2016

Annual Report of the Status of Condition A: Wetland Mitigation

SAN ONOFRE NUCLEAR GENERATING STATION (SONGS) MITIGATION PROGRAM

Marine Science Institute

UCSB

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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 fifth year of post-construction monitoring done in 2016.

A review of the performance monitoring data from 2012 through 2016 has revealed some lessons learned pertaining to the successful establishment of vegetation in San Dieguito Wetlands. About 20,000 cordgrass plants were planted widely throughout the restoration site with the latest and largest planting in November 2011. For the first two years following planting, cordgrass performed poorly. However, cordgrass establishment has become more promising and cordgrass now encompasses nearly 5 acres for the restored site. Although there was initial concern that the plantings might not lead to cordgrass establishment, one lesson learned is that may take > 2-3 years for plantings to become successfully established.

While the development of cordgrass has been encouraging, vegetation in the mid and high marsh has under performed in some areas, most noticeably on the west side of the freeway in modules W2/3. Performance monitoring has revealed that elevation, slope of the constructed marsh plain, and time affect vegetation development. The cover of vegetation at elevations of < 3.5' of W2/W3 has increased steadily since the initiation of performance monitoring in 2012. However, vegetation was much slower to develop during the first two years of monitoring at elevations initially graded higher than ~3.5' and with little change in elevation over distances exceeding 100m perpendicular to the river channel. Tidal waters in this area remained on the surface where evaporation contributed to high soil salinities that were probably detrimental to plant establishment. In March 2014, much of the higher elevations in this module were re-graded lower to increase the frequency of tidal inundation, and re-contoured to improve drainage. Some pickleweed seedlings were present in 2015, but cover generally remained sparse in 2016. However, vegetation was filling in as of April 2017. A lesson learned pertaining to vegetation development is that it may take > 3 years for the vegetation to start filling in following re-grading.

The restored wetland is continuing to support salt marsh vegetation, birds, fish, invertebrates, and eelgrass (*Zostera marina*). During monitoring surveys in 2016, 88 species of birds were recorded. The five most abundant species were American Wigeon, Western Sandpiper, California Gull, Dowitchers, and Least Sandpiper. During monitoring surveys in 2016, 25 species of fish were recorded. The fish fauna was dominated by gobies, including juvenile gobies, adult Arrow and Shadow Gobies, and Longjaw Mudsuckers. A promising development is that the Yellowfin Goby, a non-native species among the top 5 most abundant species in 2013, has not been abundant in the 2014-2016 monitoring surveys. Fifty-eight taxa of macro-invertebrates were recorded. Three of the five most abundant taxa were small worms that included Capitellidae, the spionid *Streblospio benedicti*, and Oligochaetes.

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 in 2016. These included standards pertaining to Topography, Tidal Prism, Plant Reproductive Success, and Exotic Species. The absolute standard not yet met pertains to Habitat Areas, primarily due to the underperformance of vegetation cover. The restored wetland met 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 2016, 86.7% of the relative standards were met in the San Dieguito Wetlands compared with 73.3% of standards met by Tijuana Estuary, the lowest performing reference wetland. The two relative standards that were not similar in San Dieguito Wetlands compared with the reference wetlands pertained to vegetation cover and macro-invertebrate density in tidal creek habitat. The poor plant development in modules W2/3 and portions of modules W4/W16 was largely responsible for the less encouraging results for vegetation cover in the restored site in 2016. The reason for the slow development of macro-invertebrates in tidal creek habitat is unknown at present, but may be related to differences in soil properties (e.g., organic matter content, grain size) between the restored wetland and reference wetlands or a requirement for more time for the invertebrates to become established.

The SONGS permit also has a special requirement for the Biological Communities standards that pertain to birds, fish, and macro-invertebrates. These standards are evaluated as a subset of the relative performance standards and require that the San Dieguito Wetlands perform at least as well for these standards as the lowest performing reference wetland within four years. San Dieguito Wetlands met this requirement in 2016 with a higher proportion of these standards met (90%) compared to Tijuana Estuary (60%), the lowest performing reference wetland.

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 lowest performing reference wetland. So far, the San Dieguito Wetlands has yet to meet the absolute standard for Habitat Areas but has met the relative standard requirement in 4 out of 5 years. Thus, although the wetland is providing habitat and food chain support for wetland plants and animals, it has not yet satisfied the performance success criteria in the SONGS permit and has not yet received mitigation credit.

On-going activities and future plans moving forward include continued performance monitoring in 2017 as required by the SONGS permit and further analysis of existing data to assist in the determination of factors underlying the underperformance of vegetation cover and macro-invertebrate densities.

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 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 2016 (the fifth 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 1983 and 1984, 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 are fully operational is about 2.4 billion gallons.

The water taken in is 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 kills fish eggs, larvae and small immature fish taken into the plant. The mortality of these young stages of fish is responsible for the substantial impact of adult nearshore fish in the Southern California Bight. To cool the discharge water, the diffusers draw in ambient seawater at a rate about ten times the discharge flow and mix it with the discharge water. The surrounding water is swept up along with sediments and organisms and transported offshore at various distances. Mixing caused by the diffuser system results 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 are responsible for the substantial impact on the kelp forest habitat down coast of the diffusers.

Neither Units 2 and 3 of SONGS are 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 very small 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 on over 3,000 tubes, in 15,000 places, in the replacement steam generators that were installed in 2010 and 2011. A decision to shutdown 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 the reactors or place fuel in the reactors. Since the shutdown, the flow in each unit has been reduced to about 42 to 49 million gallons per day or roughly 3 to 4% of the normal operating flow (D. Kay, SCE, pers. com.).

SONGS Impacts: A condition of the SONGS 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 to 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 seabass 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. The contract program staff is also assisted on occasion by independent consultants and contractors when expertise for specific tasks as 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 far from the impacts (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 that are 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 Timeline

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

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

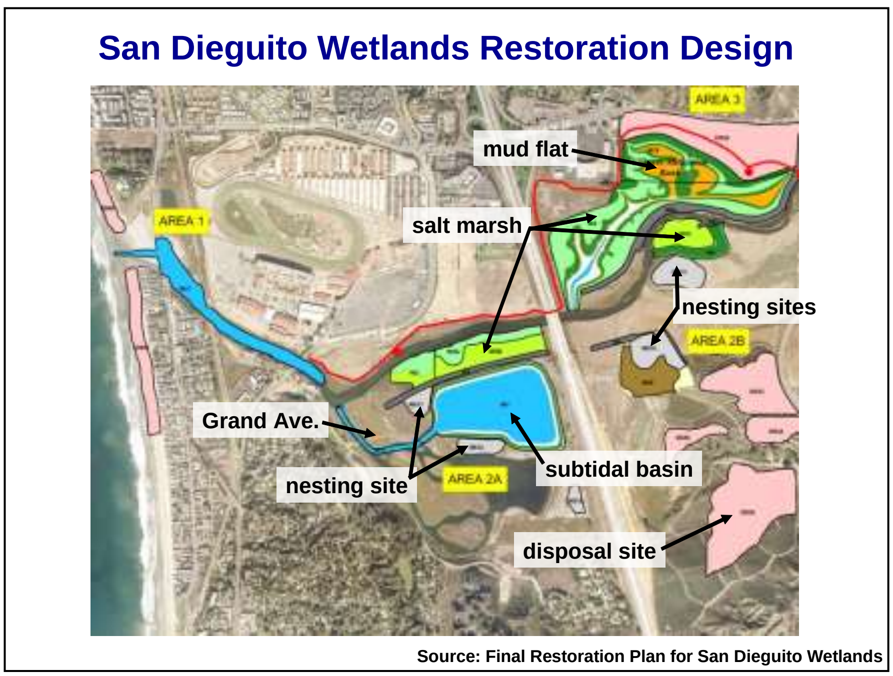


Figure 3.1.1. The design plan view of the restoration project that was approved by the CCC. The project included the creation of tidal salt marsh, indicated by shades of green, mudflat, indicated by the light brown, and subtidal basin, indicated by blue. In addition, four nesting sites, shown in gray, 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.

Modules W2/3 (Fig. 3.1.2) in Area 2A were completed in February 2008 with tidal creek extensions added in November 2010 to the originally constructed linear channels. 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 January/February 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.

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.

Timeline

Start date	**September 2006**
Project Task	**Completion Date**
Construction:	
All modules	November 2010
Additional wetland (Grand Ave)	February 2011
Re-grading of W2/W3	March 2014
Planting:	November 2008, 2009, 2011, 2016
Inlet dredging:	September 2011
	November 2015

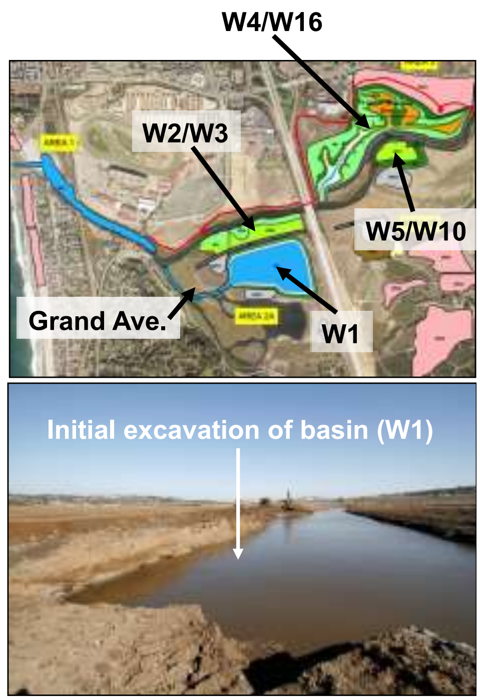


Figure 3.1.2. Timeline for the San Dieguito Wetlands Restoration Project.

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

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 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. Independent monitoring is conducted by scientists from UCSB with advice from the Science Advisory Panel.

3.2 Salt marsh vegetation: status, lessons learned, and adaptive management
A high cover of salt marsh vegetation is characteristic of relatively undisturbed, natural tidal wetlands in the region. Vegetation provides habitat for invertebrates as well as nesting and foraging habitat for birds, including the state listed endangered Belding's Savannah Sparrow and the federally endangered Ridgeway's (formerly the Light Footed Clapper) Rail. The San Dieguito Wetlands Restoration entailed the grading of 92 acres to tidal elevations expected to support high, mid, and low marsh vegetation. Pickleweed (*Salicornia virginica*) and other species are expected to become established in the mid and high marsh. Cordgrass (*Spartina foliosa*) is expected to become established the in low marsh. Vegetation development is critically important to the ability of the San Dieguito Wetlands Restoration Project to meet the requirements for successful mitigation. This section reviews some lessons learned from the performance monitoring and opportunities for adaptive management as it pertains to vegetation development in the restoration project.

About 20,000 cordgrass plants were planted widely throughout the restoration site with the latest and largest planting in November 2011 (Fig. 3.2.1). For the first couple of years following planting, cordgrass performed poorly (Fig. 3.2.2a). The total area of cordgrass in 2013 was less than 0.5 acre.

Figure 3.2.1. Planting locations, indicated by the yellow crosses in the portion of the wetland on the east side of freeway where most of the planting occurred.

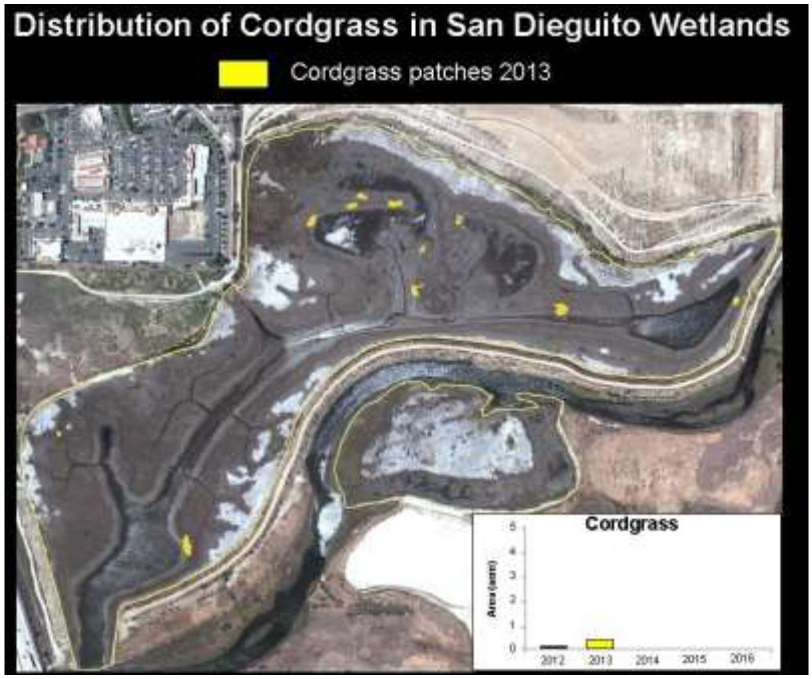


Figure 3.2.2a. The distribution and size of cordgrass patches established in the portion of the restoration site on the east side of the freeway in 2013.

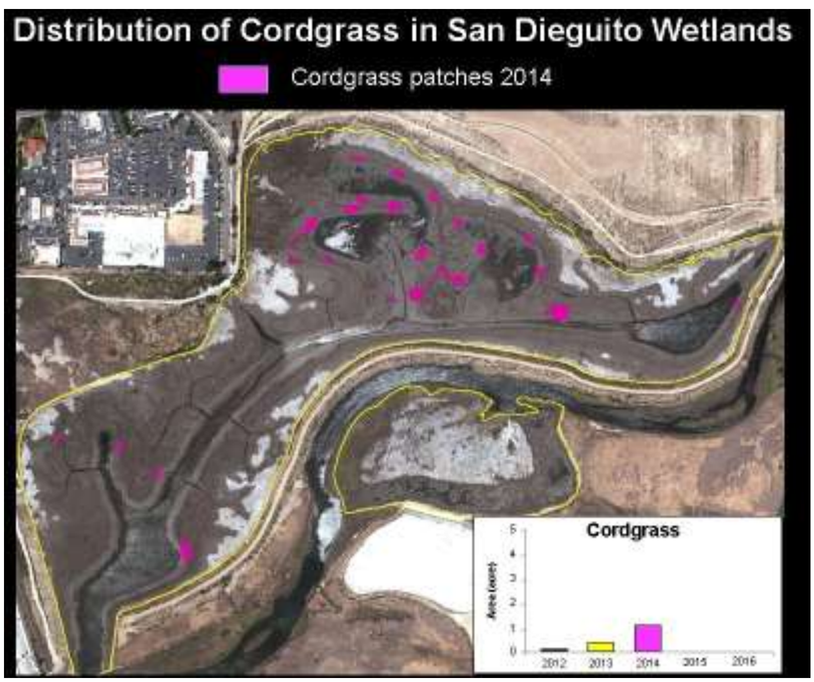


Figure 3.2.2b. The distribution and size of cordgrass patches, comprising approximately 1.2 acres, on the east side of the I-5 freeway in 2014.

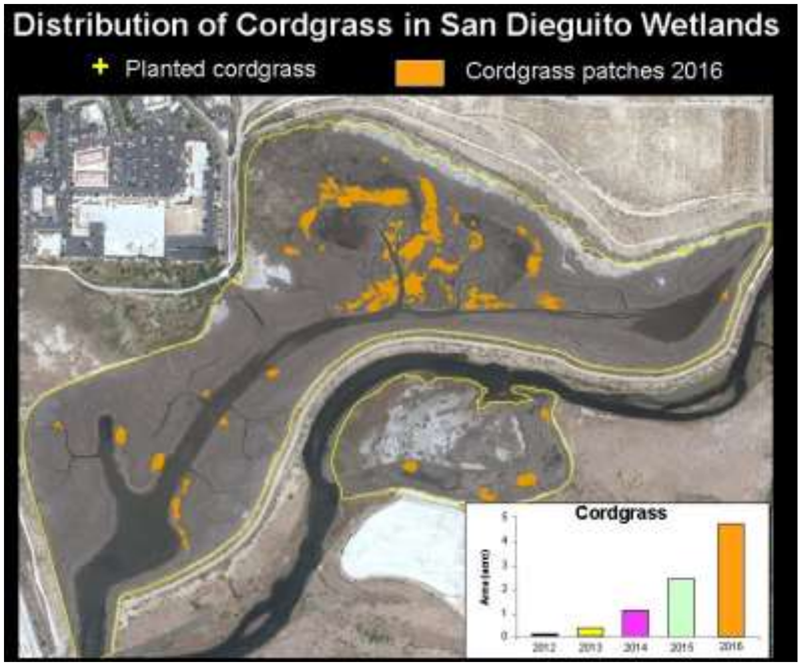


Figure 3.2.2c. The distribution and size of cordgrass patches on the east side of the I-5 freeway in 2016. Cordgrass covered nearly 5 acres.

However, cordgrass establishment has become more promising in recent years (Figs. 3.2.2b,c). The distribution and size of cordgrass patches expanded from 2013 through 2016 and now encompasses nearly 5 acres for the restored site.

Figure 3.2.2d. The location of current patches relative to the original planting sites and to some locations not originally planted (circled in red).

Cordgrass has spread away from the original planting sites, and also has recruited to a few sites that were not planted (Fig. 3.2.2d). This is worth noting because the natural recruitment of cordgrass by seed is generally thought to be rare. Although CCC contract scientists were initially concerned that the plantings might not be successful, and plants were grazed on heavily by rabbits and insects, one lesson learned is that it may take > 3 years for plantings to become successfully established.

While the development of vegetation has been promising in some areas, it has under performed in other portions of the restoration site, most noticeably on the west side of the freeway in modules W2/3 that were graded to a high elevation and relatively flat. Construction grading of module W2/3 on the west side of the freeway was completed in 2008 – 2010. Performance monitoring began in 2012. The cover of vegetation at elevations of lower than 3.5' has increased steadily over time (Fig 3.2.3). However, vegetation was much slower to develop in the first two years of monitoring at elevations initially graded higher than 3.5' and that were relatively flat. This area of sparse vegetation was very evident in 2013 (Fig 3.2.3). SCE was aware of the problem and much of the higher elevations in this module were re-graded to lower elevations to increase the frequency of tidal inundation, and were re-contoured to improve drainage in March 2014. Some seedlings were present in 2015, and some vegetation was present in the re-graded areas in 2016, but cover generally remained sparse. However, vegetation is coming in as evidenced in the photo taken in April 2017. A lesson learned here is that even after re-grading to lower elevations it may take some time (it will have been > 3 years after re-grading) for the vegetation to start filling in. Other portions of the restoration site (e.g., modules W4/W16) also have areas that are sparsely vegetated. Some of these areas are also high and flat, similar to W2/W3 before re-grading, which likely contributes to their poor vegetation performance.

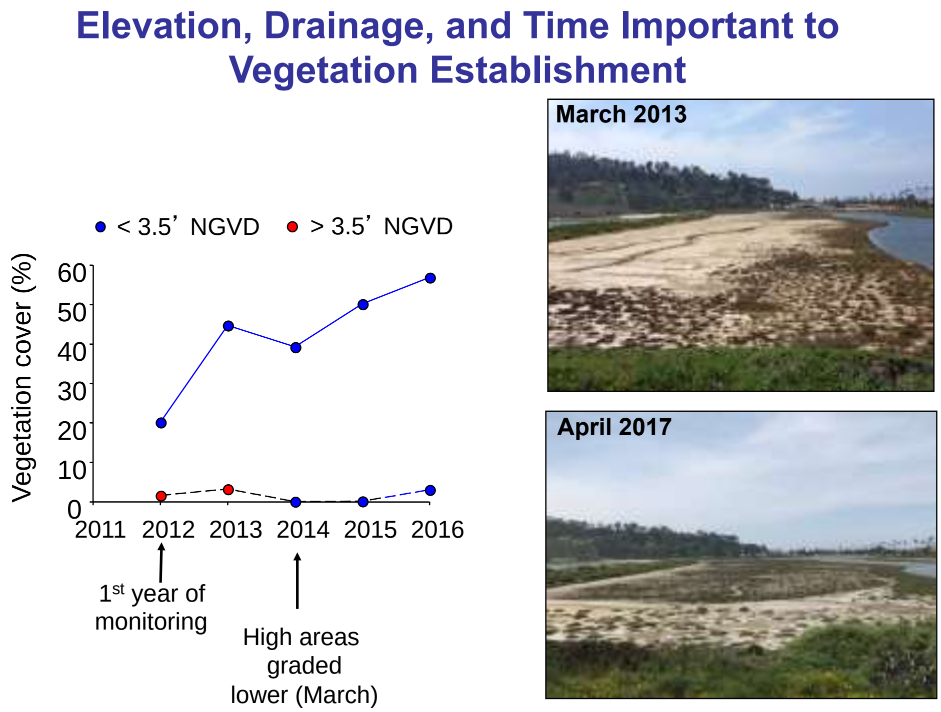


Figure 3.2.3. Panel on the upper right shows much greater vegetation cover at lower tidal elevations near the river channel in module W2/3 in March 2013 compared with areas graded higher. Panel on the lower right shows this area in April 2017. Re-grading in March 2014 lowered the elevation of the marsh plain to generally < 3.5' NGVD and re-contoured the surface to improve drainage. Vegetation development remains poor in areas not re-graded (foreground).

In addition to the importance of elevation, drainage, and time to vegetation establishment, smaller scale heterogeneity has influenced vegetation development. Furrows created during construction are more vegetated than adjacent higher areas (Fig. 3.2.4). It is possible that the furrows retain moisture or trap seeds, and topographic heterogeneity is something to consider during construction or re-grading.

Finally, plant species other than pickleweed will recruit to higher elevations in the restored site as evidenced in a photo (Fig. 3.2.5) taken next to the berm in a module (W4) on the east side of the freeway. A mix of species occurs at this location, including the native sea lavender, *Limonium californicum*, considered regionally rare. A non-native tamarisk plant also recruited into this area. The soil was moist, perhaps due to local ground or surface water inputs, which probably facilitated plant establishment.

SCE is engaged in adaptive management to improve the establishment of vegetation through a planting program targeting areas of low vegetation cover (Fig. 3.2.6).

Habitat Heterogeneity and Vegetation Establishment

Figure 3.2.4. Vegetation cover was highest in furrows created during construction at lower elevations.

Recruitment of Species Other Than *Salicornia*

Figure 3.2.5. Photo of native marsh plants, and the non-native Tamarisk, which have become established in a section graded to be high marsh in module W4 next to the berm.

On-going Adaptive Management - Vegetation

Figure 3.2.6. Adaptive management to improve the establishment of vegetation is on-going through a planting program targeting high areas of low vegetation cover.

Summary

- Planted *Spartina* may take years following planting to increase appreciably in abundance.
- *Spartina* will spread through natural recruitment to areas not planted.
- Elevations above approximately 3.5' NGVD with poor drainage were slow to develop vegetation via natural recruitment.
- Grading to elevations < 3.5' NGVD with sloping topography will increase colonization by native pickleweed.
- Planting and watering may be required at higher elevations to achieve vegetation establishment and increase diversity.

3.3 Status of birds, fish, macro-invertebrates and eelgrass

During monitoring surveys in 2016, 88 species of birds were recorded compared with 93 species the previous year. Three of the top five most abundant species in 2015 were also among the top five most abundant species in 2016 and included a shorebird, the Least Sandpiper, a duck, the American Widgeon, and the California Gull (Fig. 3.3.1). During monitoring surveys in 2016, 25 taxa of fish were recorded, compared with 19 taxa recorded in 2015. The five most abundant groups in both years included juvenile gobies (too small to identify to genus), Arrow Goby, Shadow Goby, and Longjaw Mudsucker, and the California Killifish (Fig. 3.3.2). A promising development is that Yellowfin Goby, a non-native species among the top 5 most abundant species in 2013, was not abundant in 2015 or 2016.

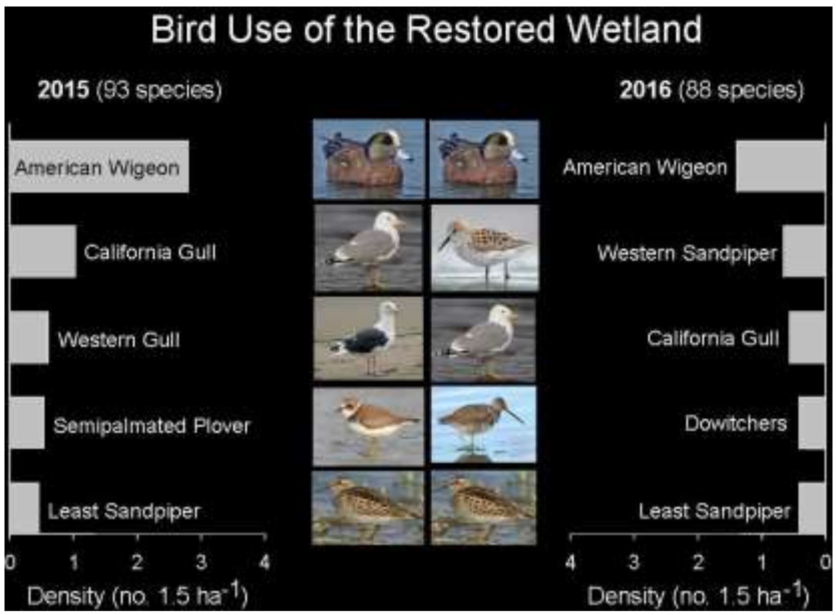


Figure 3.3.1. The top five most abundant bird species using the restored wetland in 2016 and 2016.

During surveys in 2016, 58 taxa of macro-invertebrates were recorded compared with 69 taxa the previous year. Three of the five most abundant taxa were small worms in both years (Fig. 3.3.3). These small invertebrates are important food for larger invertebrates such as crabs, and for fish and birds. Eelgrass, which provides habitat for invertebrates and fish, recruited to the inlet channel and the entrance to the W1 basin prior to the post-construction inlet opening in September 2011. Eelgrass impacted by final inlet channel construction was transplanted to W1 in January 2011. There has been considerable recruitment and expansion of eelgrass in W1, and it now covers most (> 90%) of the bottom of the basin (W1) and extends east of the I-5 freeway and into subtidal areas in the W4 module.

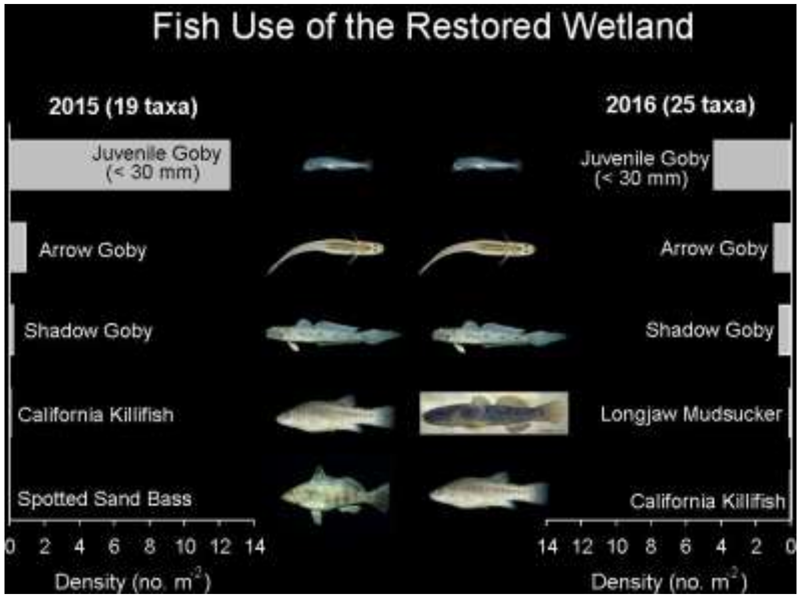


Figure 3.3.2. The top five most abundant fish using the restored wetland in 2015 and 2016.

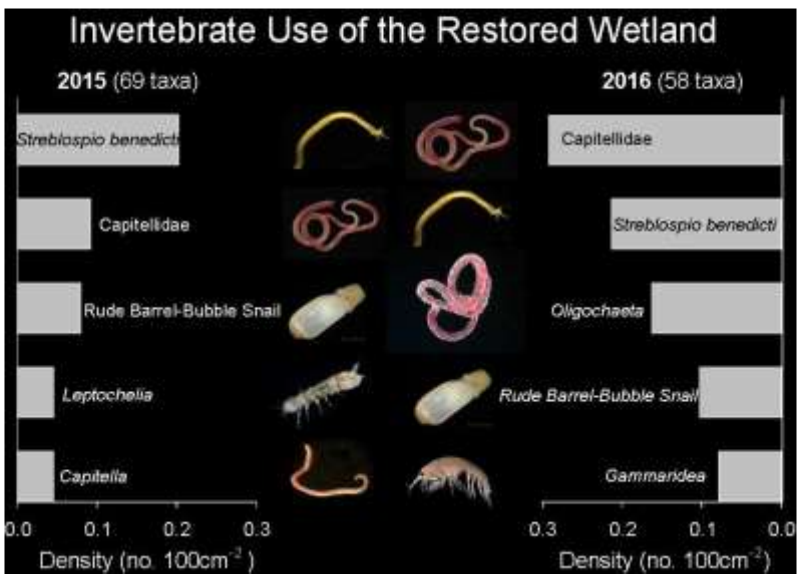


Figure 3.3.3. The top five most abundant macro-invertebrate taxa using the restored wetland in 2015 and 2016.

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). A maintenance dredging of the inlet channel was conducted in November 2015 to remove built-up sand that could impede tidal flushing and reduce the tidal prism. The expansion of cordgrass in the restored wetland is indicative 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 (Fig. 3.4.1). A Tamarisk plant was recently removed from tidally influenced habitat by CCC contract scientists. Continued vigilance is necessary to ensure that non-native species do not invade tidally influenced habitat. SCE currently has an active weed abatement program to control weeds on the berms and disposal sites.

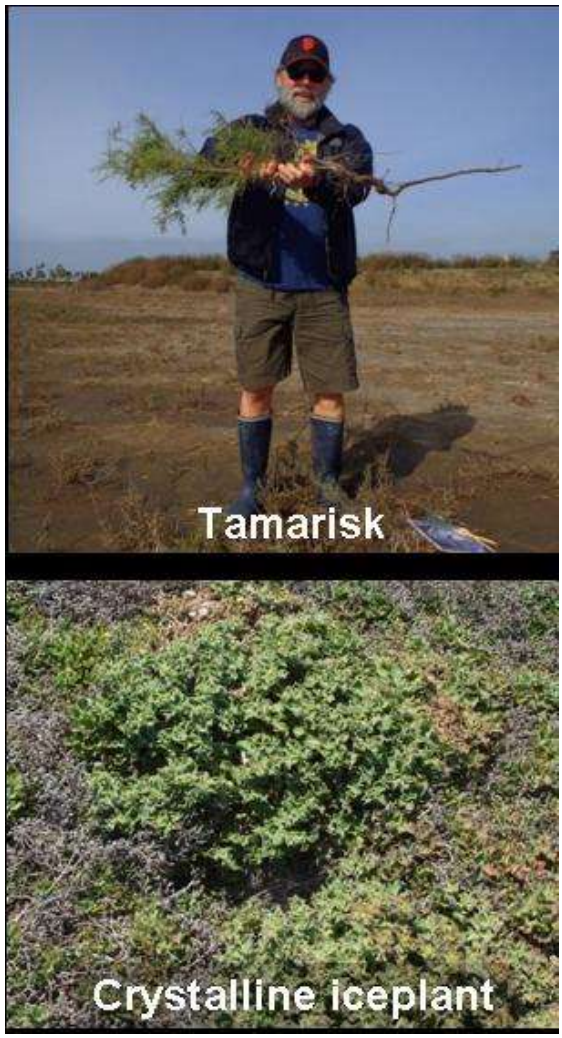


Figure 3.4.1. Tamarisk is a non-native plant that can invade salt marsh habitat. Crystalline iceplant is tolerant of salty soils and abundant in some areas on berms surrounding the restored wetland.

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, January 2016, February 2017, and July 2017 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 (erosion, sedimentation), water quality (e.g., oxygen concentration), tidal prism (which affects tidal flushing), and habitat areas, and 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 (e.g., for Habitat Areas, Tidal Prism) or 2) using best professional judgment (Topography). All absolute standards must be met in a given 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. For monitoring data collected in years one through three (i.e. 2012-2014) the running average was computed using the available years.

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 nearby reference wetlands will 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, are 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 at 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 percent cover of Salt Marsh 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 about a mean value. The performance for a particular relative performance variable at San Dieguito Wetlands is considered to be worse than the lowest 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 ≤ 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 rational for determining similarity are provided in the Monitoring Plan for the SONGS Wetland Mitigation Project.

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, it should be judged successful. The scaling of the p-value (α) 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 (e.g. Tijuana Estuary) 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 the public and SCE.

5.0 Progress Report on 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 fifth 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_%20updated_january2016.pdf).

5.1 Absolute Performance Standards

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 evaluated 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 in July 2012 following completion of construction and is 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 provides 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 Habitat Areas below), the tidal prism can not 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. 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 that is towed back and forth across the width of the channel 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 high tides using a portable Acoustic Doppler Current Profiler (ADCP) system (SonTek River Surveyor, Fig. 5.1.1). The performance standard is met if the regression line fit through the prism measurements taken during a given monitoring year falls within 12% of the as-built prism values measured in July of 2012.

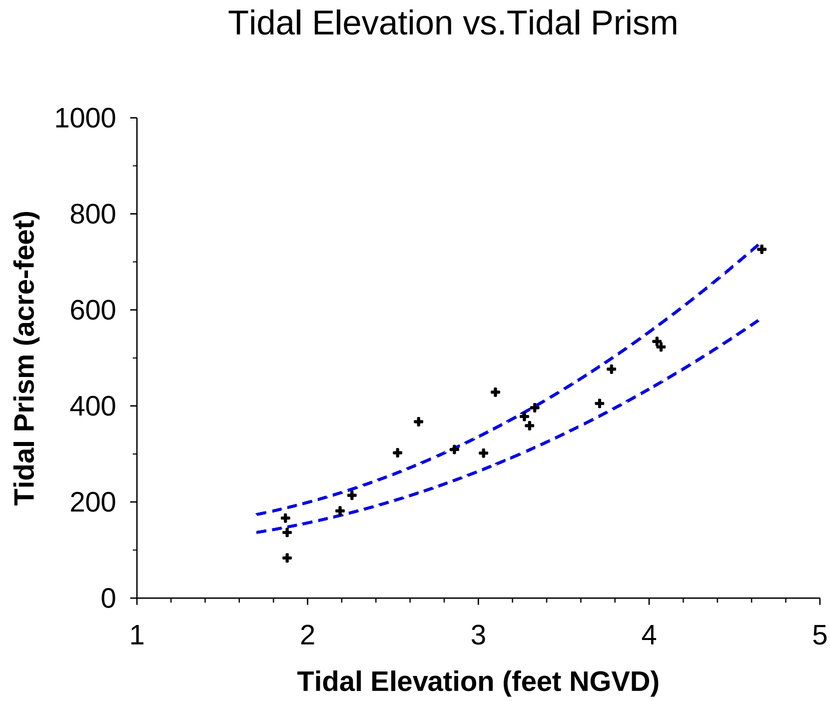


Figure 5.1.2. The regression fit to the tidal prism measurements taken January-December 2016 must fall within the dashed blue lines, which represent 88% and 112% of the as-built prism, for the tidal prism to be maintained.

Results: The regression fit to the tidal prism measurements for 2016 falls between the dotted blue lines, indicating that the tidal prism at the San Dieguito Wetlands was maintained in 2016 (Fig. 5.1.2). Therefore, this performance standard is met for 2016.

Habitat areas
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. 5.1.3). 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. 5.1.4). The upper elevation limit for mudflat was based on the observation of surface salt deposits above this level in some areas indicating infrequent tidal inundation. The lower elevation was determined using continuously recording data loggers that measure water level height in a restored portion of the wetland. 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, with at least 30% cover of salt marsh plants in a minimum plot size of 10 x 10 m^2 (Fig. 5.1.5). 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^2 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.

Planned acres*:

Salt marsh: green 92.6 acres
Mudflat: brown 24.9 acres
Subtidal: blue 32.0 acres
***Final Restoration Plan (SCE 2005)**

Figure 5.1.3. 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.

Assessed as Mudflat Habitat if:

- **Intertidal and ≤3.5' NGVD**
- **<5% cover of vegetation (mudflats are defined as intertidal and unvegetated)**

Assessed as Subtidal Habitat if:

- **Continuously submerged**

Figure 5.1.4. Criteria used to classify areas of the restoration project as mudflat and subtidal habitat.

Habitat assessed as Salt Marsh if:

- **Intertidal and <4.5' NGVD**
- **≥30% cover of vegetation evaluated using aerial imagery**

Vegetation cover evaluated under the Relative Standards

Salt Marsh Habitat in San Dieguito Wetlands

Insufficient cover of vegetation for Salt Marsh

Figure 5.1.5. Criteria used to classify portions of the restoration project as salt marsh habitat, and examples of an area assessed as salt marsh habitat and an area where cover of vegetation was insufficient to be assessed as salt marsh.

Results: The areas of mudflat, and salt marsh habitat measured in the 2016 surveys were not within ±10% of the planned acreages (Fig. 5.1.6). There was a deficit of approximately

40 acres in salt marsh habitat compared with the planned acreage and approximately 29 acres were assessed as "other", not assessed as one of the planned habitats in the Final Restoration Plan. As a result the San Dieguito Wetlands did not meet the performance standard for Habitat Areas in 2016.

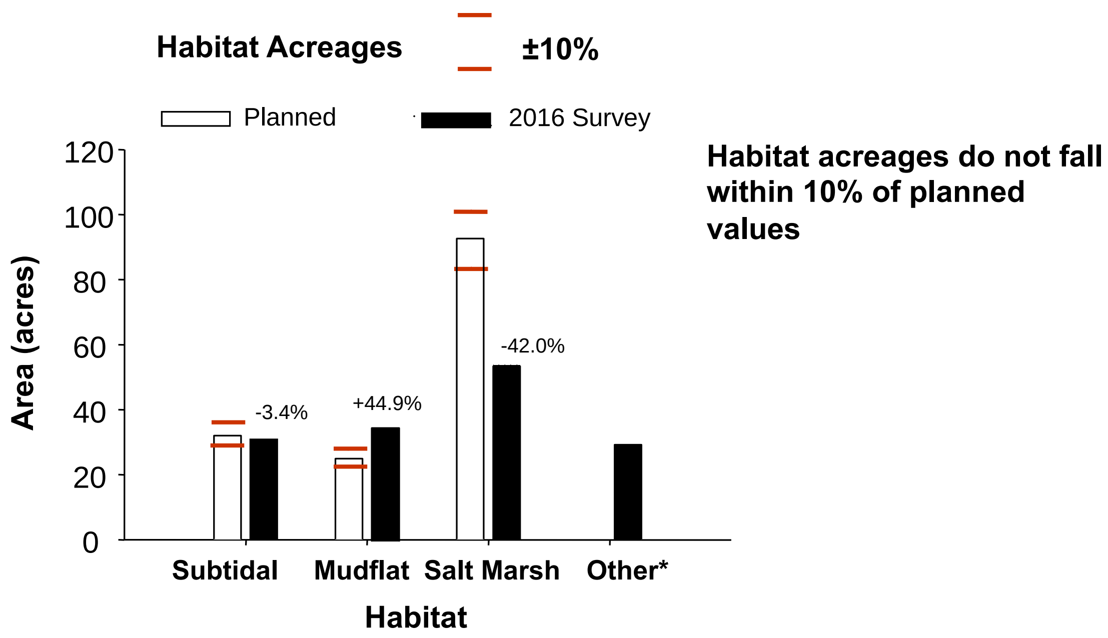
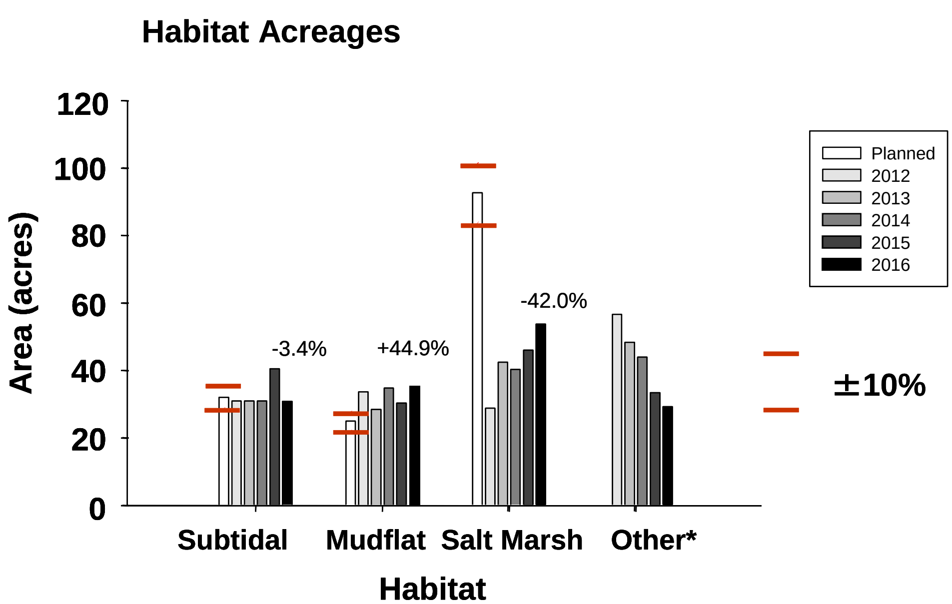


Figure 5.1.6. Comparison of the areas of subtidal, mudflat, and salt marsh habitat in the Final Restoration Plan to the 2016 survey. Areas assessed as "other" were not assessed as one of the planned habitats provided in the Final Restoration Plan.



*not a planned salt marsh habitat

Figure 5.1.7. Comparison of the areas of subtidal, mudflat, and salt marsh habitat in the Final Restoration Plan to the 2012 through 2016 surveys.

Although not yet meeting the standard for Habitat Areas, the monitoring results for 2016 are encouraging in that there has been an increase of approximately eight acres classified as salt marsh habitat from 2015 and a continuous decline in the acreage of “other”. 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 to improve tidal flows and water levels and area of subtidal habitat in 2016 returned to pre-El Niño levels seen in 2014.

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 is likely to occur. Constructed berms and associated structures (e.g. culverts and 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 2016 and therefore this performance standard is currently met.

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 and again in 2016, which is consistent with the permit requirements (Fig 5.1.8). Since all seven species produced seed within three years, the standard for Reproductive Success is met for 2016.

Plant	Seed Set 2012	2015	2016
Parish's Glasswort	✓	✓	✓
Saltgrass	✓	✓	✓
Alkali Heath	✓	✓	✓
Marsh Jaumea	✓	✓	✓
Spiny Rush	✓	✓	✓
California Sea Lavender	✓	✓	✓
Pickleweed	✓	✓	✓

Figure 5.1.8. Plant species evaluated for seed set.

Exotics

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.

Figure 5.1.9. Exotic species targeted during the special survey (left panel) and divers preparing to enter the basin (W1) to conduct the special survey (right panel).

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. 5.1.9).

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 2016. Notably, the Yellow Fin 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 three years.

5.2 Relative Performance Standards

Relative Performance Standards for the San Dieguito Wetlands Restoration Project

1. **Water Quality**
2. **Bird Density**
3. **Bird Species Richness**
4. **Fish Density – Main Channels**
5. **Fish Species Richness – Main Channels**
6. **Fish Density – Tidal Creeks**
7. **Fish Species Richness – Tidal Creeks**
8. **Macro-invertebrate Density – Main Channels**
9. **Macro-invertebrate Species Richness – Main Channels**
10. **Macro-invertebrate Density – Tidal Creeks**
11. **Macro-invertebrate Species Richness – Tidal Creeks**
12. **Vegetation Cover**
13. **Algae Cover**
14. ***Spartina* canopy architecture***
15. **Food chain support**

*** Evaluated relative to Tijuana Estuary only**

Water Quality

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 continuously recording environmental data loggers (e.g., YSI sonde 600 XLM). Dataloggers are deployed in the restored and reference wetlands to characterize the value of dissolved oxygen concentrations within the wetlands.

Dissolved oxygen concentration (DO) below 3 ppm 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.

Results: Figure 5.2.1 shows the mean number of hours of continuous hypoxia at the San Dieguito Wetlands compared with the three reference wetlands annually from 2012 through 2016 and the four-year running average, which is used to evaluate the standard. Again, this standard is evaluated by comparing values in San Dieguito 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 similar to the reference wetlands. Therefore, San Dieguito Wetlands currently meets the Water Quality standard.

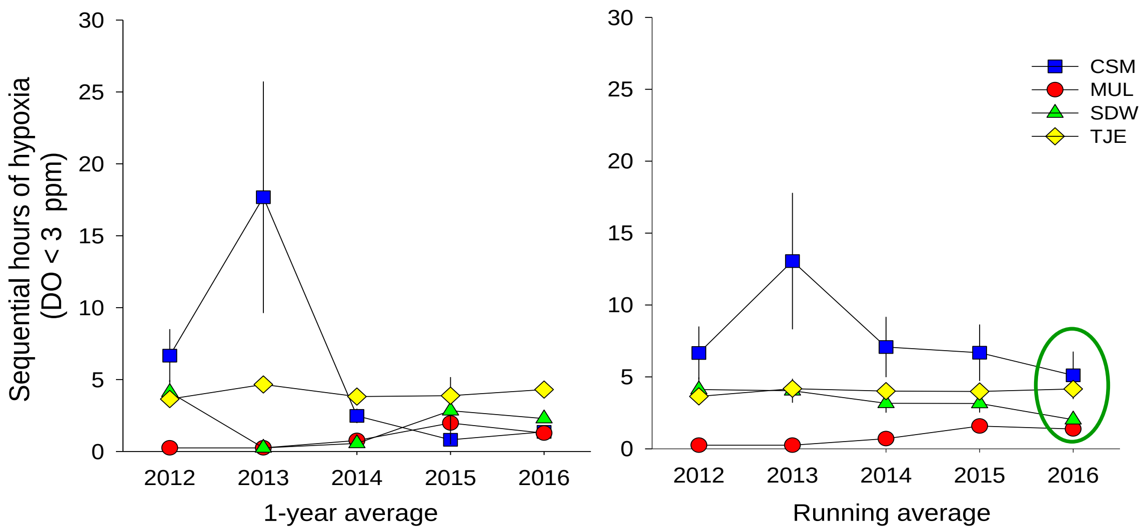


Figure 5.2.1. Mean length in hours of continuous hypoxia ([O_2] < 3 ppm) in the San Dieguito Wetlands compared with the three reference wetlands. Abbreviations used in this and subsequent figures: CSM=Carpinteria Salt Marsh, MUL=Mugu Lagoon, SDW=San Dieguito Wetlands, and TJE=Tijuana Estuary. Mean values ±1SE in this and subsequent figures.

General sampling design for fish and macro-invertebrates.

San Dieguito Wetlands and the three reference wetlands are sampled in the early fall in order to avoid the nesting season of the California Least Tern. Six tidal creeks and six sections of main channel/basin are sampled in each wetland (Fig. 5.2.2). 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 sampled creeks or sections of main channel/basin are treated as replicates in subsequent analysis. 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.

Figure 5.2.2. Location of tidal creeks and sections of main channel and basin sampled in San Dieguito Wetlands.

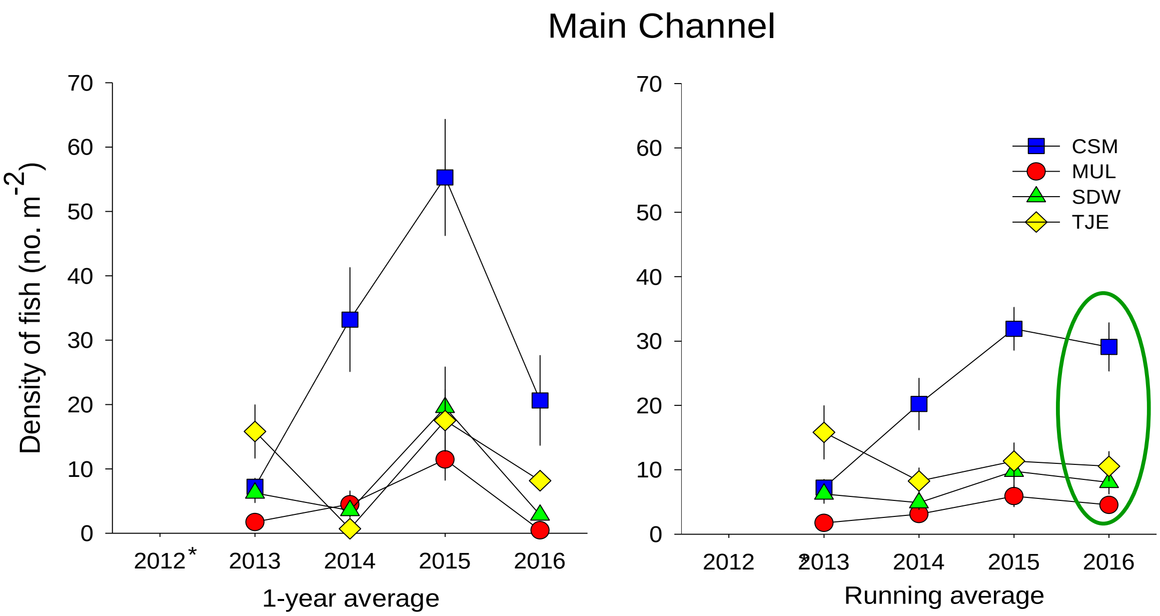
Fish

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.

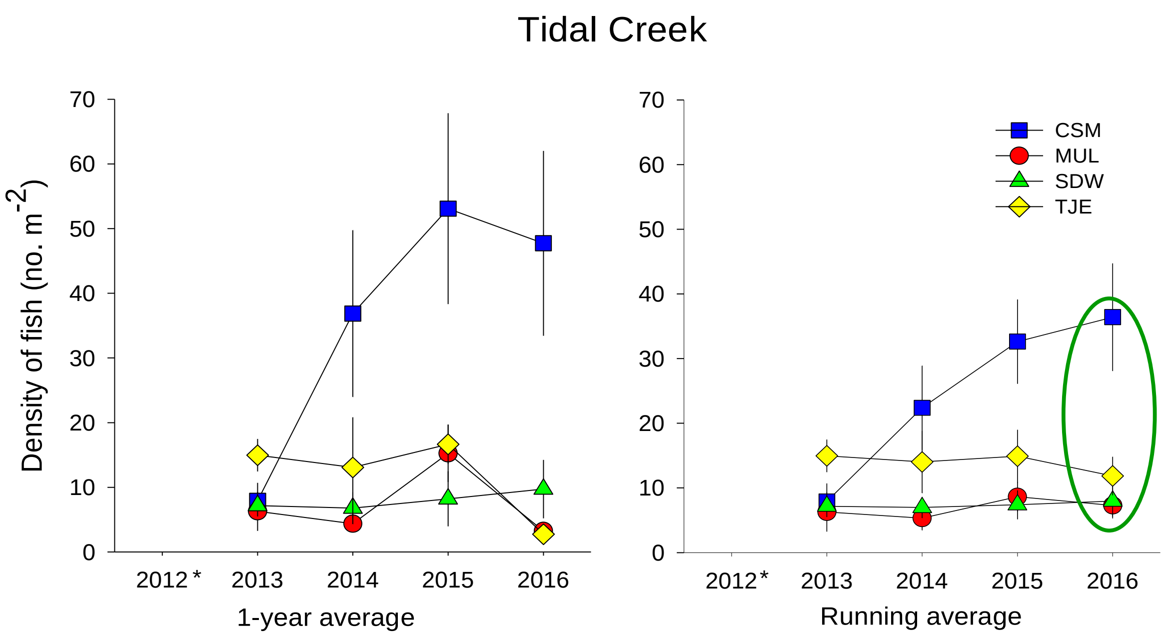
Approach: Data on the density and numbers of species of fish are collected using 0.43 m^2 circular enclosure traps and larger beach seines (generally 1000 m^2). Enclosure traps are used to sample gobies, which are small, numerically abundant fishes that are poorly sampled by other methods (Steele et 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 densities and species richness of fish for each creek or section of main channel/basin sampled are computed using the combined enclosure trap (i.e., gobies) and beach seine (excluding gobies) samples. Density and species richness values averaged across the six creeks or six sections of main channel/basin are used to compare wetlands. Ridgeway's 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:



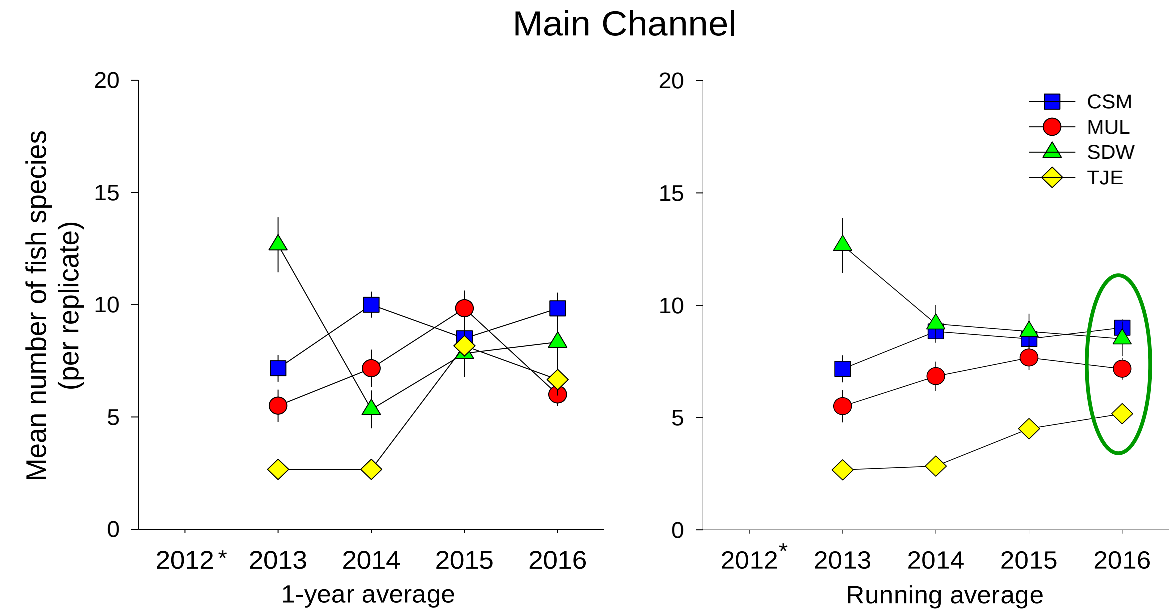
*2012 enclosure samples only



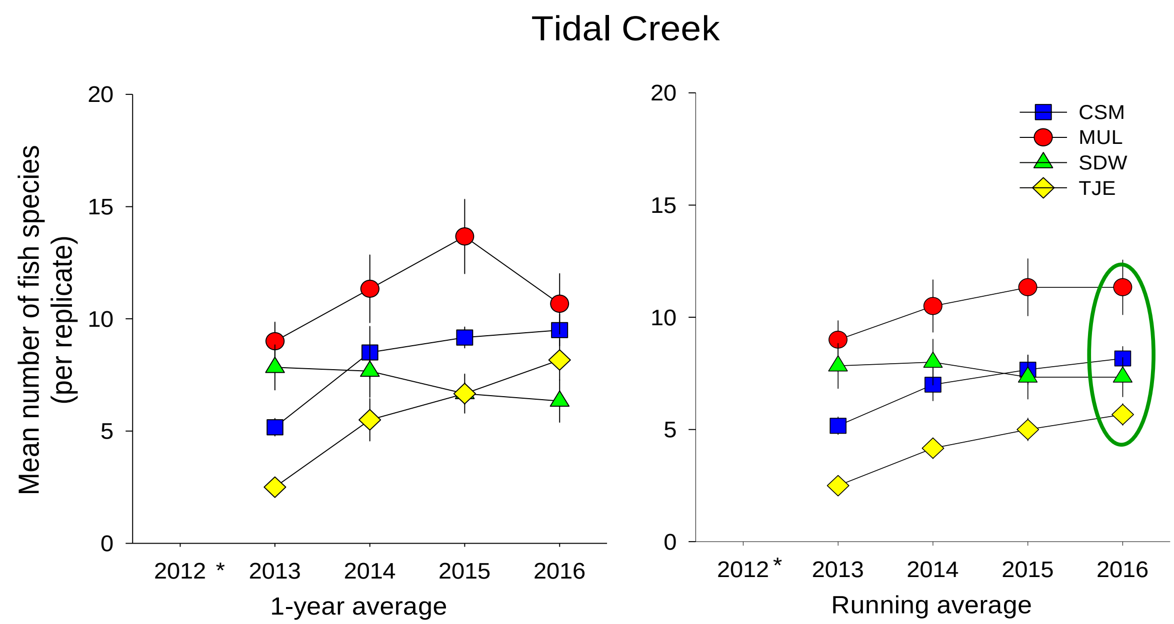
*2012 enclosure samples only

Figure 5.2.3. Comparison of fish annual density and the running average between San Dieguito Wetlands and Tijuana Estuary, Mugu Lagoon, and Carpinteria Salt Marsh in main channel and tidal creek habitats.

Annual data from 2013 through 2016 and the running average for fish density and fish species richness are presented in Figures 5.2.3 and 5.2.4. Fish density increased



*2012 enclosure samples only



*2012 enclosure samples only

Figure 5.2.4. Comparison of annual fish species richness and the running average between San Dieguito Wetlands and the reference wetlands for main channel and tidal creek habitats. Results are expressed per replicate (i.e., per section of main channel or tidal creek).

dramatically from 2013 to 2016 in Carpinteria Salt Marsh in both main channel and tidal creek habitats. This increase was due to the recruitment of large numbers of gobies into this wetland. For the four-year running average, fish density in both main channel and tidal creek habitats in San Dieguito Wetlands was not significantly lower than Mugu Lagoon, the lowest performing reference wetland. Therefore, the standards for fish density in main channels and tidal creeks are currently met.

For fish species richness (Fig. 5.2.4), the four-year running average in main channel and tidal creek habitats in San Dieguito Wetlands was not significantly lower than Tijuana Estuary, the lowest performing reference wetland. Therefore, the restored wetland currently meets the standards for fish species richness in main channels and tidal creeks.

Macroinvertebrates
WITHIN 4 YEARS OF CONSTRUCTION, THE TOTAL DENSITIES AND NUMBER OF SPECIES OF MACROINVERTEBRATES 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 (i.e., animals that live on the sediment surface such as the California Horn Snail, are sampled by counting individuals within 25 x 25 cm quadrats placed on the unvegetated banks of tidal creeks and sections of main channel/basin. Second, deep living larger infauna (i.e., animals that live 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 (e.g., most 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. Biota retained on the screen are identified and counted.

The density values of macro-invertebrates at each station used in the analysis consists of the combined data from the quadrat (i.e., epifauna), and small and large cores (small and large infauna) standardized for the area sampled. The number of different species (or lowest identified taxon) of invertebrates sampled using the various methods are also combined to provide an estimate of species richness for each station. Density and species richness values averaged across the 6 creeks or 6 sections of main channel/basin were used to compare wetlands.

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. While the four-year running average of density of macro-invertebrates in the main channels of San Dieguito Wetlands was similar to the lowest performing reference wetland, this value for tidal creeks was lower at San Dieguito Wetlands compared with the lowest performing reference wetland. Thus, the standard for invertebrate density is currently met for main channel, but not for tidal creek habitat (Fig. 5.2.5).

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. The four-year running average of species richness of macro-invertebrates in the main channels and tidal creeks of San Dieguito Wetlands, however, was similar to the lowest performing reference

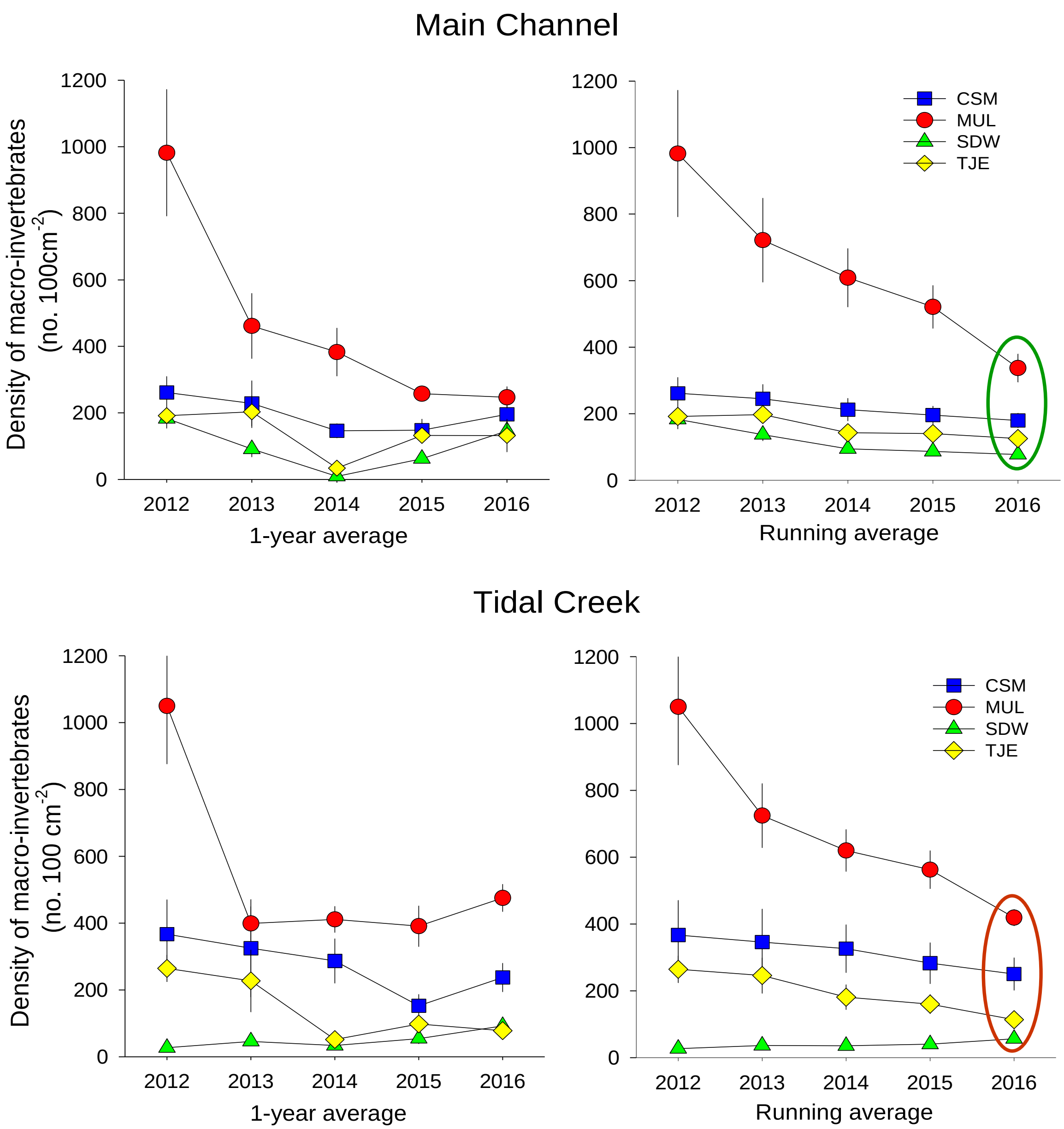
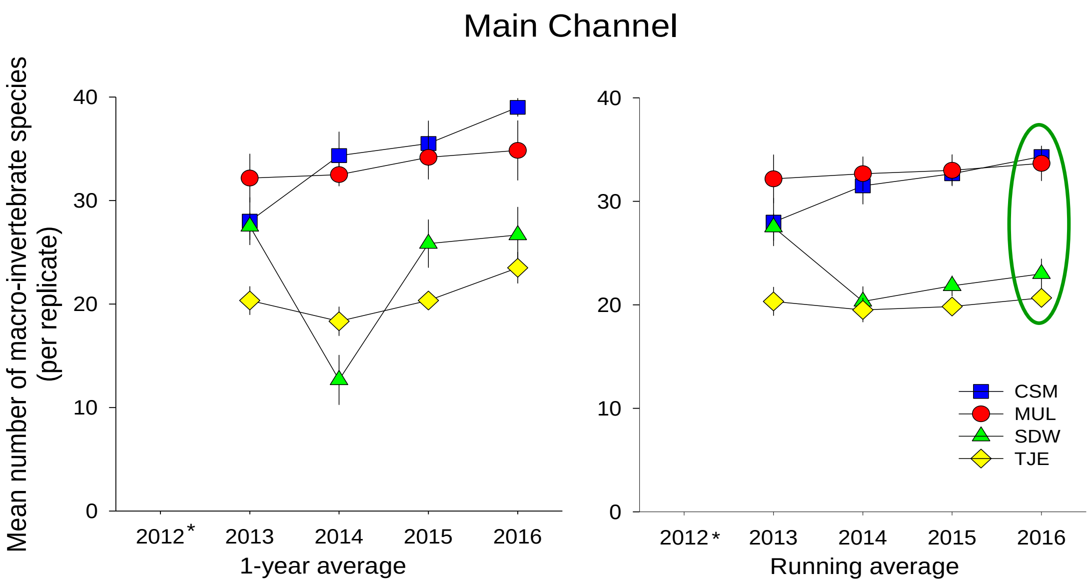
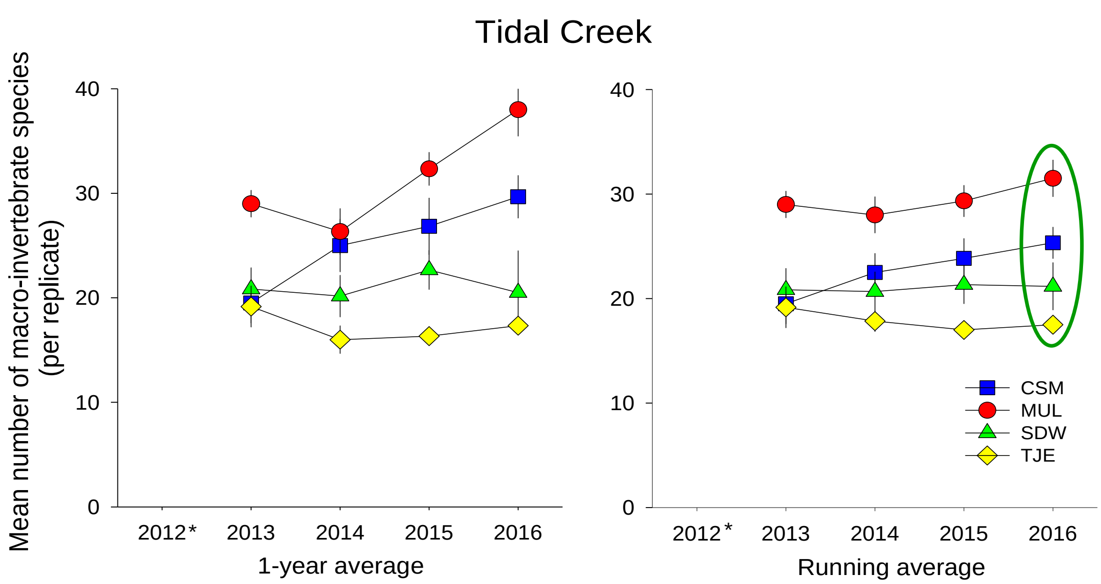


Figure 5.2.5. Comparison of macro-invertebrate density between San Dieguito Wetlands (SDW) and the reference wetlands for main channel and tidal creek habitats.



*enclosure traps only



*enclosure traps only

Figure 5.2.6. Comparison of macro-invertebrate species richness between San Dieguito Wetlands and the reference wetlands for main channel and tidal creek habitats. Results are expressed per replicate (i.e., per section of main channel or tidal creek).

wetland. Therefore, the performance standards for macro-invertebrate species richness in both main channel and tidal creek habitats of San Dieguito Wetlands are currently met (Fig. 5.2.6).

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. 5.2.7 shows distribution of plots in the San Dieguito Wetlands) 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. 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 5.2.7. 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 density and species richness 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 densities and number of species of birds sampled over time within each plot are averaged across the 18 survey dates. The mean densities and number of species of birds within each wetland used for comparing the restored and reference wetlands is computed using the 20 plot means as replicates for each wetland.

Results: Mugu Lagoon had the highest annual bird density from 2012 through 2016 and the highest four-year running average for bird density. However, the four-year running average of bird density in San Dieguito Wetlands was higher than in Carpinteria Salt Marsh, the wetland with the lowest value over this period (Fig. 5.2.8). Therefore, the standard for bird density in San Dieguito Wetlands is currently met.

Figure 5.2.9 compares bird species richness, and the running average, as mean number of species per acre, in San Dieguito Wetlands to the three reference wetlands. For the four-year running average, bird species richness in San Dieguito Wetlands was higher than that in the Carpinteria Salt Marsh, the wetland with the lowest value over this period. Therefore, the standard for bird species richness in San Dieguito Wetlands is currently met.

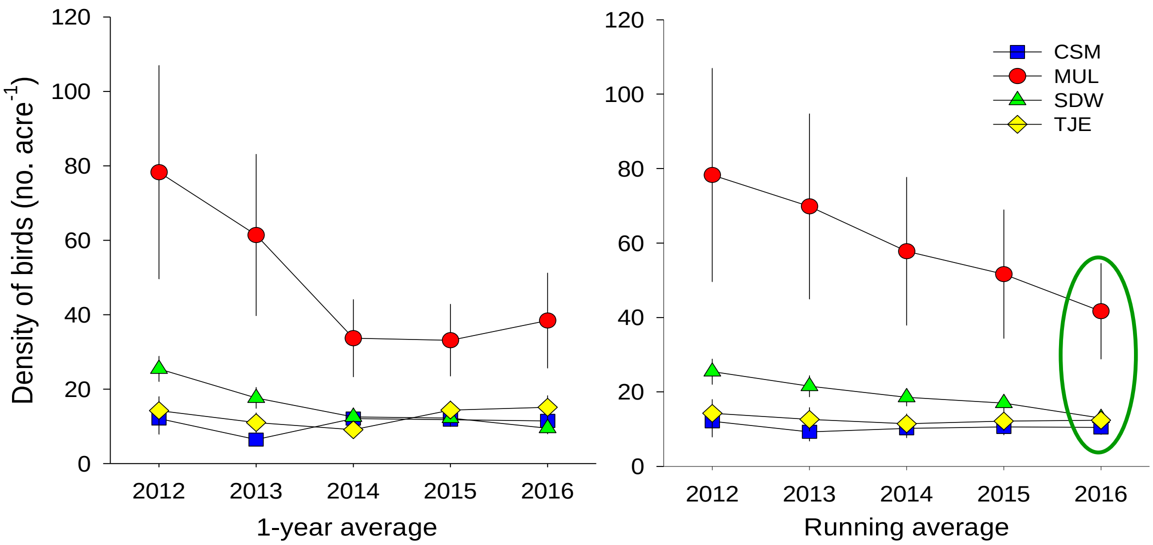


Figure 5.2.8. Comparison of bird total density between San Dieguito Wetlands and Tijuana Estuary, Mugu Lagoon, and Carpinteria Salt Marsh.

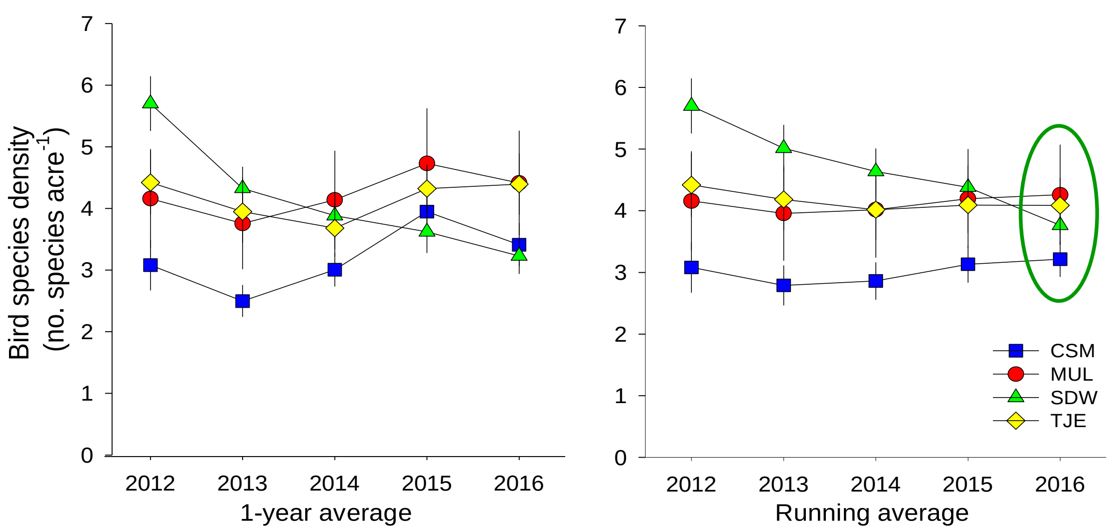


Figure 5.2.9. Comparison of bird species richness between San Dieguito Wetlands and the three reference wetlands.

Vegetation

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

Figure 5.2.10. View of San Dieguito Wetlands modules W5 & W10 in March 2016 showing cordgrass (in center) and mudflat below it.

Approach: Estimates of percent cover of salt marsh vegetation and algae in San Dieguito Wetlands and the reference wetlands are made using aerial imagery taken in the late spring or early summer. Cover estimates of salt marsh vegetation are compared among wetlands in salt marsh habitat as defined under Habitat Area standard.

Results: Although vegetation is colonizing San Dieguito Wetlands and annual mean cover has increased slowly over the past 5 years (Fig. 5.2.11), vegetative percent cover in salt marsh habitat (between 60-65) remained lower than in any of the reference wetlands, which has ranged from 85% to 95% in 2016. As a result, the four-year running average of cover of vegetation was lower in San Dieguito Wetlands compared with the lowest performing reference wetland and thus the restoration site is not yet similar to the reference wetlands and failed to meet this standard.

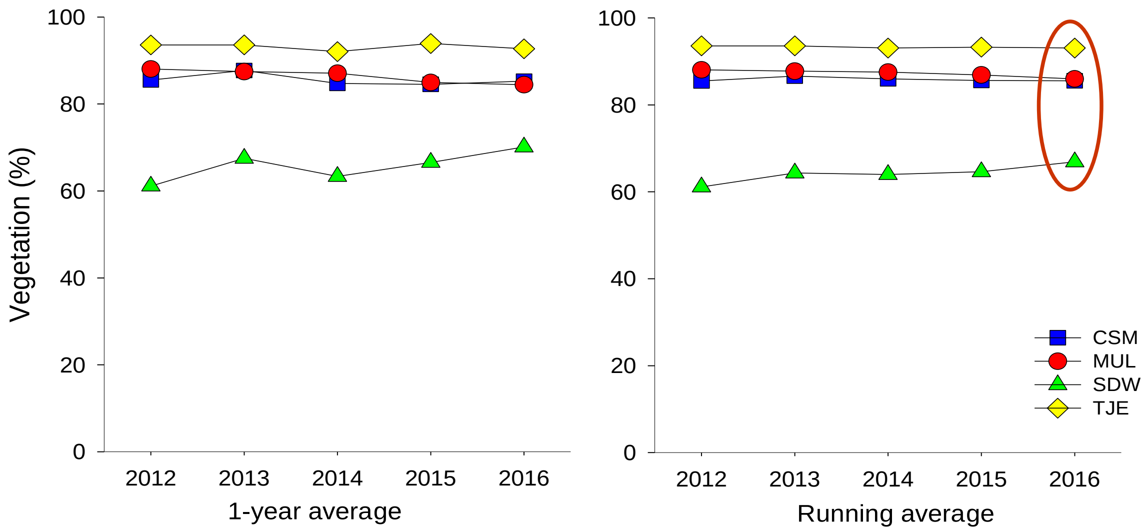


Figure 5.2.11. Comparison of the percent cover of salt marsh plants between San Dieguito Wetlands and the reference wetlands.

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 (e.g., 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 at least be similar to the reference wetland with the highest cover of macroalgae.

Results: Macroalgal cover in San Dieguito Wetlands was lower than the reference wetland with the highest value in 2012, 2013, 2015, and 2016, but slightly higher than the reference wetland with the highest value (Carpinteria Salt Marsh) in 2014 (Fig. 5.2.12). For the four-year running average, however, macroalgal cover in San Dieguito Wetlands was not higher than the value for the reference wetland with the highest cover (Mugu Lagoon). Therefore, the relative standard for Algae is currently met.

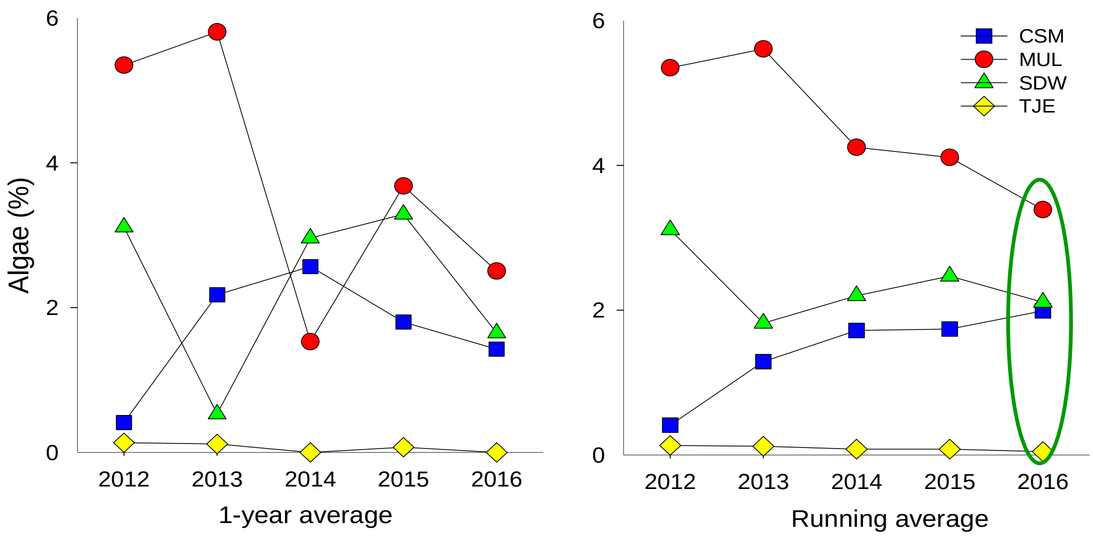


Figure 5.2.12. Comparison of percent cover of macroalgae between San Dieguito Wetlands and the reference wetlands.

***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 (formerly the Light-footed Clapper Rail) and other bird species. The number and height of stems of *S. foliosa* in the restored wetland and in Tijuana Estuary are 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 0.1 m^2 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. 5.2.13) 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 patches as replicates, and this value is compared between wetlands.

Figure 5.2.13. View of sampling transect overlying a patch of cordgrass in module W4. Cordgrass is sampled in 0.1 m^2 quadrats placed every two meters along the 20 m long transect line.

Results: There has been considerable variability in the annual mean proportion of stems > 3 feet (or 91 cm) tall in San Dieguito Wetlands and Tijuana Estuary, including a decline in this value in San Dieguito Wetlands from 2014 to 2016 (Fig. 5.2.14). The decline in the height of stems in San Dieguito from 2014 to 2016 was possibly due to increased stress of the plants associated with higher water levels in the wetland in 2014-2015 associated with generally higher coastal water levels and the build up of sand at the inlet that increased tidal inundation of the plants. Nevertheless, the four-year running average of mean proportion of stems >3 feet (or 91 cm) tall was similar between San Dieguito Wetlands and Tijuana Estuary. Therefore, the relative standard for *Spartina* canopy architecture is currently met.

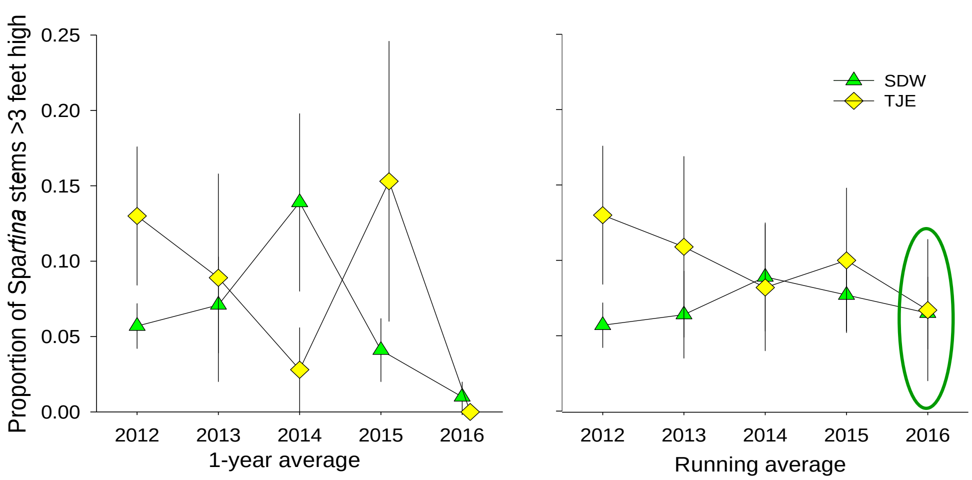


Figure 5.2.14. Comparison of the mean proportion of stems > 3 feet (91 cm) tall between San Dieguito Wetlands and Tijuana Estuary.

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 is one of the more important functions of coastal wetlands. Measurements of food chain support 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 consisting primarily of mudflat or unvegetated channel. A bird is recorded as feeding if one feeding attempt is made over a five-minute time interval. Feeding observations are made on shorebirds typically 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.

Results: The highest density of feeding birds occurred in Mugu Lagoon in 2012 through 2016 (Fig. 5.2.15). However, the four-year running average of feeding activity was not significantly lower at San Dieguito Wetlands compared with the lowest performing reference wetland. Therefore, the relative standard for Food Chain Support is currently met.

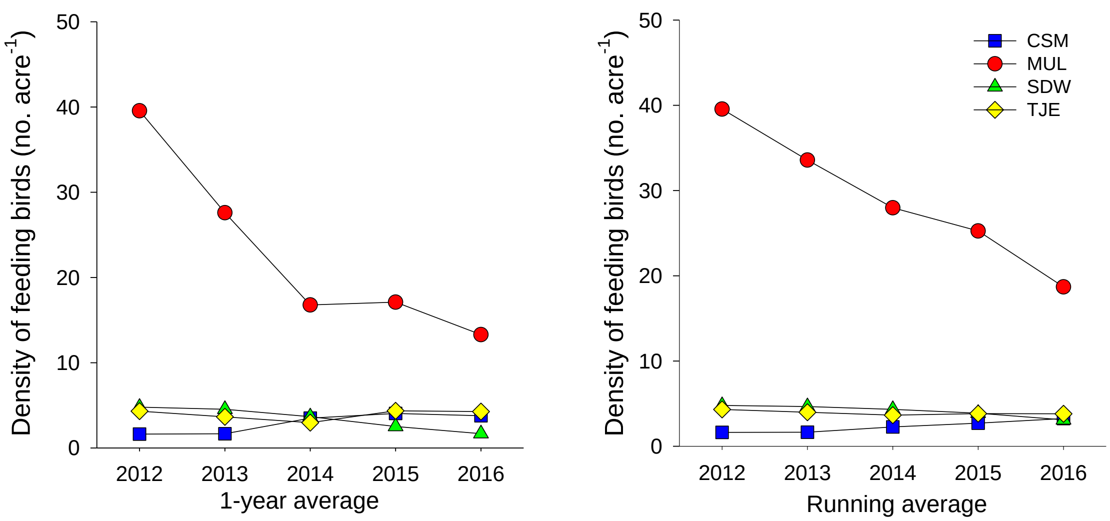


Figure 5.2.15. Comparison of the densities of feeding birds between San Dieguito Wetlands and the reference wetlands.

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.

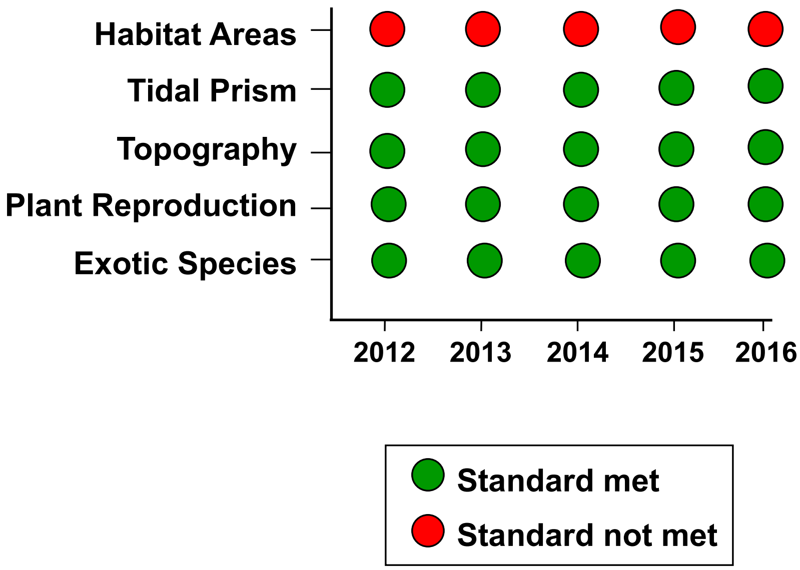


Figure 6.1.1. Summary of assessment of the absolute standards for 2016.

Figure 6.1.1 provides a summary evaluation of the absolute standards for 2016. 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 - 2016, but failed to meet the requirement of the Habitat Areas standard during this period. Since the Habitat Areas standard was not met in 2016, and all absolute standards must be met in the current year to receive credit, the San Dieguito Wetlands cannot receive mitigation credit for 2016.

6.2 Summary Assessment of the Relative Performance Standards
In order for the San Dieguito Wetlands to receive mitigation credit for a given year, it must also meet as high a proportion of the relative performance standards as the lowest performing reference wetland. The relative performance standards are measured in San Dieguito Wetlands, Tijuana Estuary, Mugu Lagoon, and Carpinteria Salt Marsh and assessed using a four-year running average (Section 4.2). For standards in which only three or fewer years of data are available, the running average for those years is used. Figure 6.2.2 provides a summary assessment of the relative performance standards for 2016. Again, 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. Comparing the four-year running averages, Mugu Lagoon and Carpinteria Salt Marsh were the best performing wetlands in 2016 with a higher proportion of standards met, 0.929 and 1.000, respectively, than the other wetlands. San Dieguito Wetlands received a higher proportion

of **green** dots (0.867) than Tijuana Estuary (0.733), the reference site with the next lowest proportion of **green** dots (0.857). Therefore, San Dieguito Wetlands met the relative standards for 2016.

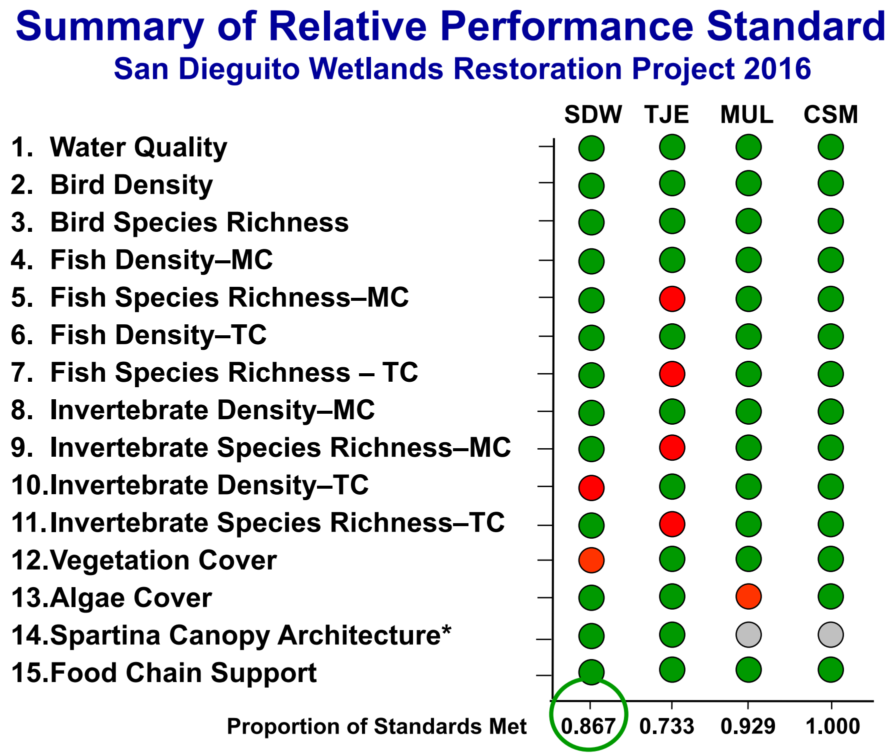


Figure 6.2.1. Summary evaluation of the relative standards for 2016. The *Spartina* canopy architecture standard is only evaluated in San Dieguito Wetlands and Tijuana Estuary.

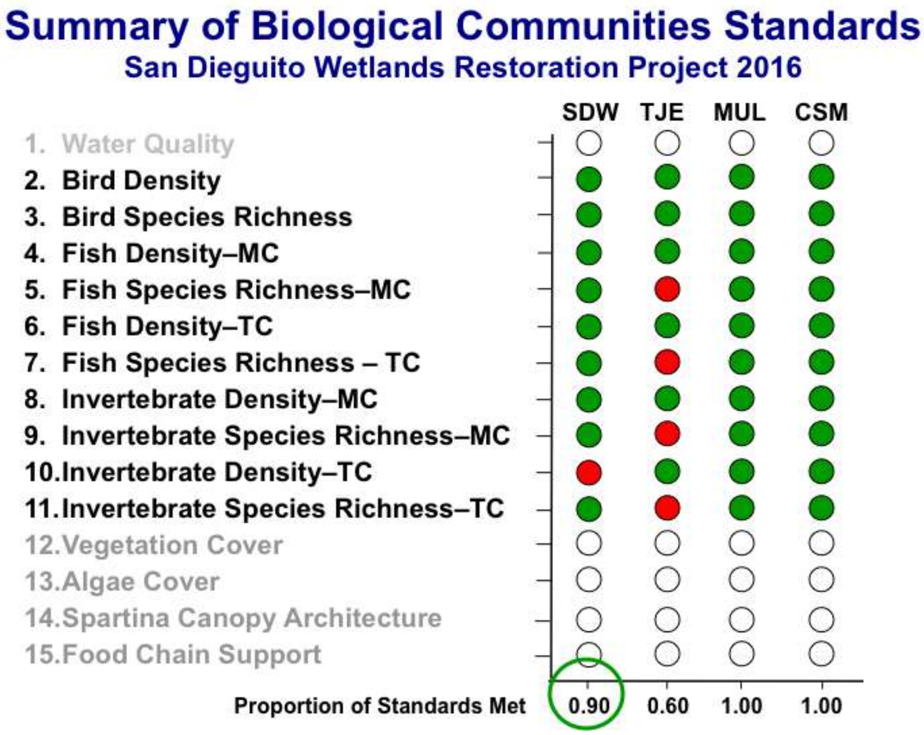


Figure 6.2.2. Summary evaluation of the special requirement for standards that pertain to Biological Communities: within 4 years of construction, the total densities and number of species of fish, macro-invertebrates and birds shall be similar to the densities and number of species in similar habitats in the reference wetlands.

The SONGS permit also has special requirements for the Biological Communities standards, which comprises standards that pertain to birds, fish, and macro-invertebrates. The special requirement for Biological Communities is evaluated as a subset of the relative performance standards—the San Dieguito Wetlands must perform at least as well as the worst performing reference wetland. Figure 6.2.2 provides a summary assessment of the relative performance standards that pertain to Biological Communities for 2016. A **green** dot indicates that performance variable at a particular wetland is similar to the other wetlands; a **red** dot indicates that it was not. Comparing the running averages, San Dieguito Wetlands received a higher proportion of green dots (0.90) than Tijuana Estuary, the reference wetland with the lowest value (0.60). Consequently, San Dieguito Wetlands met the special requirement that the standards for Biological Communities be met in four years.

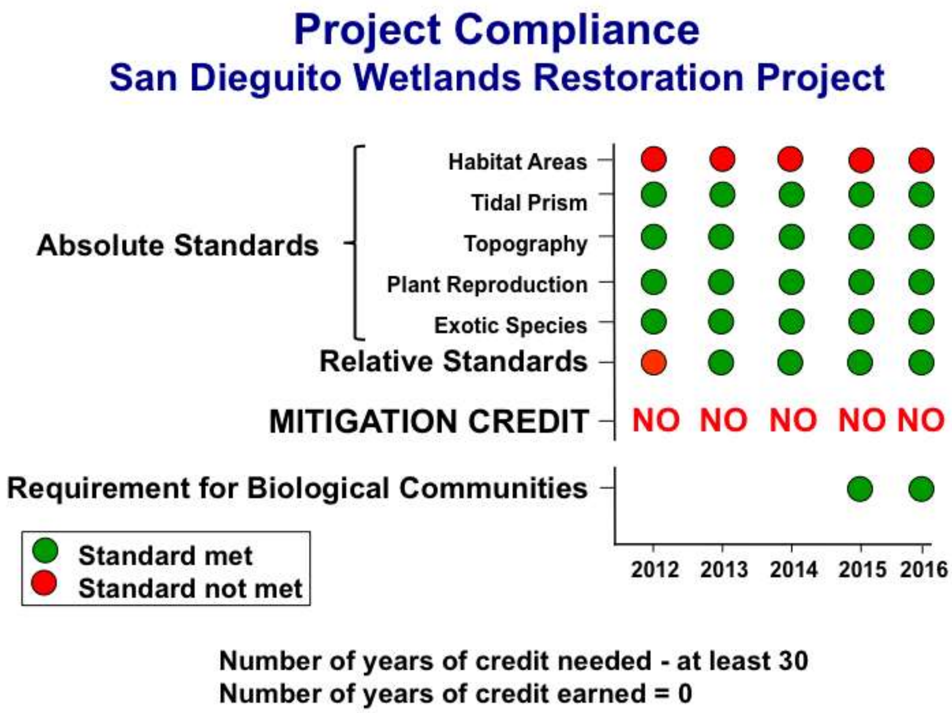


Figure 6.3.1. Status of compliance with the performance standards provided in the SONGS Permit.

6.3 Summary Assessment of Project Compliance

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 lowest or worst performing reference wetland. To date, the San Dieguito Wetlands has met the absolute standards for tidal prism, topography, and exotic species, but has yet to meet the Habitat Areas standard (Fig. 6.1.1), primarily due to slow vegetation development. It is encouraging to note that the project has met the relative standard requirement in 4 out of 5 years, and the special requirement that the standards for Biological Communities be met within 4 years. While there are many signs that the 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 2017

Monitoring of the San Dieguito Wetlands, and the reference wetlands, Carpinteria Salt Marsh, Mugu Lagoon, and Tijuana Estuary will continue in 2017 as required by the SONGS Permit using the same level of effort and methods employed in 2016. In addition, existing data will be analyzed to examine the reasons for the underperformance of vegetation and failure to meet the Habitat Areas standard. CCC staff and SCE will also be consulted regarding next steps to address the underperformance of vegetation cover and steps to bring the project into compliance with the SONGS permit.

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