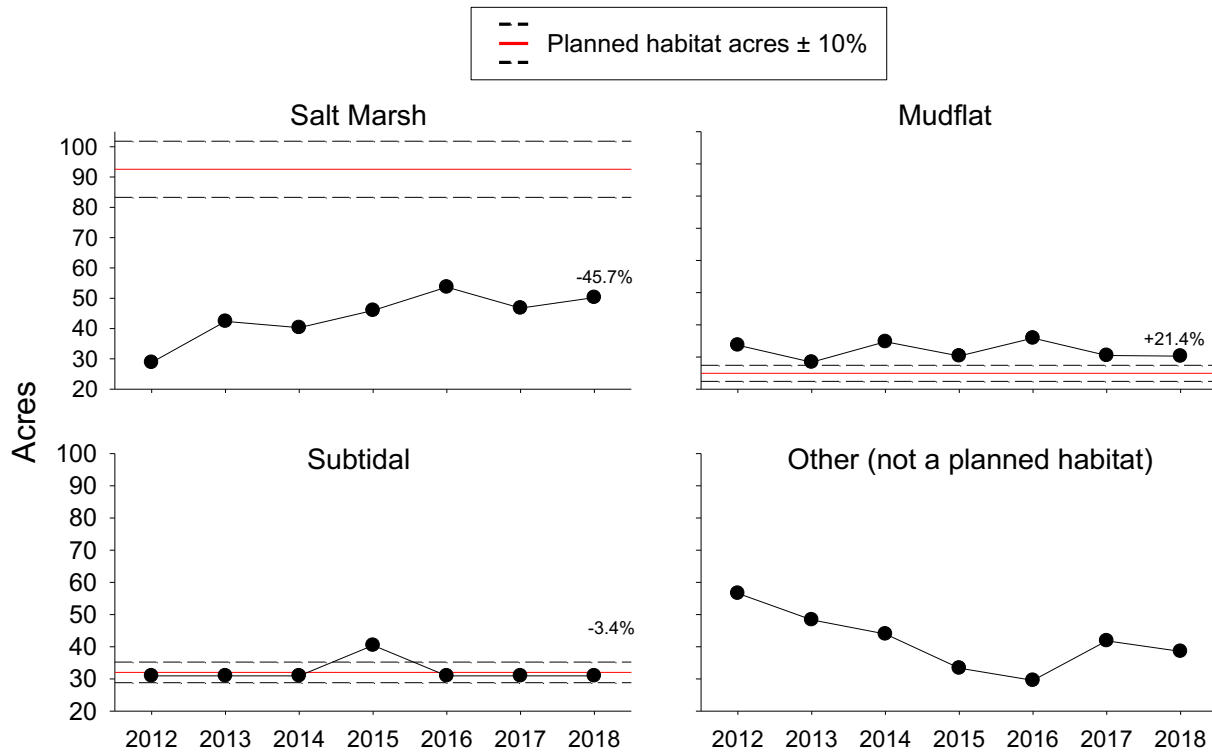


Figure 5.1.2.5. Comparison of the areas of subtidal, mudflat, and salt marsh habitat determined in the 2012 through 2018 surveys to the planned areas in the Final Restoration Plan (red line, dashed lines  $\pm 10\%$ ).

Figure 5.1.2.5 shows the trend over time in acres of the salt marsh, mudflat, and subtidal habitat categories and the “other” category, not a planned habitat. Although there has been an increase in salt marsh habitat since 2012, the acres of salt marsh have remained relatively unchanged over the past 3 years. The increase in Other from 2016 to 2018 can largely be accounted for by the colonization of areas regraded in W2/3 by vegetation, but that have not yet achieved the minimum of 30% cover required for salt marsh habitat (Fig. 5.1.2.5). The greater amount of subtidal habitat in 2015 compared to other years was likely related to the generally higher coastal water levels associated with El Niño and to sand build up in the inlet channel that prevented the wetland from draining during low tides. The inlet was dredged in November 2015 and again in November-December 2017 to improve tidal flows.

### 5.1.3. Topography

*THE WETLAND SHALL NOT UNDERGO MAJOR TOPOGRAPHIC DEGRADATION (SUCH AS EXCESSIVE EROSION OR SEDIMENTATION).*

Approach: The intent of the Topography Standard is to ensure that the expected functions of the wetland are not affected by excessive erosion or sedimentation. Topographic changes resulting from excessive erosion or sedimentation could impede tidal flow within the wetland, altering tidal prism and the areas of planned wetland habitat. Erosion or sedimentation within the restored wetland may result from high

volumes of storm run-off, littoral movement of sand that blocks the inlet channel, slumping of banks or berms, or other causes.

Survey data and field observations are used to determine whether the topography standard is met. Visual surveys are done throughout the restored wetland to identify any sign of substantial erosion or sediment deposition that could impede tidal flow. Additional surveys are done following storm events when bank erosion, channel scour and sediment deposition are likely to occur. Constructed berms and associated structures (e.g. culverts, weirs) are a special topographical feature of the restored wetland. These features are visually inspected during the surveys.

Results: Survey data and field observations indicated that the expected functions of the San Dieguito Wetlands were not affected by excessive erosion or sedimentation in 2018 and therefore this performance standard is currently met.

**5.1.4. Reproductive success**

*CERTAIN PLANT SPECIES, AS SPECIFIED IN THE WORK PROGRAM, SHALL HAVE DEMONSTRATED REPRODUCTION (I.E. SEED SET) AT LEAST ONCE IN THREE YEARS.*

Approach: The reproductive success of salt marsh plants is evaluated by measuring whether seed are produced for seven common species found in the mid to high salt marsh: Parish’s Glasswort (*Arthrocnemum subterminale*), Pickleweed (*Salicornia virginica = Sarcocornia pacifica*), Alkali Heath (*Frankenia salina*), Spiny Rush (*Juncus acutus*), Marsh Jaumea (*Jaumea carnosa*), California Sea Lavender (*Limonium californicum*), and Salt Grass (*Distichlis spicata*). These are the most common species found within the restoration site. The seven common species are inspected for the presence of seeds at 10 sampling stations per plant species distributed throughout the wetland in summer-fall when seed set is greatest. Seed set is identified from a subsample of mature flowers of each species.

Results: All seven species produced seed in 2015 through 2018, which is consistent with the permit requirements (Fig 5.1.4.1). Since all seven species produced seed within three years, the standard for Reproductive Success is met for 2018.

Plant	2015	2016	2017	2018
Parish’s Glasswort	yes	yes	yes	yes
Saltgrass	yes	yes	yes	yes
Alkali Heath	yes	yes	yes	yes
Marsh Jaumea	yes	yes	yes	yes
Spiny Rush	yes	yes	yes	yes
California Sea Lavender	yes	yes	yes	yes
Pickleweed	yes	yes	yes	yes

Figure 5.1.4.1. Plant species evaluated for seed set. A “yes” indicates the species produced seed for that year.

### 5.1.5. Exotics

#### 5. THE IMPORTANT FUNCTIONS OF THE WETLAND SHALL NOT BE IMPAIRED BY EXOTIC SPECIES.

Approach: Exotic species can cause compositional and functional changes in estuarine ecosystems. Such changes can occur, for example, through the alteration of food webs or the physical structure of habitats (e.g., burrowing activities that affect the stability of tidal channel banks, Talley et al. 2001). Monitoring data collected for fish, invertebrates, birds, and vegetation are used to assess the prevalence of exotic species.

a)

b)



Figure 5.1.5.1. a) Exotic species targeted during the special survey and b) divers preparing to enter the basin (W1) to conduct the special survey.

In addition, a special survey looking for exotic species was conducted that covered as much of the wetland as possible. This special survey focused on plants and non-cryptic macro invertebrates in intertidal and subtidal habitats (Fig. 5.1.5.1).

Results: Densities of exotic species were very low and there was no evidence that exotic species impaired the important functions of San Dieguito Wetlands in 2018. Notably, the Yellowfin Goby, an exotic species that was the fifth most abundant fish as determined from our fish sampling in 2013 has not been abundant the last five years.

### 5.2. Relative Performance Standards

There are 15 relative performance standards, listed below (Fig. 5.2.1). Standard 1, Water Quality is a physical standard, standards 2-14 are biological standards pertaining to birds, fish, invertebrates, and plants, and standard 15 pertains to food chain support provided to birds.

## Relative Performance Standards

1. Water Quality
2. Bird Density
3. Bird Species Richness
4. Fish Density – Main Channel (MC)
5. Fish Species Richness – MC
6. Fish Density – Tidal Creek (TC)
7. Fish Species Richness – TC
8. Invertebrate Density – MC
9. Invertebrate Species Richness – MC
10. Invertebrate Density – TC
11. Invertebrate Species Richness – TC
12. Vegetation Cover
13. Algal Cover
14. Spartina Canopy Architecture
15. Food Chain Support



Figure 5.2.1. Relative performance standards used to evaluate the success of the San Dieguito Wetlands Restoration Project.

### *1. WATER QUALITY VARIABLES [TO BE SPECIFIED] SHALL BE SIMILAR TO REFERENCE WETLANDS.*

Approach: Because of its documented importance to wetland health, the concentration of dissolved oxygen (DO) is used to evaluate water quality within the restored wetland. Dissolved oxygen concentration can change rapidly with inlet closure resulting in adverse effects on estuarine biota. However, dissolved oxygen also varies with location, the tidal cycle and time of day (it is generally higher during the day due to oxygen provided by photosynthesis, and lower during the night due to respiration). Measurements of dissolved oxygen are therefore made using a continuously recording environmental data logger (e.g., HOBO Dissolved Oxygen Datalogger U26-001) deployed in comparable channel locations at the restored and reference wetlands to characterize representative values of dissolved oxygen concentrations within the wetlands. Data are recorded every 15 minutes and downloaded every 2-3 weeks after which the logger is re-calibrated.

Dissolved oxygen concentration (DO) below 3 ppm (=3 mg/l) is considered hypoxic and sustained concentrations below this value may be detrimental to estuarine biota (Ecological Society of America, 2012). Therefore, one approach to assessing dissolved oxygen is to assess the length of time continuously spent below this concentration. The water quality standard is evaluated by comparing the mean length in hours of continuous hypoxia between San Dieguito Wetlands and the reference wetlands. If the

mean number of consecutive hours with DO <3 ppm is significantly higher in the San Dieguito Wetlands than in the reference wetland with the highest value, then San Dieguito Wetlands fails to meet the standard.

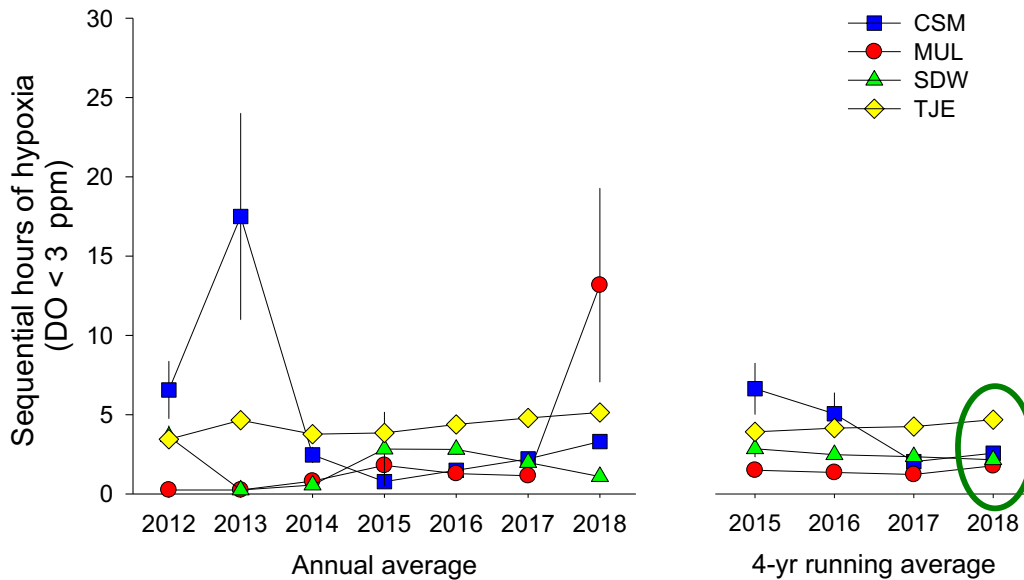


Figure 5.2.1.1. Mean length in hours of continuous hypoxia ( $[O_2] < 3$  ppm) in the San Dieguito Wetlands compared with the three reference wetlands. Abbreviations used in this and subsequent figures: CSM=Carpinteria Salt Marsh, MUL=Mugu Lagoon, SDW=San Dieguito Wetlands, and TJE=Tijuana Estuary. Mean values  $\pm 1$ SE are shown in this and subsequent figures. Green circle denotes meeting the standard for 2018.

**Results:** Figure 5.2.1.1 shows the mean number of hours of continuous hypoxia at the San Dieguito Wetlands compared with the three reference wetlands annually from 2012 through 2018 and the four-year running average, which is used to evaluate the standard. Again, this standard is evaluated by comparing values in San Dieguito Wetlands to the reference wetland with the highest value of sequential hours of hypoxia. For the four-year running average, the value for sequential hours of hypoxia at San Dieguito was lower than the reference wetland with the highest value (Tijuana Estuary) and therefore San Dieguito Wetlands currently meets the Water Quality standard.

### 5.2.2. General sampling design for fish and macro-invertebrates.

San Dieguito Wetlands and the three reference wetlands are sampled in the late summer-fall. Six tidal creeks and six sections of the main channel-basin habitat are sampled in each wetland (Fig. 5.2.2.1). Because tidal creeks and main channels differ in width, water depth, and hydrology, and are thus likely to support different assemblages of fish and macro-invertebrates, tidal creeks and main channels are assessed separately. A potential concern for the monitoring design was that basins of the type constructed in the San Dieguito Wetlands Restoration do not occur naturally in southern California wetlands, and thus cannot be compared to natural reference sites. However, data collected by Marine Ecological Consultants (1993) on fish abundance from different habitats at San Dieguito Lagoon prior to restoration found that fish assemblages were similar in basin and main channel habitats and thus it is biologically



reasonable to treat the constructed basin as main channel habitat in post-construction monitoring. The six sampled creeks or sections of the main channel or basin habitat (in the case of San Dieguito) are treated as replicates in subsequent analysis.



Figure 5.2.2.1. Location of tidal creeks (TC) and sections of main channel and basin (MC) sampled for fish and macro-invertebrates in San Dieguito Wetlands. Blue dots indicate stations sampled for macro-invertebrates within each TC and MC replicate.

### 5.2.3. Fish

*WITHIN 4 YEARS OF CONSTRUCTION, THE TOTAL DENSITIES AND NUMBER OF SPECIES OF FISH SHALL BE SIMILAR TO THE DENSITIES AND NUMBER OF SPECIES IN SIMILAR HABITATS IN THE REFERENCE WETLANDS.*

Approach: Data on the density and numbers of species of fish are collected using 0.43 m<sup>2</sup> circular enclosure traps and larger beach seines (generally 1000 m<sup>2</sup>). Enclosure traps are used to sample gobies, which are small, numerically abundant fishes that are poorly sampled by other methods (Steele et al 1996a). Beach seines in combination with blocking nets are used to sample larger more mobile fishes (Steele et al 1996b). Fish captured by both methods are identified and counted in the field and returned to the water alive.

The total number of fish is standardized to 1 m<sup>2</sup> for each enclosure or beach seine sample. The averages for enclosures and beach seines are averaged to produce a combined estimate of total density (average number per 1 m<sup>2</sup>) for each tidal creek or main channel-basin replicate. Species richness is determined as the number of unique species for each tidal creek or main channel replicate. These replicate values for density and species richness are used to calculate the means and standard errors used to evaluate similarity in total density and species richness of fish in tidal creeks and main channel-basin habitats between the restored and reference wetlands in a given year. Ridgeway's Rail (formerly the Light-footed Clapper Rail) nesting in Tijuana Estuary prevented sampling using seines in 2012 so that year is not included in the running average calculation of fish density and richness.

Results: Fish density increased dramatically from 2013 to 2015 in Carpinteria Salt Marsh in both main channel and tidal creek habitats (Fig. 5.2.3.1). This increase was due to the recruitment of large numbers of gobies in this wetland. For the 4-year running averages, fish density in main channel habitat in San Dieguito Wetlands was not significantly lower than the lowest performing reference wetland in 2018 (Fig 5.2.3.1).

Fish density remained highest in the main channels of Carpinteria Salt Marsh. The 4-year running average of fish density in tidal creek habitat in San Dieguito Wetlands was significantly lower than Mugu Lagoon, the lowest performing reference wetland (Fig 5.2.3.1). Therefore, the standard for fish density in main channel habitat was met, but this standard was not met for tidal creek habitat in 2018.

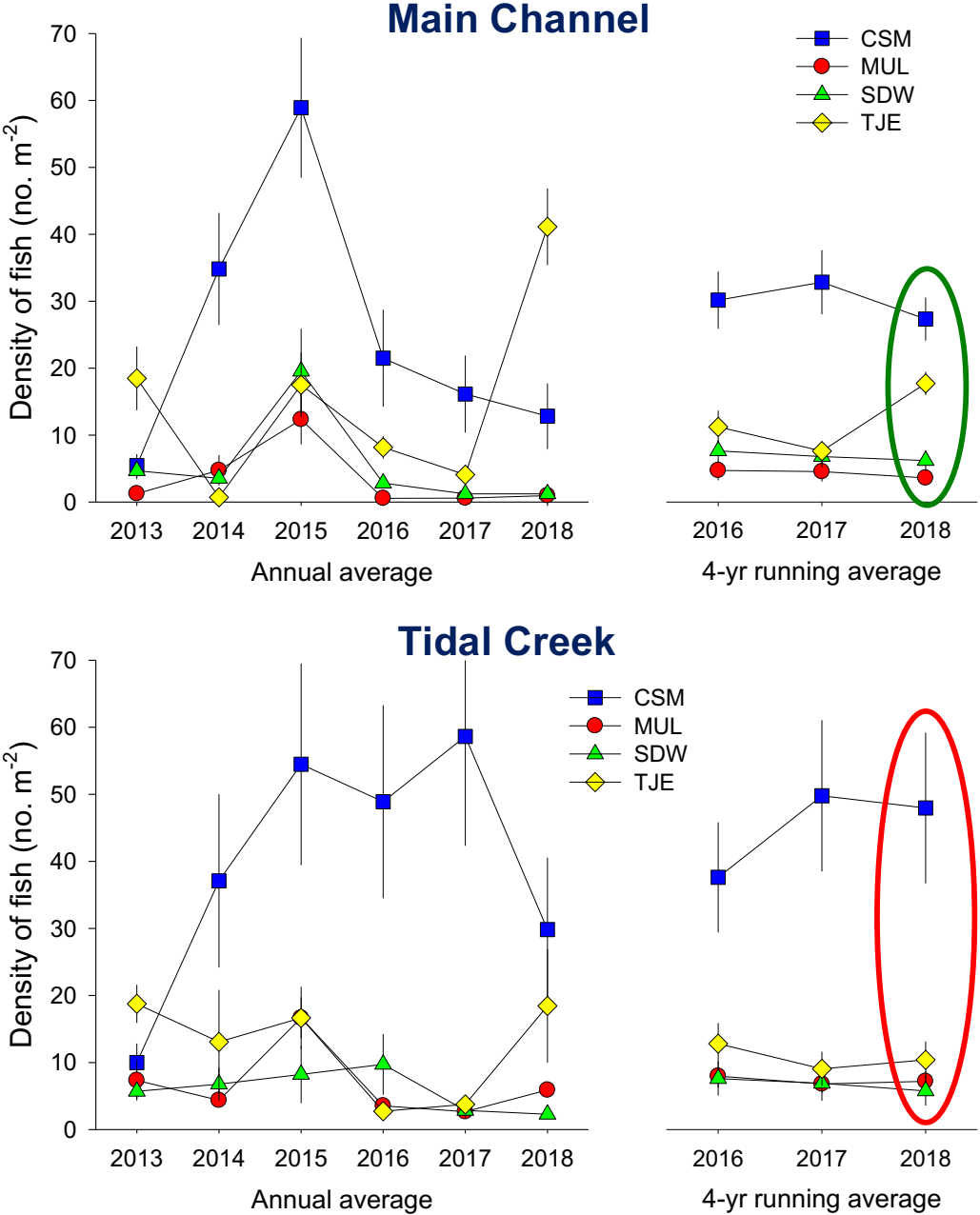


Figure 5.2.3.1. Comparison of annual fish density (left) and the 4-year running average used to evaluate the standard (right) between San Dieguito Wetlands and the reference wetlands in main channel and tidal creek habitats. Section of main channel-basin or individual tidal creek is the unit of replication (n = 6 in each habitat type).



For fish species richness, the 4-year running averages in main channel habitat in San Dieguito Wetlands was not significantly lower than the lowest performing reference wetland (Fig. 5.2.3.2). However, the 4-year running average for tidal creek habitat in San Dieguito Wetlands was significantly lower than Tijuana Estuary, the lowest performing reference wetland. Therefore, the restored wetland currently meets the standards for fish species richness in main channel but not tidal creek habitats.

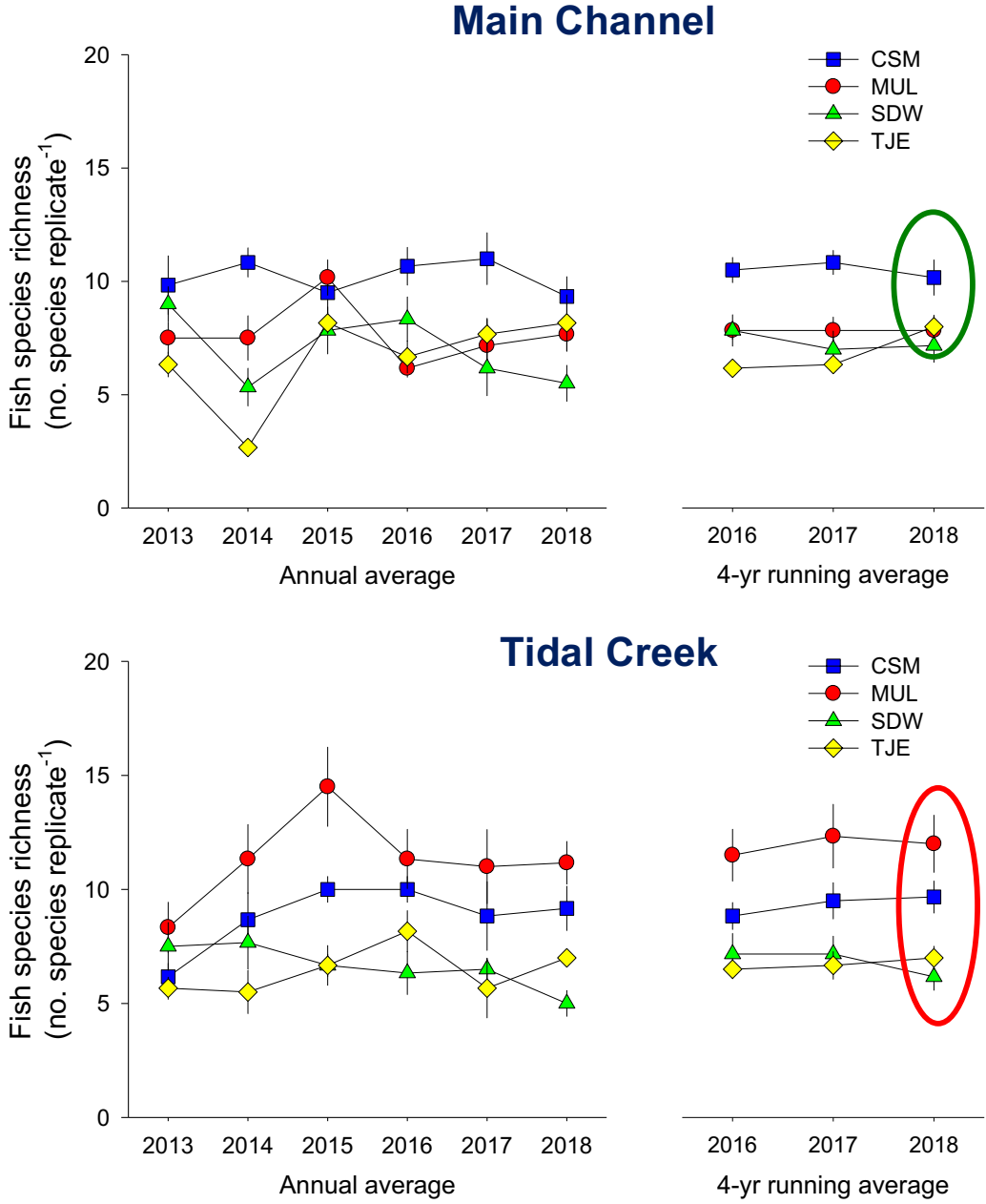


Figure 5.2.3.2. Comparison of annual fish species richness (left) and the running average used to evaluate the standard (right) between San Dieguito Wetlands and the reference wetlands for main channel and tidal creek habitats. Section of main channel-basin or individual tidal creek is the unit of replication (n=6 in each habitat type).

#### **5.2.4. Macro-invertebrates**

*WITHIN 4 YEARS OF CONSTRUCTION, THE TOTAL DENSITIES AND NUMBER OF SPECIES OF MACRO-INVERTEBRATES SHALL BE SIMILAR TO THE DENSITIES AND NUMBER OF SPECIES IN SIMILAR HABITATS IN THE REFERENCE WETLANDS.*

Approach: Three methods are used to sample macro-invertebrates. First, epifauna (e.g., California Horn Snail, *Cerithidea californica*) are sampled by counting individuals within two sets of 3-25 x 25 cm quadrats spaced uniformly (low, mid, high) at each station on the unvegetated banks of tidal creeks and sections of main channel-basin between the lower limit of vegetation (or, if unvegetated, an elevation of ~1.3' NGVD) and the thalweg for tidal creeks or in main channel a water depth of approximately 50 to 80 cm, which accommodates deployment of the enclosure traps. Second, deep living larger infauna (i.e., animals that live well beneath the sediment surface such as the Jackknife Clam and Ghost Shrimp) are sampled adjacent to the quadrats using a 10 cm diameter (large) core pushed into the sediment to a maximum depth of 50 cm. The contents of the 10 cm core are sieved through a 3-mm mesh screen in the field. Animals retained by the 3-mm mesh are identified and counted in the field and returned to the habitat. Third, smaller infaunal invertebrates (primarily worms) are sampled using a 3.5-cm diameter (small) core pushed into the sediment to a depth of 6 cm. The small core samples are taken adjacent to the large core samples and are preserved on site in 10% buffered formalin. The samples are returned to the laboratory where they are screened through a 0.5mm mesh. Specimens are identified and counted under the microscope and archived in ethanol. Invertebrates are identified to the lowest practical taxon for smaller specimens (e.g., polychaetes, oligochaetes, amphipods) and to species for larger specimens (e.g., bivalves, decapod crustaceans).

Density of macro-invertebrates sampled using each method are standardized to number per 100 cm<sup>2</sup> and then combined to obtain a density value for each of the 5 stations within a tidal creek or section of main channel-basin. These station values are then averaged for each tidal creek or section of main channel-basin, which are the units of replication giving 6 replicate estimates of macroinvertebrate density in each habitat per wetland. Species richness of macro-invertebrates is evaluated by recording the number of unique species per tidal creek or section of main channel-basin obtained using all sampling methods, including any invertebrate species noted in the enclosure traps and beach seines used to sample fish. Species richness is assessed as the mean number of species in the 6 replicate tidal creeks and sections of main channel-basin for each wetland in a year. These replicate values are used to calculate the means and standard errors used to evaluate similarity in total density and species richness of macro-invertebrates in tidal creeks and sections of channel-basin between the restored and reference wetlands in a given year.

Results: The annual density and running average of density of macro-invertebrates has been highest in both main channel and tidal creek habitat in Mugu Lagoon. The 4-year running average of density of macro-invertebrates in the main channels and tidal creeks of San Dieguito Wetlands has been lower than the lowest performing reference wetland, which has been Tijuana Estuary from 2015 to the present. Thus, the standards for

macro-invertebrate density in main channel and tidal creek habitats are currently not met (Fig. 5.2.4.1).

The annual mean and running average for species richness in both main channel and tidal creek habitat has been highest in Mugu Lagoon and Carpinteria Salt Marsh. However, the 4-year running average of species richness of macro-invertebrates in the main channels and tidal creeks of San Dieguito Wetlands was similar to Tijuana Estuary, the lowest performing reference wetland. Therefore, the performance standards for macro-invertebrate species richness in main channel and tidal creek habitats of San Dieguito Wetlands are currently met (Fig. 5.2.4.2). Unique invertebrates recorded during fish sampling using seines are included in determining invertebrate richness. Seine sampling was not conducted in 2012 due to Ridgeway's Rail nesting and richness is not included for that year.

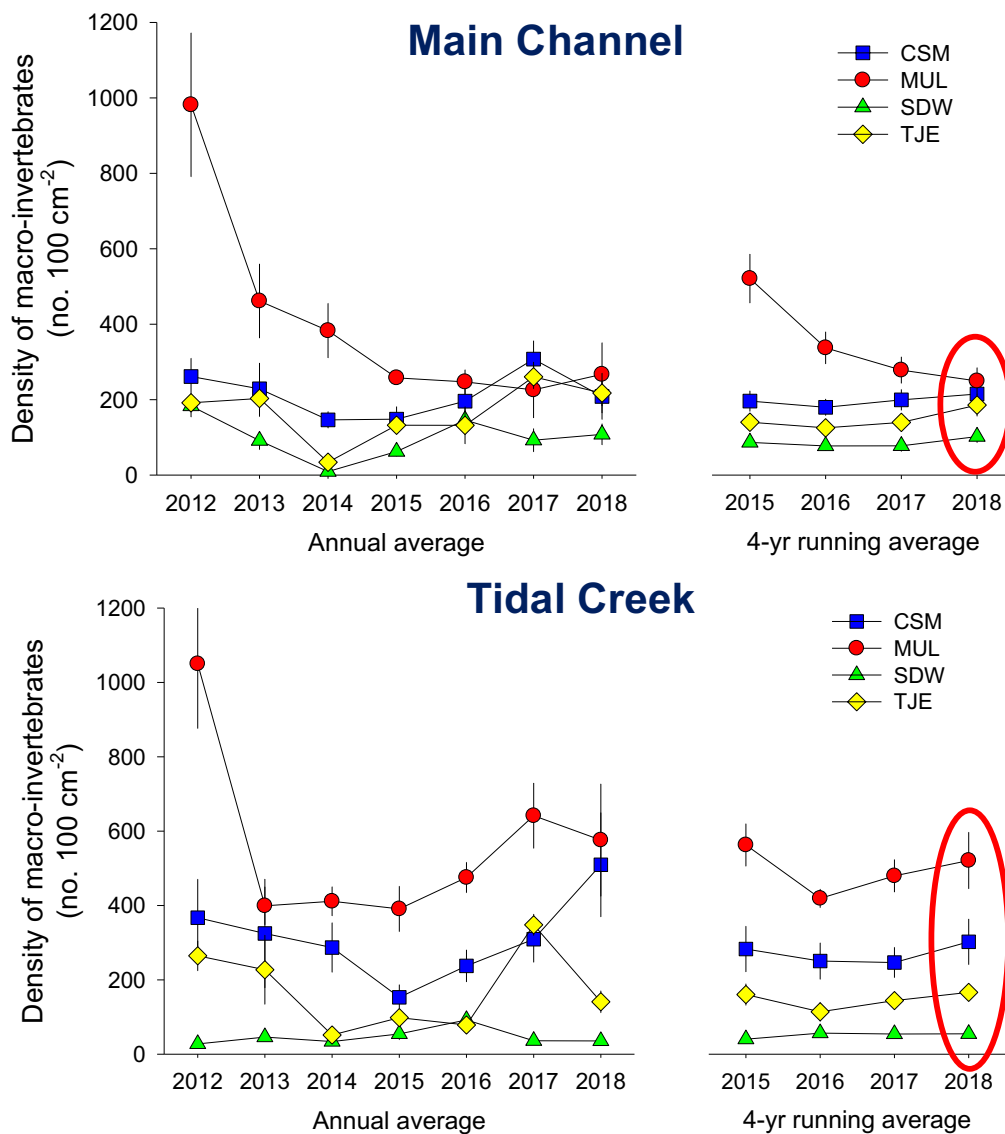


Figure 5.2.4.1. Comparison of macro-invertebrate density between San Dieguito Wetlands and the reference wetlands for main channel and tidal creek habitats. Section of main channel-basin or individual tidal creek is the unit of replication. Red circle denotes standard not met.

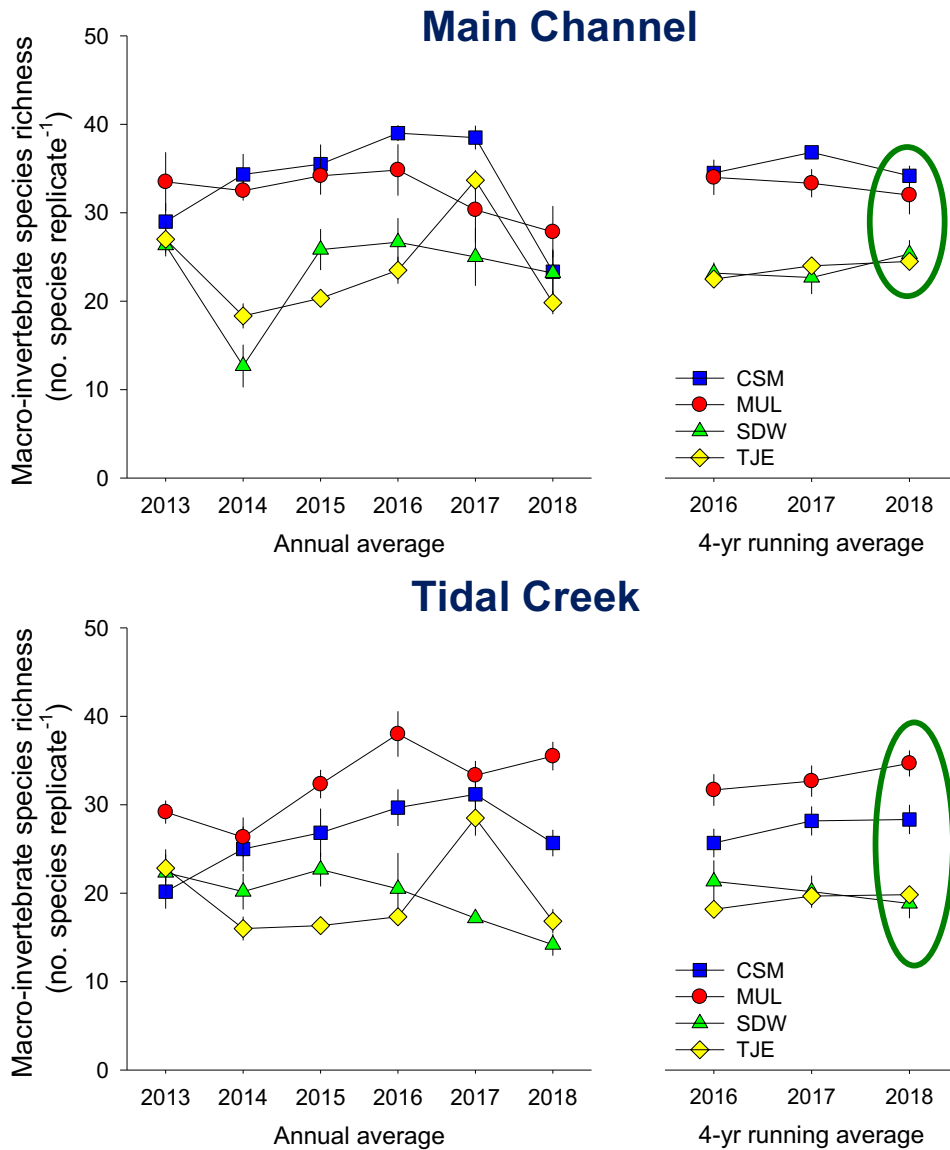


Figure 5.2.4.2. Comparison of macro-invertebrate species richness between San Dieguito Wetlands and the reference wetlands for main channel and tidal creek habitats. Section of main channel-basin or individual tidal creek is the unit of replication. Complete sampling not conducted for invertebrate richness in 2012.

### 5.2.5. Birds

*WITHIN 4 YEARS OF CONSTRUCTION, THE TOTAL DENSITIES AND NUMBER OF SPECIES OF BIRDS SHALL BE SIMILAR TO THE DENSITIES AND NUMBER OF SPECIES IN SIMILAR HABITATS IN THE REFERENCE WETLANDS.*

Approach: Birds are sampled by walking within clear viewing distance (using binoculars or spotting scope) of 20 replicate rectangular plots of 100 x 150 m spread throughout the wetlands (Fig. 5.2.5.1) and visually identifying and counting all birds sighted within each plot. The time spent identifying and counting birds within each plot is five minutes to standardize sampling effort. Bird sampling is conducted during the same period of the

tide cycle (falling and low tide) to reduce the potential effects of this variable on bird abundance. Birds overflying the plots are counted if they are within approximately 30 m above the plot. All wetlands are sampled within a few days of one another to reduce the potential effects of weather, and other factors that might vary among wetlands over time, on bird density and species richness.



Figure 5.2.5.1. Distribution of the 20-100 x 150 m bird sampling plots in the San Dieguito Wetlands.

Bird assemblages in coastal wetlands of southern California exhibit strong seasonal variations in species richness and density that are driven by the movement of migratory birds. Sampling observations are made during three periods: winter (January, February), spring (April, May), and fall (October, November) that have high bird densities and distinctive species composition. Six sampling surveys are made in each wetland during each seasonal period with three surveys taken within each of the two months of each period.

The total density and number of species (species density) of birds within each plot are averaged across the 18 survey dates to provide a mean value for these response variables for each plot providing 20 mean values per wetland. Yearly mean total densities and mean species density of birds within each wetland are computed using the 18-survey averages for each of the 20 plots as replicates for each wetland and these values are used for evaluating similarity between the restored and reference wetlands.

Results: Mugu Lagoon had the highest bird density in 2012 through 2018 and the highest 4-year running average for bird density over the same time period. The 4-year running average of bird density in San Dieguito Wetlands was similar to Carpinteria Salt Marsh, the reference wetland with the lowest value over this period (Fig. 5.2.5.2). Therefore, the standard for bird density in San Dieguito Wetlands is currently met.

The 4-year running average of bird species richness remained highest in Mugu Lagoon and Tijuana Estuary in 2018. Although there appears to be a general decrease in the 4-year running average for bird species richness in San Dieguito Wetlands relative to the reference wetlands, the 4-year running average for bird species richness in the San Dieguito Wetlands was similar to species richness at Carpinteria Salt Marsh, the lowest performing reference wetland (Figure 5.2.5.3). Therefore, the standard for bird species richness in San Dieguito Wetlands is currently met.

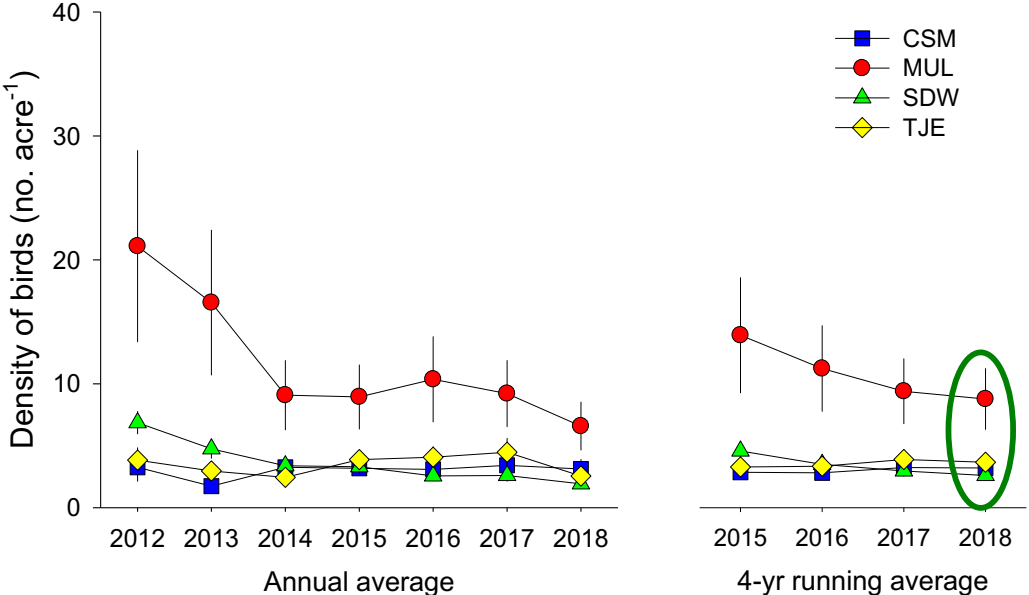


Figure 5.2.5.2. Comparison of bird total density between San Dieguito Wetlands and Tijuana Estuary, Mugu Lagoon, and Carpinteria Salt Marsh.

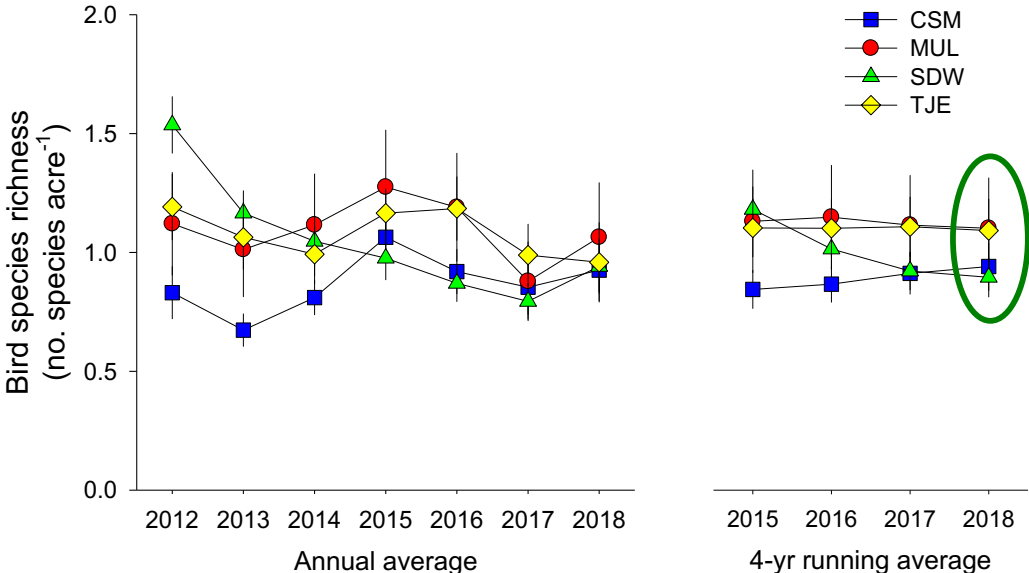


Figure 5.2.5.3. Comparison of bird species richness between San Dieguito Wetlands and the three reference wetlands.



### 5.2.6. Vegetation

*THE PROPORTION OF TOTAL VEGETATION COVER AND OPEN SPACE IN THE MARSH SHALL BE SIMILAR TO THOSE PROPORTIONS FOUND IN THE REFERENCES SITES.*



Figure 5.2.6.1. View of San Dieguito Wetlands modules W5 & W10 taken in March 2016 showing cordgrass (in center) and mudflat below it.

**Approach:** The percent cover of salt marsh vegetation and open space is evaluated in the restored and reference wetlands in replicate 10 m x 10 m plots forming grids that entirely cover salt marsh habitat as defined above (see Habitat Areas). Estimates of the percent cover of salt marsh vegetation in San Dieguito Wetlands and the reference wetlands are made using aerial imagery taken in the late spring or summer. Mean percent cover of vegetation in salt marsh habitat in the restored and reference wetlands is computed using the 10 m x 10 m plots as replicates. Since the entire salt marsh habitat is censused in each wetland, comparisons are made only using mean values. This performance standard is met if the average percent cover of vegetation within the restored wetland is not lower than that in the reference wetlands.

**Results:** Although vegetation is colonizing San Dieguito Wetlands, it has increased slowly in distribution and cover (see Section 3.2), and the annual and 4-year running average of percent cover of vegetation in salt marsh habitat remains much lower than in any of the reference wetlands (Fig. 5.2.6.2). The cover of vegetation in SDW is not yet similar to the reference wetlands and consequently the performance standard for cover of vegetation has not yet been met.

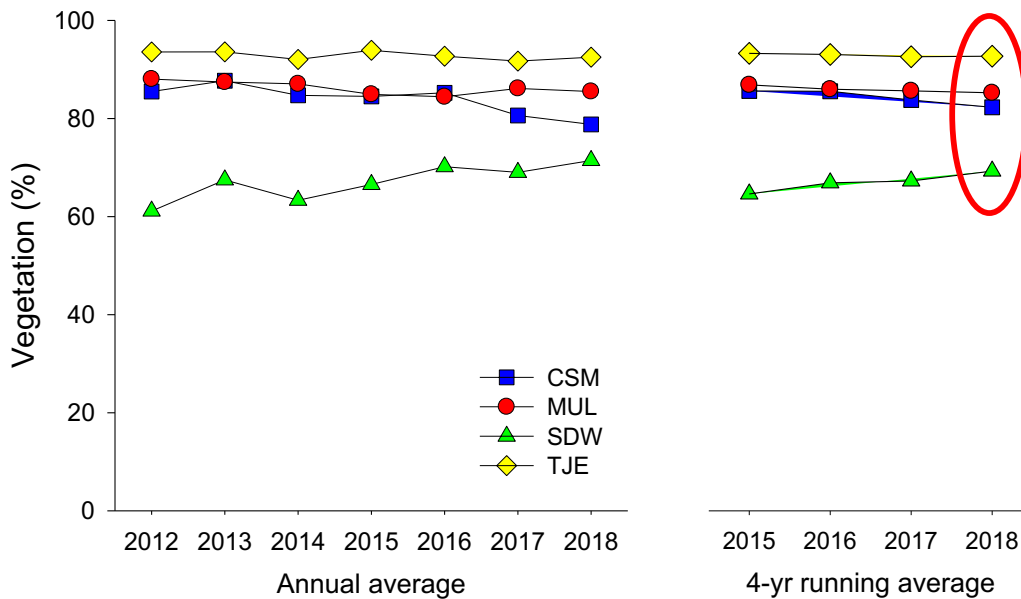


Figure 5.2.6.2. Comparison of the percent cover of salt marsh vegetation between San Dieguito Wetlands and the reference wetlands. Percent cover is evaluated in areas assessed as salt marsh habitat.

### 5.2.7. Algae

*THE PERCENT COVER OF ALGAE SHALL BE SIMILAR TO THE PERCENT COVER FOUND IN THE REFERENCE SITES.*

Approach: This performance standard is designed to monitor the development of unusually dense mats of filamentous green macroalgae in the restoration site. Thick mats of macroalgae have the potential to interfere with wetland structure and function by smothering benthic invertebrates and inhibiting bird feeding (Everett 1991). Macroalgal mats can also be deposited on the salt marsh during high tides, adversely affecting salt marsh vegetation, and can lower dissolved oxygen concentration during decomposition. Estimates of the cover of macroalgae are made from the aerial images taken to monitor the cover of salt marsh vegetation. Since excessive macroalgal growth can be detrimental, the percent cover of macroalgae in the restored wetland must be lower than the reference wetland with the highest cover of macroalgae. Since the entire wetland is censused, comparisons of the average percent cover of algae among wetlands are made only using mean values.

Results: The percent cover of macroalgae in San Dieguito Wetlands was lower than that in the reference wetland with the highest value (Mugu Lagoon) in 2012, 2013, and 2015 through 2018, but slightly higher than the reference wetland with the highest value (Carpinteria Salt Marsh) in 2014 (Fig. 5.2.7.1). The 4-year running average of macroalgal cover in San Dieguito Wetlands has been lower than the value in the reference wetland with the highest cover (Mugu Lagoon) from 2015 to the present and the relative standard for algae is therefore currently met for 2018 (Fig. 5.2.7.1).

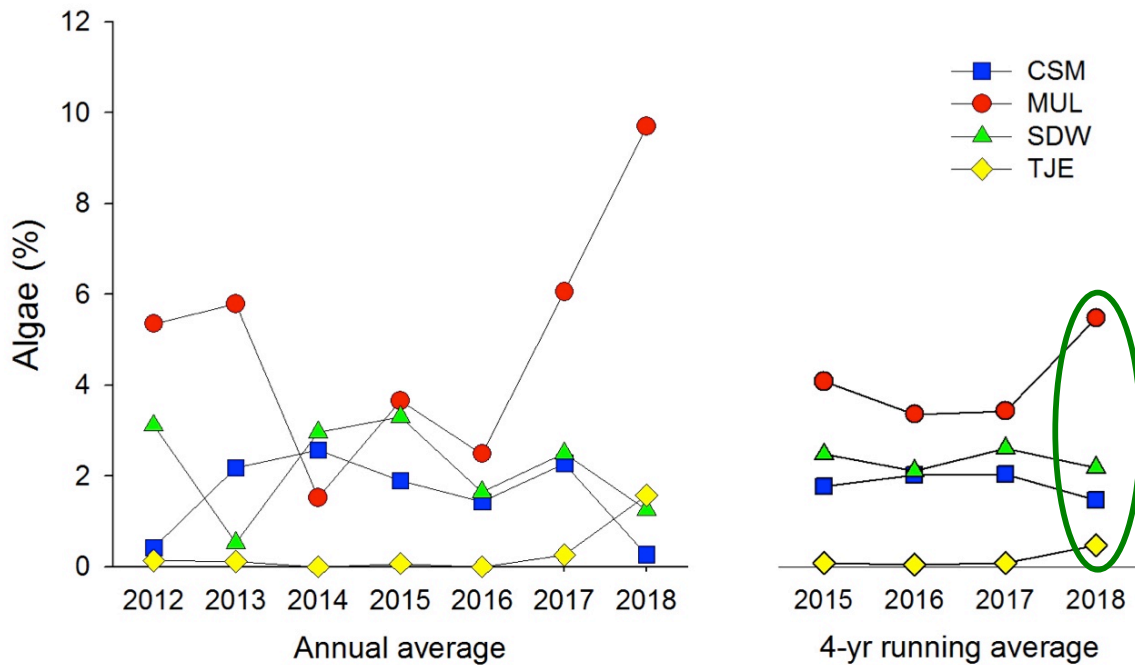


Figure 5.2.7.1. Comparison of percent cover of macroalgae between San Dieguito Wetlands and the reference wetlands.

### 5.2.8. *Spartina* canopy architecture

*THE RESTORED WETLAND SHALL HAVE A CANOPY ARCHITECTURE THAT IS SIMILAR IN DISTRIBUTION TO THE REFERENCE SITES, WITH AN EQUIVALENT PROPORTION OF STEMS OVER 3 FEET TALL.*

Approach: The canopy of *Spartina foliosa* provides habitat for the federally endangered Ridgeway's Rail and other bird species. The number and height of stems of *S. foliosa* in the restored wetland and in Tijuana Estuary is assessed in four patches in each wetland. This standard is only evaluated relative to Tijuana Estuary because *Spartina* is absent in Carpinteria Salt Marsh and, until recently, uncommon in Mugu Lagoon.

*Spartina* is sampled in replicate 0.1 m<sup>2</sup> circular quadrats placed over the cordgrass every 2 m along a 20 m long transect line extending parallel to the water line in each patch (Fig. 5.2.8.1) following methods developed by Zedler (1993) in Tijuana Estuary. From the sampling, the mean proportion of stems >3 feet (91 cm) tall (excluding flowering stalks) is determined for each cordgrass patch. The mean proportion of stems >3 feet tall for each wetland is calculated using four sampled patches per wetland as replicates, and this value is compared between wetlands.

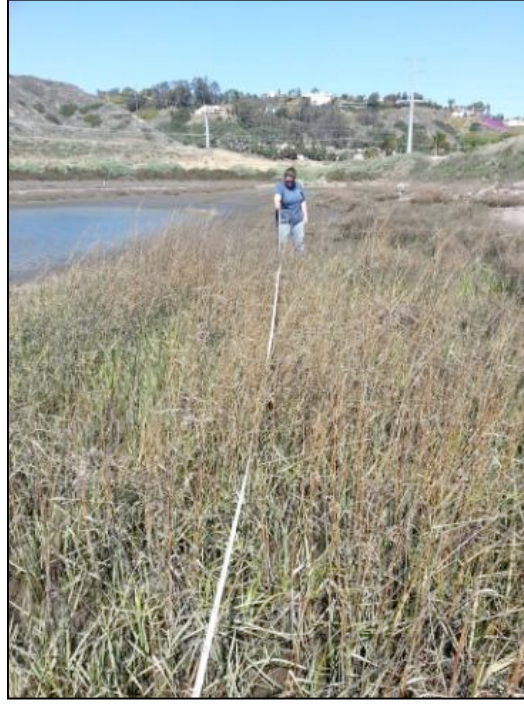


Figure 5.2.8.1. View of a sampling transect overlying a patch of cordgrass in module W4. Cordgrass is sampled in 0.1 m<sup>2</sup> quadrats placed every two meters along the 20 m long transect line. There are four transect lines per wetland.

Results: The annual mean proportion of stems >3 feet (or 91 cm) tall in San Dieguito Wetlands and Tijuana Estuary has been variable over time, including a drop in this value in San Dieguito Wetlands from 2014 to 2016 (Fig. 5.2.8.2). The decline in the height of stems in San Dieguito from 2014 to 2016 was possibly due to increased stress experienced by the plants associated with higher water levels in the wetland in 2014-2015 and the associated increase in tidal inundation of the plants. However, the average annual proportion of stems >3 feet tall has increased in 2017 and 2018 in San Dieguito Wetlands, whereas this value dropped abruptly in Tijuana Estuary in 2018. The 4-year running average dampens the annual variability and the mean proportion of stems >3 feet was similar between San Dieguito Wetlands and Tijuana Estuary in 2018. Therefore, the relative standard for *Spartina* canopy architecture is currently met.

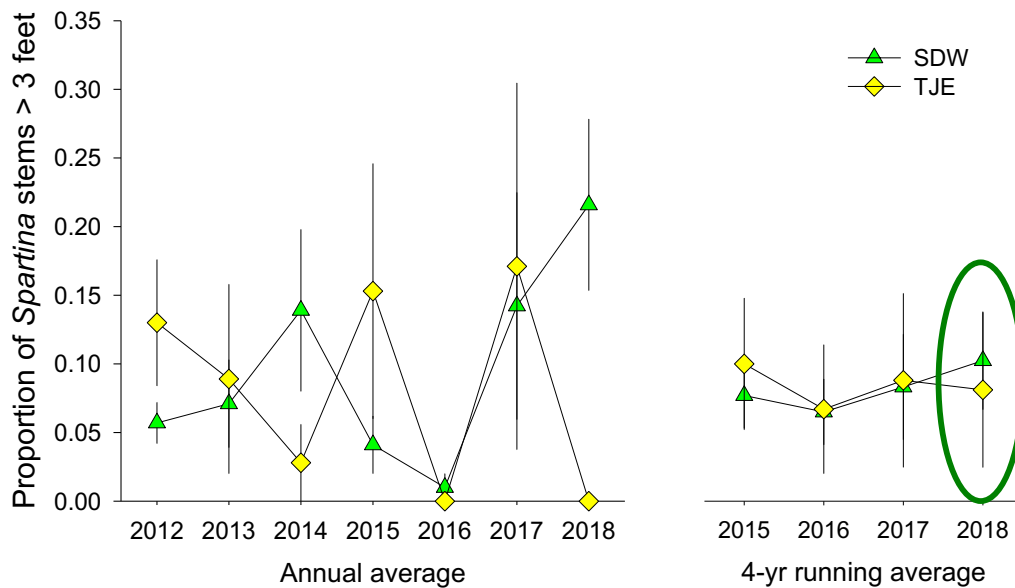


Figure 5.2.8.2, Comparison of the mean proportion of stems > 3 feet (91 cm) tall between San Dieguito Wetlands and Tijuana Estuary.

### 5.2.9. Food chain support

*THE FOOD CHAIN SUPPORT PROVIDED TO BIRDS SHALL BE SIMILAR TO THAT PROVIDED BY THE REFERENCE SITES, AS DETERMINED BY FEEDING ACTIVITY OF THE BIRDS.*

Approach: Food chain support (FCS) is one of the more important functions of coastal wetlands. Measurements of FCS provided to birds are conducted at the same time that birds are sampled to determine their density and species richness. This performance standard is evaluated using the density of birds feeding within selected plots. A bird is recorded as feeding if one feeding attempt is made over a five-minute time interval. Feeding observations are made on shorebirds found in all of the study wetlands (e.g., Willet, Marbled Godwit, Dowitcher). The density of feeding birds in each of the selected plots used in the analysis consists of the average across the 18 survey dates.

Because bird feeding is evaluated for shorebirds on mudflat, the sample size (number of plots) evaluated for bird feeding varies among wetlands depending on the number of plots that contain mudflat. To ensure that each wetland is weighted equally, the densities of feeding birds are averaged across sample dates for each plot containing mudflat in a given year, then is resampled with replacement 20 times (20 being the targeted sample size). This process is iterated 1000 times, and the mean for each iteration is calculated to produce a dataset of 1000 FCS values for each wetland for a given year.

The 4-year running median of the FCS values for each wetland is calculated using a 4-year mean of each iteration based on the current year and the previous three years producing 1000 values of the 4-year average of the FCS values for each wetland. The 4-year median and standard deviation of the FCS values for each wetland is calculated from the resampled distribution of these 1000 values. The four-year running median of

the FCS value at San Dieguito Wetland must be similar to that at the lowest performing reference wetland (as per the methods described in Section 2.3) in order for the San Dieguito Wetland to meet this performance standard for any given year.

**Results:** The highest annual density of feeding birds occurred in Mugu Lagoon in 2012 through 2018 (Fig. 5.2.9.1). Although the 4-year running average of bird feeding activity has not been significantly lower at San Dieguito Wetlands compared with the lowest performing reference wetland 2015-2017, density of feeding birds was significantly lower than Carpinteria Salt Marsh, the lowest performing reference wetland, in 2018. Therefore, the relative standard for FCS was not met in 2018.

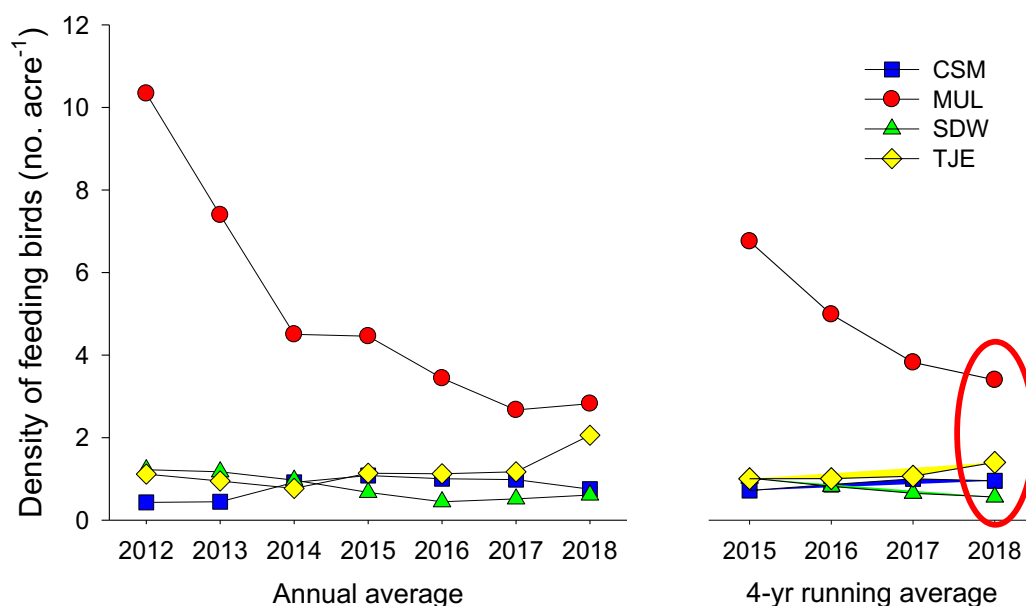


Figure 5.2.9.1. Comparison of the densities of feeding birds between San Dieguito Wetlands and the reference wetlands.



## 6.0 Permit Compliance

### 6.1. Summary Assessment of the Absolute Performance Standards

In order for the San Dieguito Wetlands to receive mitigation credit for a given year, it must meet all of the absolute performance standards. The absolute standards are measured only in San Dieguito Wetlands and are assessed only for the current year.

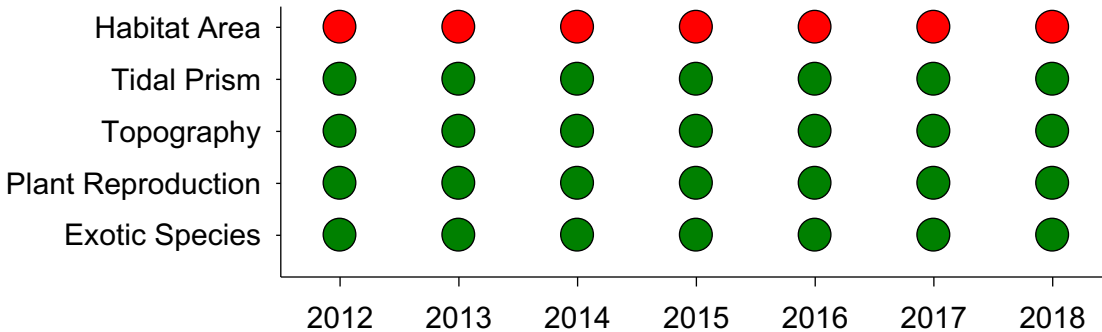


Figure 6.1.1. Summary of assessment of the Absolute Standards from 2012 through 2018. A [green](#) dot indicates that the San Dieguito Wetlands Restoration met the required criteria for a given absolute standard; a [red](#) dot indicates that it did not.

The San Dieguito Wetlands Restoration has met 4 of the 5 absolute standards from 2012 - 2018, but has consistently failed to meet the requirement of the Habitat Areas standard during this period. Since the habitat areas standard was not met in 2018, and all absolute standards must be met in the current year to receive credit, the San Dieguito Wetlands did not receive mitigation credit for 2018 (Fig. 6.1.1).

### 6.2. Summary Assessment of the Relative Performance Standards

A requirement of the SONGS permit is that the response variables used to assess the relative performance standards of the San Dieguito Wetlands Restoration Project be “similar” to those of the reference wetlands (Section 4.4). To be considered similar to the reference wetlands, San Dieguito Wetlands must meet two conditions. The first condition requires that the mean value for the relative performance variable at San Dieguito Wetlands not be significantly worse than the mean value at the three reference wetlands (Section 4.4). The relative performance standards measured in San Dieguito Wetlands are compared to the reference wetlands using a 4-year running average. The second condition in the assessment of the relative standards requires that the proportion of relative standards met by the San Dieguito Wetlands is equal to or greater than the proportion of relative standards met by any of the reference wetlands. See Section 4.4 for details on the rationale and methodology of this approach.

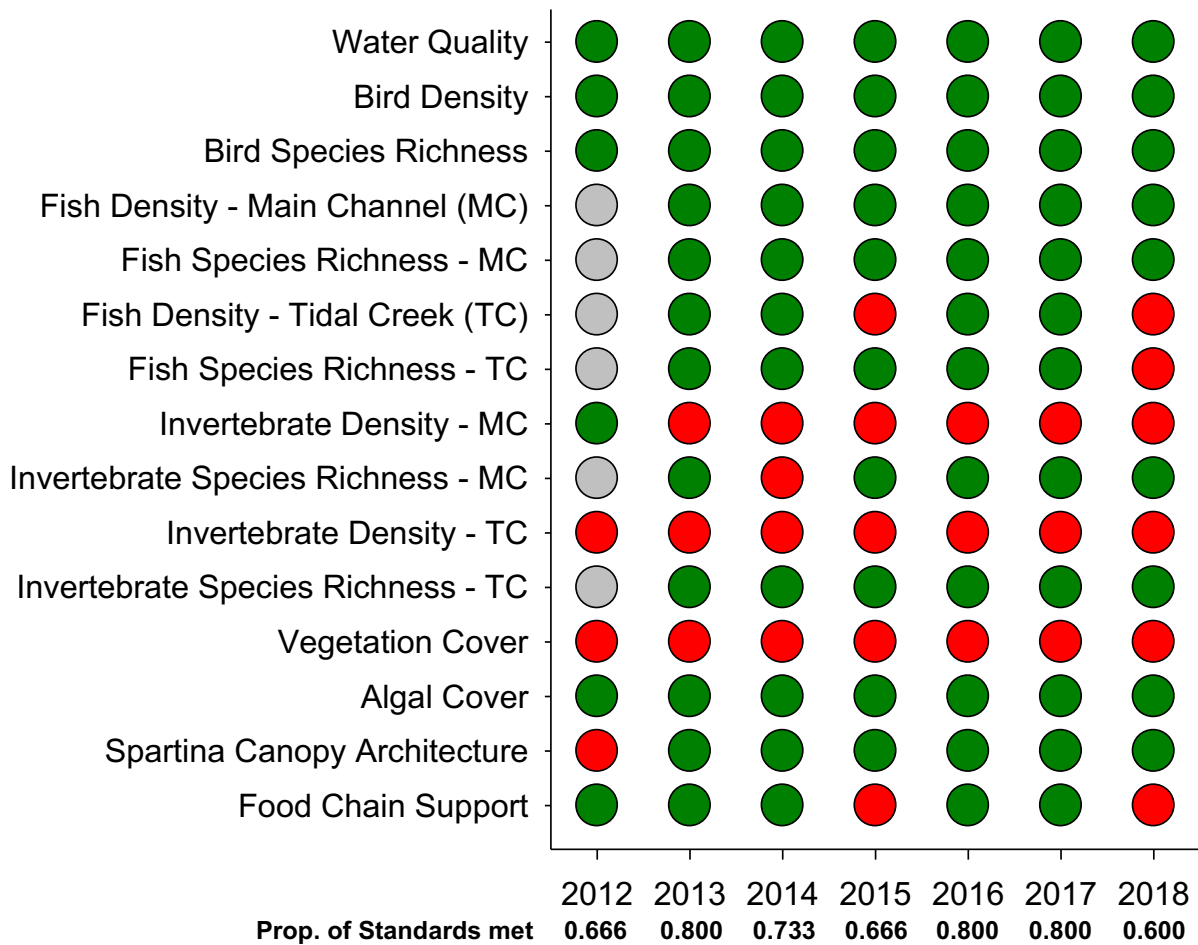


Figure 6.2.1. Summary of the assessment of the Relative Standards from 2012 through 2018. A **green** dot indicates that the San Dieguito Wetlands Restoration was similar to the reference wetlands for that standard in that year; a **red** dot indicates that it was not similar to the reference wetlands.

Figure 6.2.1 summarizes the annual assessment of the relative standards from 2012 through 2018 for San Dieguito Wetlands. The restoration project has consistently performed the same or better than the reference wetlands for standards pertaining to water quality, bird species density and richness, and fish density and species richness in main channel habitat, algal cover, and *Spartina* canopy architecture. The project has consistently failed to meet standards for invertebrate density in main channel and tidal creek habitat, and vegetation cover.

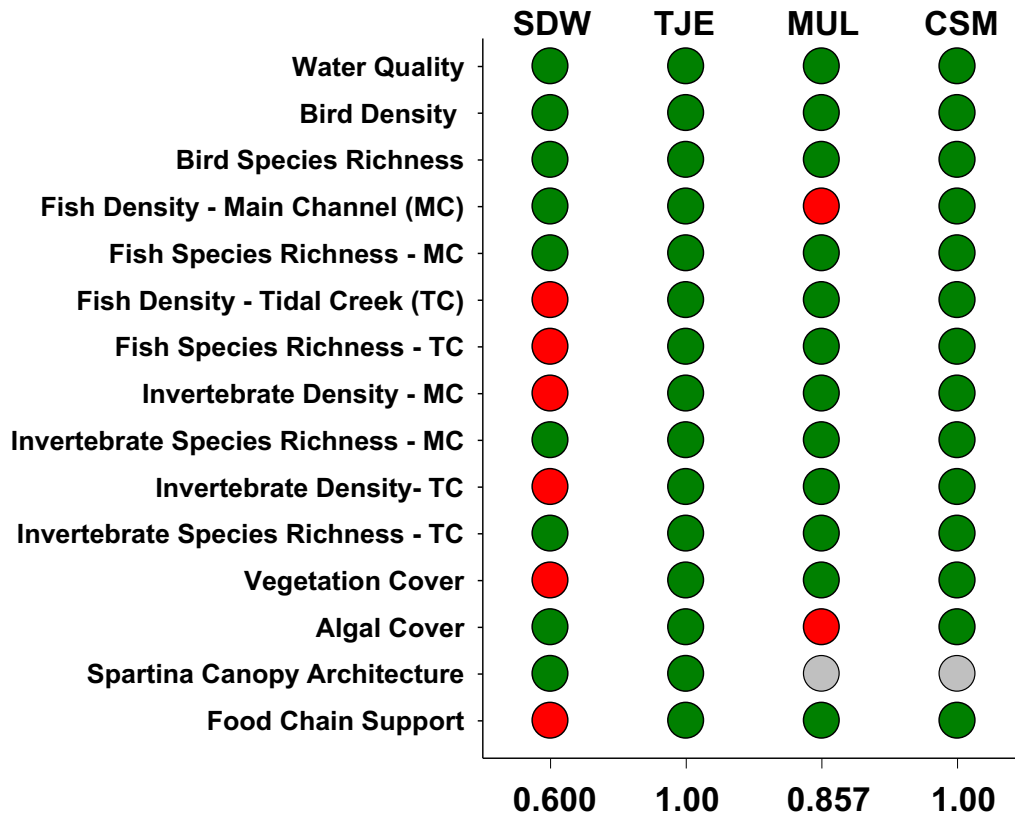


Figure 6.2.1. Summary evaluation of the Relative Standards for 2018. A [green](#) dot indicates that the value for the indicated response variable at a particular wetland is similar to the other wetlands. A [red](#) dot indicates that the indicated response variable was statistically worse or lower than the other wetlands. *Spartina* canopy architecture was only measured at San Dieguito Wetlands and the Tijuana Estuary.

Comparing the 4-year running averages used to evaluate the relative standards between San Dieguito Wetlands and the reference wetlands, Carpinteria Salt Marsh and Tijuana Estuary were the best performing wetlands in 2018 with a higher proportion of standards met (1.000) in each wetland, than the other wetlands. San Dieguito Wetlands had a lower proportion of standards met (0.600) than Mugu Lagoon (0.857), the reference site with the next lowest proportion of standards met (Fig. 6.2.1). Therefore, San Dieguito Wetlands did not meet the relative standard requirement for 2018.

### 6.3 Project Compliance

In order to receive mitigation credit for a given year, the wetland restoration project must meet all of the absolute standards. To date, the San Dieguito Wetlands has met the absolute standards for tidal prism, topography, plant reproduction, and exotic species, but has yet to meet the habitat areas standard due to slow vegetation development (Fig. 6.3.1.).

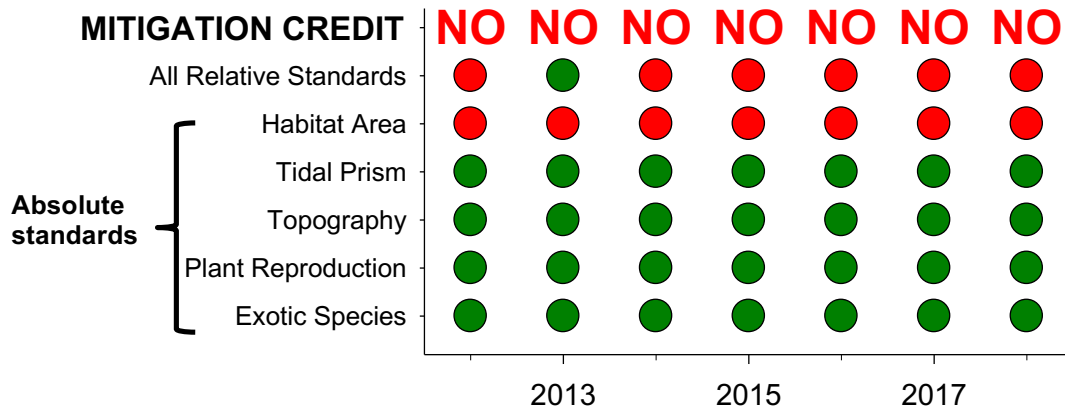


Figure 6.3.1. Status of compliance with the performance standards provided in the SONGS Permit. A green dot indicates that the value for the indicated response variable passes the standard. A red dot indicates that the indicated response variable did not pass the standard.

In order for the San Dieguito Wetlands to receive mitigation credit for a given year, it must also meet as many (as measured by the proportion of standards met) of the relative performance standards as the lowest performing reference wetland. The project has failed to meet the relative standard requirement in 6 out of 7 years (Fig. 6.3.1). While there are signs that the San Dieguito wetland is providing habitat and food chain support for wetland plants and animals, it has not yet satisfied the performance success criteria provided in the SONGS permit and has not yet received mitigation credit.

## **7.0 On-going Activities and Future Plans for 2019**

On-going activities and future plans moving forward include continued performance monitoring in 2019 as required by the SONGS permit, monitoring SCE's adaptive management program for vegetation, and further analysis of existing data, and the collection of additional data, if necessary, to assist in the determination of mechanisms underlying the under-performance of macro-invertebrate densities. Coastal Commission staff and SCE will be consulted regarding next steps to address the under-performance of vegetation cover and invertebrate densities to bring the project into compliance with the SONGS permit.

## 8.0 References

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