2012

Annual Report of the Status of Condition A: Wetland Mitigation

SAN ONOFRE NUCLEAR GENERATING STATION (SONGS) MITIGATION PROGRAM

Marine Science Institute

UCSB

2012

Annual Report of the Status of Condition A: Wetland Mitigation

San Onofre Nuclear Generating Station (SONGS) Mitigation Program

Submitted to the California Coastal Commission
August 2013

By Mark Page, Stephen Schroeter and Daniel Reed
Marine Science Institute, University of California Santa Barbara

Contributors
David Huang, Andres Deza, Katalin Patonai, Emily Blair, Justin Hoesterey, Crystal Weaver, Marine Science Institute, University of California Santa Barbara

Science Advisory Panel
Richard Ambrose, University of California Los Angeles
Peter Raimondi, University of California Santa Cruz
Russell Schmitt, University of California Santa Barbara

Project Administration
Jody Loeffler

Table of Contents

1.0 Executive Summary

Condition A of the San Onofre Nuclear Generating Station's (SONGS) coastal development permit 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 plant. San Dieguito Lagoon, located in northern San Diego County was chosen as the wetland mitigation site. The San Dieguito Wetlands Restoration Project began 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 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 first year of post-construction monitoring done in 2012.

During 2012, the development of vegetation was very promising in some areas, particularly along the border of the basin (module W1) west of the I-5 freeway, and cordgrass is becoming well-established in some areas of module W4, east of the I-5 freeway. In other areas, however, development of vegetation was less encouraging, particularly in modules W2/3, located adjacent to the San Dieguito River west of the I-5 freeway. Vegetation has been slow to establish in these modules through natural recruitment except at the lowest tidal elevations or in depressions, and extensive plantings of pickleweed and other species at higher tidal elevations in 2009 were unsuccessful. Modules W2/3 were graded by design to a high elevation to achieve high salt marsh habitat. However, these high areas are hit by the tides infrequently, and with little change in elevation over distances exceeding 100m, tidal waters sit on the surface where evaporation contributes to high soil salinities that are probably detrimental to plant establishment. Tidal creek extensions were constructed in November 2010 to better convey tidal waters from the river channel to these high marsh plain areas. Pickleweed colonized along the edges of the creeks, but little development of vegetation has occurred on the high marsh plain. SCE is currently evaluating options for addressing the poor establishment of vegetation in modules W2/3.

While vegetation has been slow to develop in portions of the wetland, the wetland is supporting birds, fish, invertebrates, and eel grass and did so even during construction. The invertebrates and fish are providing food chain support to birds. During monitoring surveys in 2012, 100 species of birds were recorded. Examples of some of these species include avocets, long billed curlew, egrets, redheads, hooded merganser and kingfisher recorded in tidal creek, main channel and basin, and the state listed endangered Belding's Savannah Sparrow, song sparrows, and red-winged blackbird were recorded in the vegetated marsh. During monitoring surveys in 2012, 21 species of fish were recorded. Examples include topsmelt, killifish, pipefish, staghorn sculpin, mudsuckers, two common small gobies, the arrow and shadow goby, diamond turbot. Juveniles of California halibut, kelp bass and giant kelp fish and several species of surf perch provide evidence that the wetland is providing nursery habitat for kelp forest fish species. Three species of rays (bat rays, round stingrays, and butterfly rays) were also recorded. Sixty-three species of macro-invertebrates were recorded including several species of clams, snails, crustaceans, and worms.

The success of the San Dieguito Wetlands in meeting the mitigation requirement for a given year will be based on its ability to meet all of the physical and biological performance standards. A summary report is provided on the results of the first year of monitoring of the San Dieguito Wetlands Restoration Project, including an evaluation of the progress of the restoration project towards meeting the performance standards required for successful mitigation. The San Dieguito Wetlands Restoration Project satisfied all of the absolute standards, which includes those that pertain to topography, tidal prism, habitat areas, plant reproductive success, exotic species. The restored wetland also showed encouraging results for ten of the fourteen relative standards. Results for four other standards were less encouraging. These standards pertain to vegetation cover, macro-invertebrate density in Main Channel and Tidal Creek Habitats, macro-invertebrate species richness in Tidal Creek Habitat, and *Spartina* canopy architecture. The poor plant development in modules W2/3 is largely responsible for the less encouraging results for vegetation cover in the restored site. The reason for the less encouraging results for macro-invertebrates is unknown at present, but may be related to a requirement for more time for the invertebrates to become established. It is very promising that *Spartina* is becoming established, spreading, and increasing in plant height throughout portions of the San Dieguito Wetlands Restoration.

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 wetlands, excluding buffer zone and transition. 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 progress of the SONGS wetland mitigation project (hereafter referred to as the San Dieguito Wetlands) during 2012 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 4 billion gallons, equivalent to a square mile 14 feet deep.

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. Power plant heated cooling water kills fish eggs, larvae and small immature fish taken into the plant. 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. 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.

Neither of 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 installed in 2010 and 2011. Neither unit was ever restarted; however, the circulating pumps have continued to operate at 50% of maximum since the Units were shutdown.

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 San Onofre 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 fished 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 mitigate the adverse impacts of the power plant on the marine environment that require SCE and its partners to: (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 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, continuous tidal maintenance 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). A half-time administrator completes the contract program staff. 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 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 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.

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 Design and Construction 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 nesting sites 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. 3.1.3, 3.1.4ab). 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

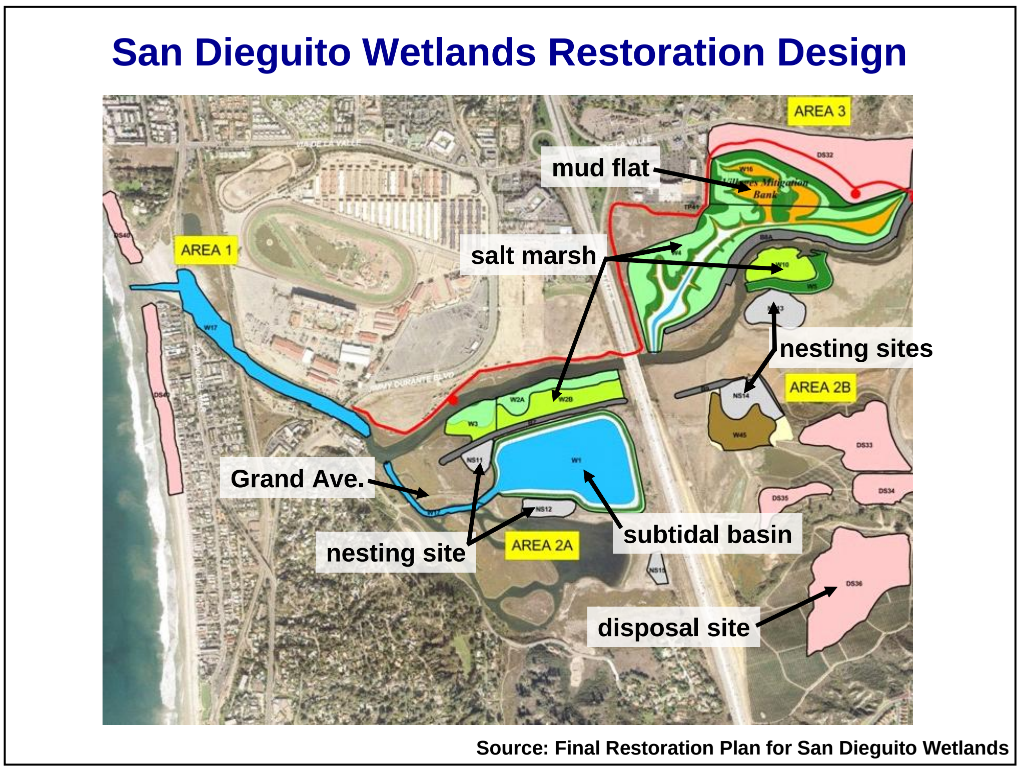


Figure 3.1.1. The design plan view of the restoration project that was approved by the CCC. The project included the creation of tidal salt marsh, indicated by shades of green, mudflat, indicated by the light brown, and subtidal basin, indicated by blue. In addition, four nesting sites, shown in gray, 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) was completed in February 2008 with tidal creek extensions added to linear channels that were originally constructed in November 2010. The construction of additional wetland ("Grand Avenue") was completed in February 2011.

Following excavation and grading, portions of the restoration project were planted with salt marsh vegetation. Planting of selected species (largely pickleweed) in high marsh habitat occurred in January/February 2009. Planting of cordgrass in the low marsh occurred following final 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. 3.1.2).

Construction Timeline

Start date	**September 2006**
Project Task	**Completion Date**
Construction of:	
W1	January 2008
W4/W16 & W5/W10	December 2008
W2/W3	
Initial grading	February 2008
Tidal creeks	November 2010
Berms	February 2009
Additional wetland (Grand Ave)	February 2011
Planting:	
W1	November 2011
W4/W16 & W5W10	November 2011
W2/W3	November 2009
Final inlet dredging	September 2011

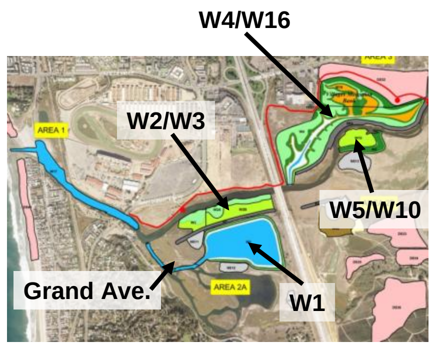


Figure 3.1.2. Construction timeline for the San Dieguito Wetlands Restoration Project.

San Dieguito Lagoon before excavation and grading (2003)

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 airfield, old agricultural fields, and a portion of the Fish and Game Basin constructed in the early 1980’s.

San Dieguito Lagoon after excavation and grading (2010)

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.

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 Status update of the San Dieguito Wetlands Restoration Project

Below is a general review of the status of the San Dieguito Wetlands Restoration Project for 2012.

Salt marsh vegetation: 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 endangered Belding's Savannah Sparrow and Light Footed Clapper Rail. The San Dieguito Wetlands Restoration entailed the creation of 92 acres graded 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 folios*a) is expected to become established in low marsh. Two methods were proposed in the Final Restoration Plan to achieve plant establishment. First, vegetation (pickleweed and other species) are expected to colonize naturally in the mid and high salt marsh. Second, since natural plant establishment in the high marsh and cordgrass establishment in the low marsh is expected to occur slowly, plugs or fragments of plants were planted in these locations to expedite vegetation development.

The development of vegetation has been very promising in some areas. Notably, pickleweed along the border of the basin (module W1), and cordgrass in some areas of module W4 is becoming well-established (Fig. 3.2.1). In other areas, however, development of vegetation has been less prominent. Development of vegetation along the northern boundary of module W16 was initially very promising, but more recently plants have turned brown and remained brown during the growing season, suggesting that they are stressed (Fig. 3.2.2). This change in plant performance may be due to a reduction in fresh groundwater that seeped beneath the adjacent disposal site and/or the deposition of sediment eroded from this disposal site that raised the elevation occupied by the plants such that they are inundated less frequently by high tides.

Modules W2/3, located adjacent to the San Dieguito River continue to be sparsely vegetated. Salt marsh plants have been slow to establish through natural recruitment except at the lowest tidal elevations or in depressions, as illustrated in Fig. 3.2.3. Plantings of pickleweed and other species at higher tidal elevations in 2009 were unsuccessful. These modules were graded by design to a high elevation to achieve high salt marsh habitat. However, these high areas are inundated by the tides infrequently, and with little change in elevation over distances exceeding 100m, tidal waters remain on the surface where evaporation contributes to high soil salinities that are probably detrimental to plant establishment. One possible solution to improve inundation of the marsh plain and reduce soil salinities was to extend the linear channels that were initially constructed to better convey tidal water from the river channel to the high marsh plain. In November 2010, SCE extended the linear channels to form the tidal creeks shown in Fig. 3.2.4, and did some re-grading lowering elevations of some areas around the creeks.

Figure 3.2.1. The development of vegetation has been very promising in some areas; for example, pickleweed along the border of the basin, module W1 and cordgrass in some areas of module W4.

Figure 3.2.2. Vegetation has developed slowly in other areas. The image on the left shows the initial growth of plants planted in early 2009 along the northern border of W16. The image on the right shows that the plants were brown in July 2012, a time of year when one would expect that they would be green. These plants are likely stressed since inspection of the stems indicated that only a small percentage of the brown plants were actually dead.

Figure 3.2.3. Vegetation has been slow to establish through natural recruitment except at the lowest tidal elevations or in depressions in modules W2/3. Plantings conducted in 2009 were unsuccessful.

Figure 3.2.4. The linear channels originally constructed in W2/W3 were extended to create tidal creeks and some areas were re-graded in November 2010 to lower the elevation of the marsh plain to better convey tidal waters throughout these modules.

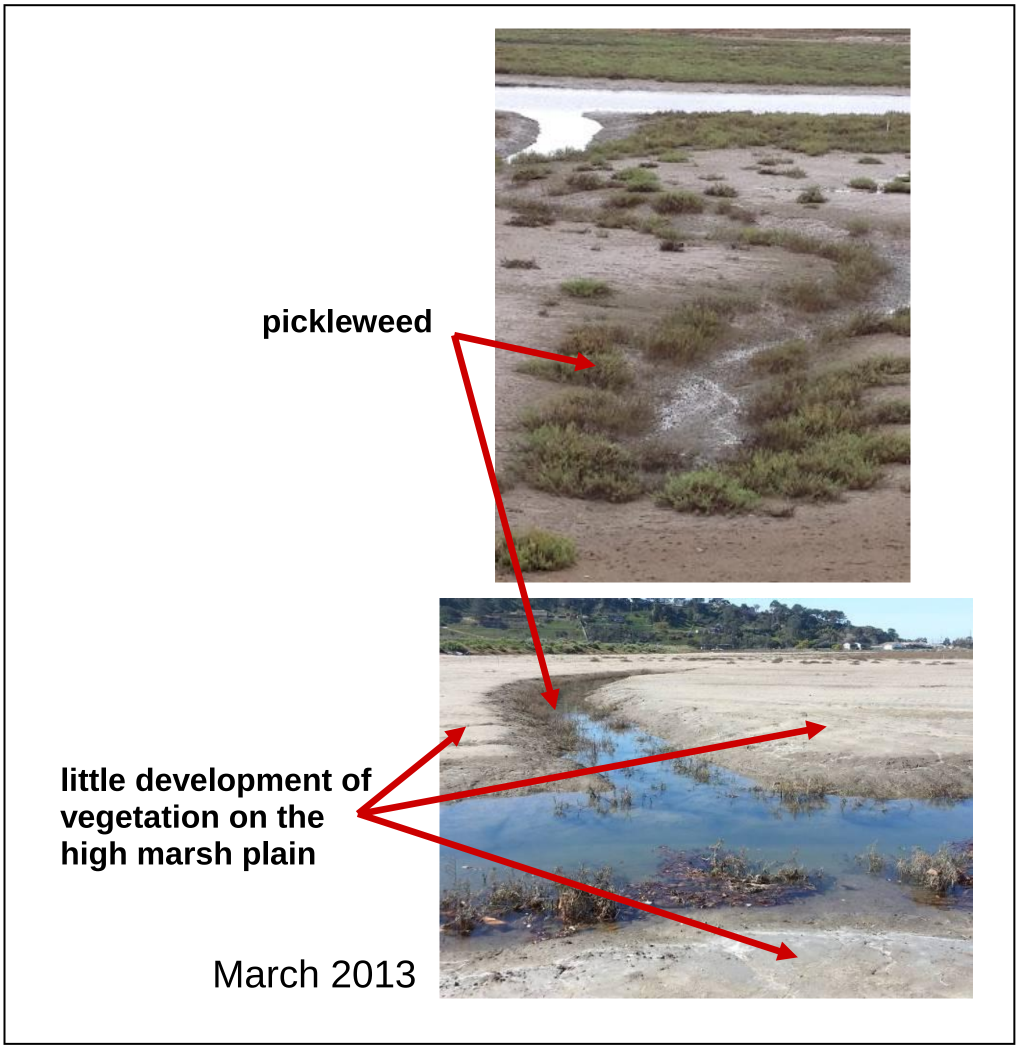


Figure 3.2.5. Views of tidal creek extensions that were constructed in November 2010 to better convey tidal waters away from the river channel. Pickleweed colonized along the edges of the creeks, but little development of vegetation has occurred on the high marsh plain. Photograph was taken in March 2013.

The tidal creek extensions improved movement of tidal waters away from the river channel (Fig. 3.2.5). Recruitment of vegetation has occurred along the edges of the constructed creeks. However, vegetation cover has been largely confined to a narrow margin along the banks of these creeks and has not spread onto the high marsh plain, which remained sparsely vegetated in 2012.

<u>Birds, fish, macro-invertebrates and eelgrass</u>. While vegetation has been slow to develop in portions of the wetland, populations of birds, fish, invertebrates, and eel grass have expanded rapidly and did so even during construction. The invertebrates and fish are providing food chain support to birds (Fig. 3.2.6). During monitoring surveys in 2012, 100 species of birds were recorded. Examples of some of these species include avocets, long

billed curlew, egrets, redheads, hooded mergansers and kingfishers recorded in tidal creek, main channel and basin habitats, and the state listed endangered Belding's Savannah Sparrow, song sparrows, and red-winged blackbird in the vegetated marsh. During monitoring surveys in 2012, 21 species of fish were recorded. Examples of some of these species include topsmelt, killifish, pipefish, staghorn sculpins, long-jawed mudsuckers, two common small gobies, the arrow and shadow goby, diamond turbot, juvenile California halibut, and bat rays, butterfly rays and round stingrays. The list also includes juveniles of kelp forest fish, notably kelp bass and giant kelp fish.

Figure 3.2.6. An osprey with a fish captured in the restored wetland.

During surveys in 2012, 63 species of invertebrates were recorded. There were five species of epifauna, invertebrates that live on the sediment surface including the California horn snail and Bubble Snail, which feed on algae, and the snail *Nassarius*, which is thought to be a scavenger. The remaining species of invertebrates were infauna, those species that live in the sediment and include the clams, common littleneck and jacknife, ghost shrimp, and much smaller forms such as amphipod crustaceans, and small worms, which can be very abundant. Eelgrass, which provides habitat for invertebrates and fish, recruited to the inlet channel and the entrance to the W1 basin prior to the final 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, where it now covers ~80% of the bottom.

3.3 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 can adversely affect dissolved oxygen concentration in the lagoon. Low dissolved concentrations can lead to invertebrate and fish kills. In addition, partial blockage of the inlet by sand can affect drainage during low tides and the death of 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). 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 can tolerate high soil salinity and could move into the restoration site. Indeed, Tamarisk has recruited into the restoration site, but was immediately removed. SCE currently has an active weed abatement program to control weeds on the berms and disposal sites.

3.4 Summary and Key Findings for 2012

- The restored San Dieguito Wetlands have been colonized by salt marsh vegetation, invertebrates, fish, and eelgrass.
- A large number of bird species are using constructed habitat and did so even during construction.
- The restoration site is currently providing habitat and food chain support for endangered and economically important species.
- Plant establishment has been highly variable within and across constructed wetland modules and, in general, low at higher tidal elevations.
- On-going management tasks important to wetland health include inlet maintenance and control of non-native species.

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 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 and the decommissioning period to the extent there are continuing circulating pump discharges. This monitoring will be done to measure 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 will oversee the monitoring studies outlined in the Plan. The SONGS permit provides a description of the performance standards and monitoring required for the wetland mitigation project. The Monitoring Plan includes a description of each performance standard and the methods that will be used to determine whether the various performance standards 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 has subsequently been updated in June and October 2011 and will continue to be refined in 2013 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. 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 to 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, 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 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 for that year and the previous three years, similar in approach to that used to evaluate success of the Wheeler North Artificial Reef. However, since performance monitoring has occurred for just one year at the San Dieguito Wetlands, evaluation will be based on the running average of sequential years up to and including year 3, and the 4 year running average thereafter. Use of the short-term (4-year) running average accounts for natural variation in time. For example, invertebrate, fish, and bird populations can vary in their species composition and abundance year to year and it is likely that the reference 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 performance standards will in some cases be measured relative 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 (e.g., swell height, water temperature) conditions 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 wetlands are not constructed or substantially restored. Tidal wetlands 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 approach 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 estimates made using aerial imagery and thus there are no estimates of variability about 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 ≤ 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 (Page et al. 2011).

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 measures 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 (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 not 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 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 number of relative standards met by the San Dieguito Wetlands is equal to or greater than the number of relative standards met by either 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 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 first year of monitoring. More detailed methods can be found in The Monitoring Plan for the SONGS Wetland Mitigation Project (Page et al. 2011).

5.1 Physical Performance Standards

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 block 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 wetland were not affected by excessive erosion or sedimentation.

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). Two dataloggers are deployed at the restored and reference wetlands to characterize the average value of dissolved oxygen concentrations within the wetlands (one near the inlet and one near the most inland extension of the wetland).

An oxygen concentration below 3 mg/l is considered hypoxic and sustained concentrations below this value may be detrimental to estuarine biota. Therefore, one approach to assessing dissolved oxygen is to incorporate not only the absolute value of 3 mg/l, but 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 Wetland the reference wetlands. The approach used to evaluate this standard will be refined in 2013 to incorporate both hours of continuous hypoxia and the frequency of hypoxic events.

Results:

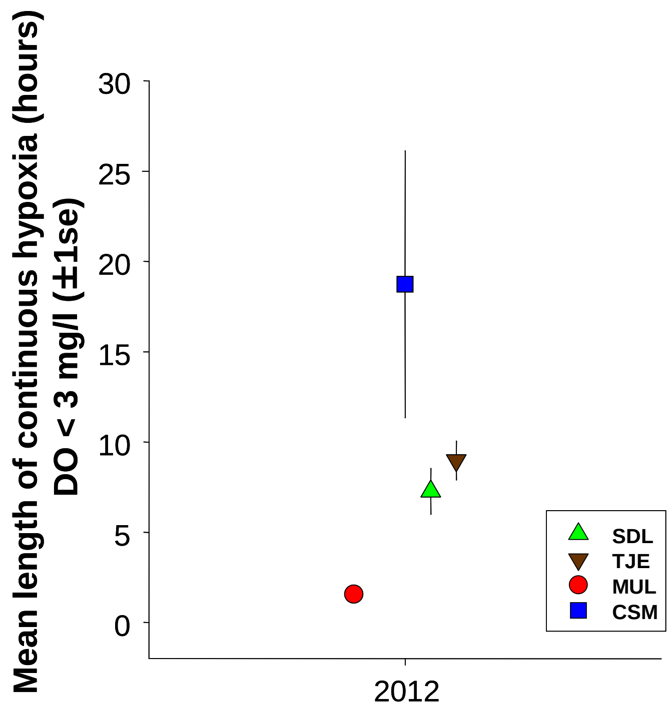


Figure 5.1.1. Mean length in hours of continuous hypoxia ($[O_2] < 3$ mg/l) in the San Dieguito Wetlands compared with the three reference wetlands. Abbreviations used in this and subsequent figures: SDL=San Dieguito Wetlands, TJE=Tijuana Estuary, MUL=Mugu Lagoon, CSM=Carpinteria Salt Marsh.

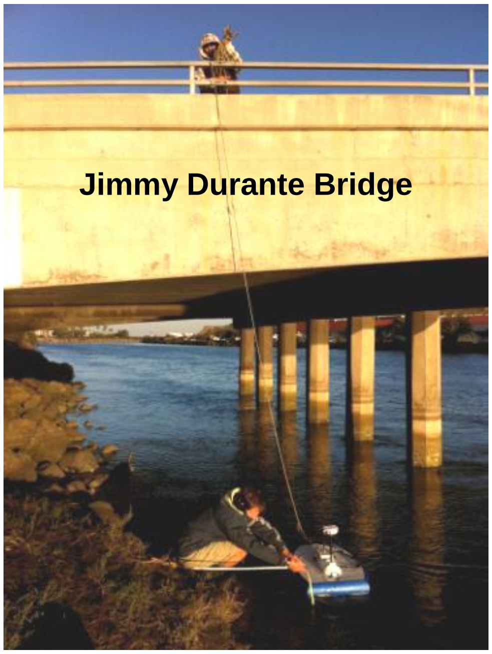
The mean length of continuous hypoxia at the San Dieguito Wetlands was higher than Mugu Lagoon, but lower than in Tijuana Estuary and Carpinteria Salt Marsh, and thus was found to be similar to the reference wetlands (Fig. 5.1.1).

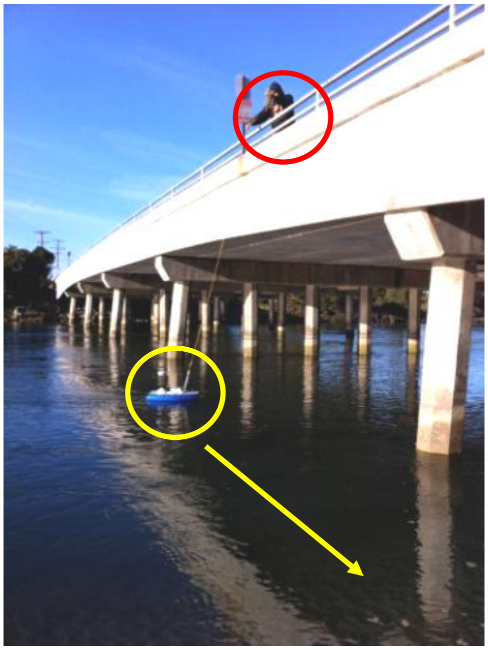
Tidal prism

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

Approach: 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 hit by the tides, the tidal prism standard is evaluated 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%. While tidal muting can occur at both upper and lower elevations, it is anticipated, based on the tidal volume-elevation relationship, that the tidal prism will be most influenced by muting at the upper elevation reached by the tides (i.e. within the salt marsh habitat). 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 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, 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. The method used to evaluate this standard may be refined as more information becomes available.





River Surveyor--Acoustic Doppler Current Profiler (ADCP)

Figure 5.1.2. 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 (Son Tek River Surveyor) 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 maximum high tides using a portable acoustic Doppler profiler/discharge measurement system (Son Tek River Surveyor) (Fig. 5.1.2). The performance standard is met if the tidal prism values estimated for the different sampling dates are equal to or greater than 88% of the as-built tidal prism value.

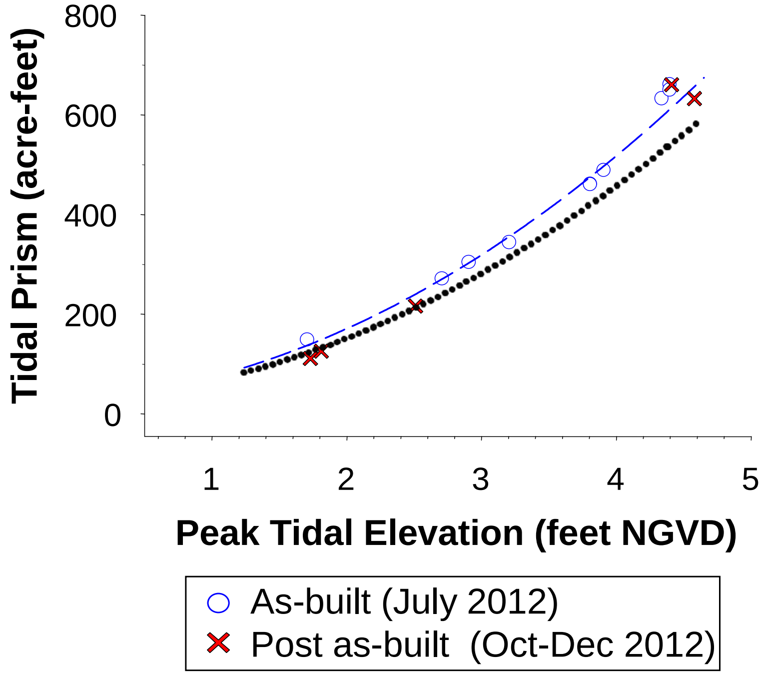


Figure 5.1.3. The tidal prism, measured from October-December 2012 plotted against the maximum high tide, indicated by the red crosses, evaluated against the "as-built" prism, shown by the blue circles, which was assessed over a range of high tides in July 2012. The dotted line represents 88% of the as-built prism.

Results: The measured prism must be not fall below the red dotted line to ensure that there is no more than a 10% shift in inundation of planned salt marsh habitat. The post as-built measurements of tidal prism are on or above the red dotted line, indicating that the tidal prism at the San Dieguito Wetland was maintained within 10% of the as-built condition in 2012 (Fig. 5.1.3).

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 is an absolute standard and applied only to the San Dieguito Wetland restoration. This performance standard is designed to guard against large scale conversions of one habitat type to another, for example of vegetated marsh to mudflat. The Final Restoration Plan (SCE 2004) 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. Therefore, one approach to evaluating this standard is to compare the areas of planned habitats within these elevational boundaries to the areas provided in the Final Restoration Plan. Following completion of construction, the as-built areas of planned subtidal, intertidal mudflat, and intertidal salt marsh were determined by surveying the elevational boundaries using a Real Time Kinematic (RTK) global positioning system (GPS) with a vertical accuracy of a few centimeters (typically 3 cm). Surveys were conducted to determine acreages of the three constructed wetland habitats types (salt marsh, mudflat, and subtidal) in 2012. These measures were compared to the “as-built” acreages to determine whether they were within 10% of the acreages in the Final Plan. The approach used to evaluate this standard will be refined in 2013 to incorporate the quality of salt marsh habitat (i.e., presence of vegetation).

Habitat elevational boundaries (from Restoration Plan):

Salt marsh: 1.3 to 4.5’ NGVD
Mudflat: -0.9 to 1.3’
Subtidal: <-0.9’

Figure 5.1.4. Panel on the left shows areas of planned salt marsh (green), mudflat (brown), and subtidal (blue) and the elevational boundaries that delineate those habitats as provided in the Final Plan for the restoration project.

Results: The areas of the different wetland habitats at San Dieguito Lagoon estimated from elevation surveys in 2012 were within ±10% of the planned acreage (Fig. 5.1.5). As a result, changes in habitat areas in 2012 were within the levels specified by the permit.

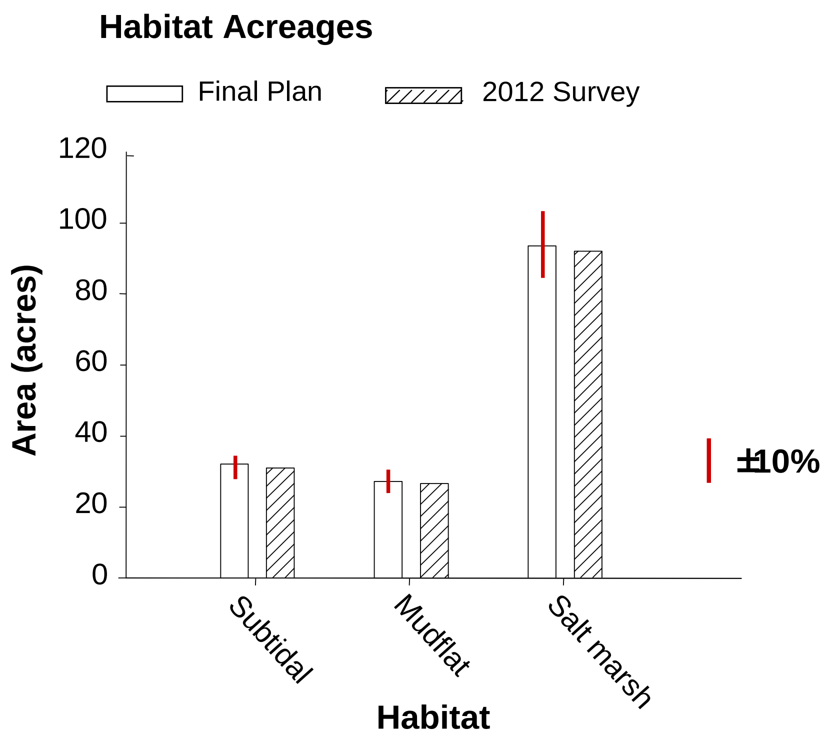


Figure 5.1.5. Comparison of the areas of subtidal, mudflat, and salt marsh habitat in the Final Restoration Plan and the 2012 survey.

5.2 Biological Performance Standards

General sampling design for fish and macro-invertebrates.

San Dieguito Wetlands and the three reference wetlands are sampled in the summer. Six tidal creeks and six sections of main channel/basin are sampled in each wetland (Fig. 5.2.1). 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 naturalreference sites. However, data collected by Marine Ecological Consultants (1993) on fish abundance from different habitats at San Dieguito Lagoon prior to restoration indicate that 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, hydrology, and thus the likelihood that they will support different assemblages of fish and macro-invertebrates, tidal creeks and main channels are assessed separately.

Figure 5.2.1. 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 enclosure traps and larger beach seines. Enclosure traps are used to sample gobies, which are small, numerically abundant fishes that are poorly sampled by other methods. Beach seines in combination with blocking nets are used to sample larger more mobile fishes. 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 is 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. Clapper Rail nesting in Tijuana Estuary prevented sampling using seines in 2012 so only data collected using enclosure traps from San Dieguito Wetlands and the reference sites were used to assess the density and species richness of wetland fish for this year.

Results:

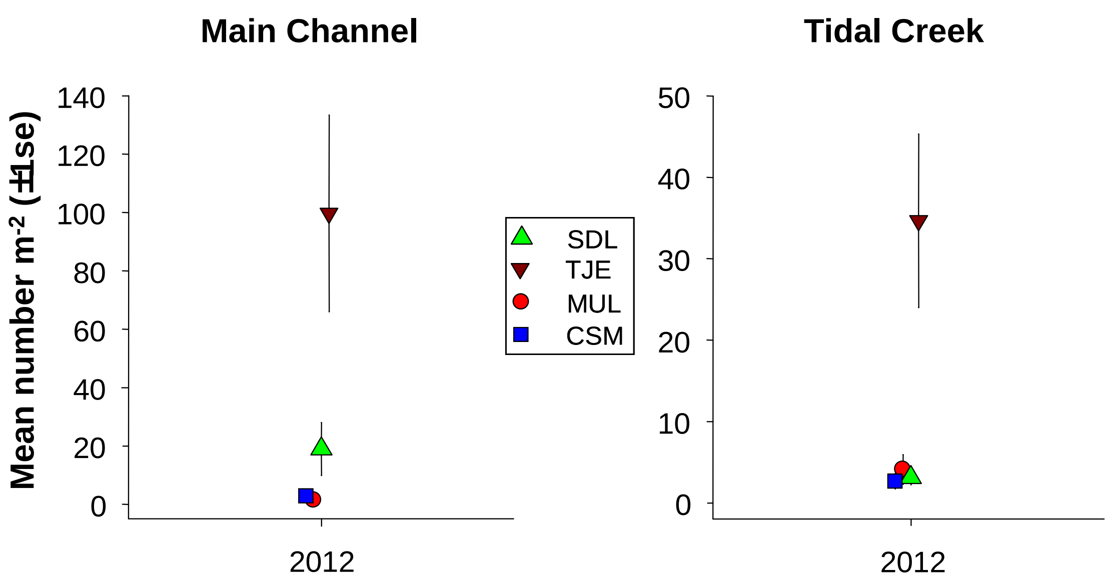


Figure 5.2.2. Comparison of fish density between San Dieguito Wetlands (SDL) and Tijuana Estuary (TJE), Mugu Lagoon (MUL), and Carpinteria Salt Marsh (CSM) in Main Channel and Tidal Creek habitats.

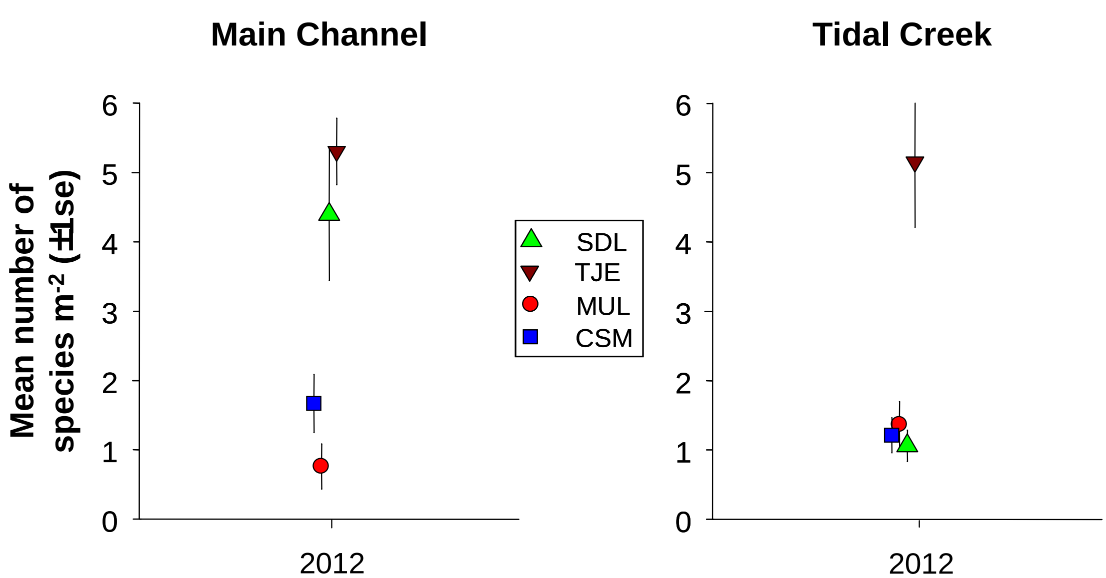


Figure 5.2.3. Comparison of fish species richness between San Dieguito Wetlands and the reference wetlands in Main Channel and Tidal Creek habitats.

Fish density in main channels was lower in San Dieguto Wetlands compared with Tijuana Estuary, but higher than at Mugu Lagoon or Carpinteria Salt Marsh (Fig. 5.2.2). Fish density in tidal creeks was also lower in San Dieguto Wetlands compared with Tijuana Estuary, and not significantly different from Mugu Lagoon or Carpinteria Salt Marsh.

Fish species richness in main channels was lower in San Dieguto Wetlands compared with Tijuana Estuary, but higher than at Mugu Lagoon or Carpinteria Salt Marsh (Fig. 5.2.3). Fish species richness in tidal creeks was not significantly different from Mugu Lagoon or Carpinteria Salt Marsh all of which were lower than species richness in tidal creeks in Tijuana Estuary.

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 50 x 50 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, 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. Further details of methods used for processing these samples in the laboratory are provided in Appendix 5 of Page et al. (2011).

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). The species of invertebrates sampled using the various methods are also combined to provide an estimate of species richness for each station. Total density and numbers of species (as species density) of macro-invertebrates are standardized for area sampled by each sampling method and added to provide an overall estimate of total density and species density for each tidal creek or main channel/basin location. Density and species richness values averaged across the 6 creeks or 6 sections of main channel/basin are used to compare wetlands.

Results: The density of macro-invertebrates was lower in the San Dieguito Wetlands than in the lowest of the reference wetlands, Carpinteria Salt Marsh (main channels) and Tijuana Estuary (tidal creeks) for both main channels and tidal creeks in 2012 (Figs. 5.2.4). Species richness of macro-invertebrates in main channels at San Dieguito Wetlands was higher than in Tijuana Estuary and Carpinteria Salt Marsh (Fig. 5.2.5). For tidal creeks, however, macro-invertebrate species richness was lower in San Dieguito Wetlands than in Carpintera Salt Marsh, which had the lowest value of the three reference wetlands (Fig. 5.25).

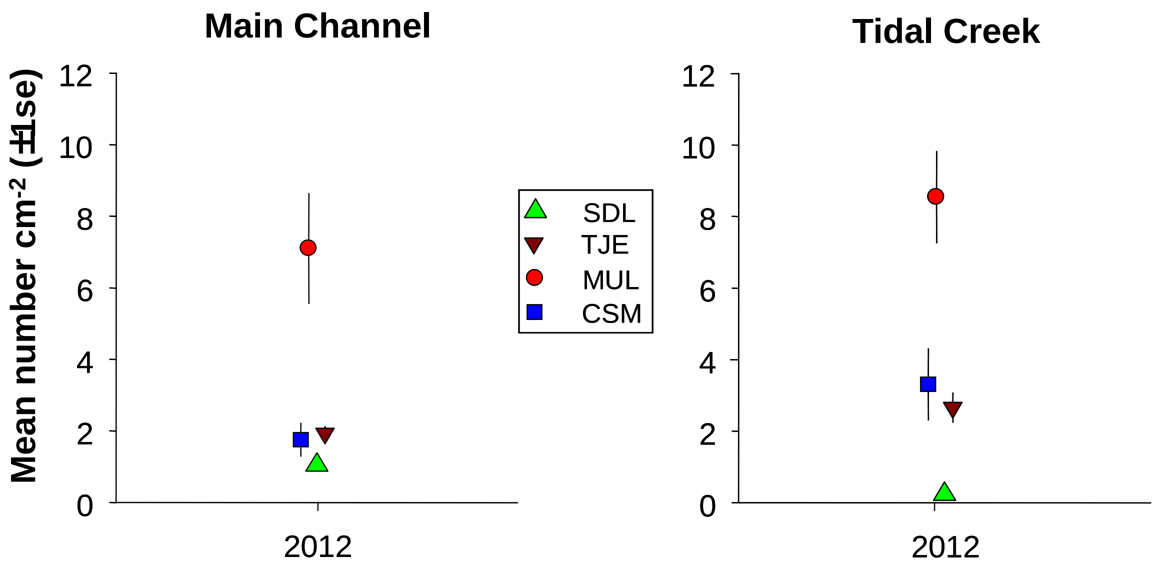


Figure 5.2.4. Comparison of macro-invertebrate density between San Dieguito Wetlands (SDL) and the reference wetlands for Main Channel and Tidal Creek habitats.

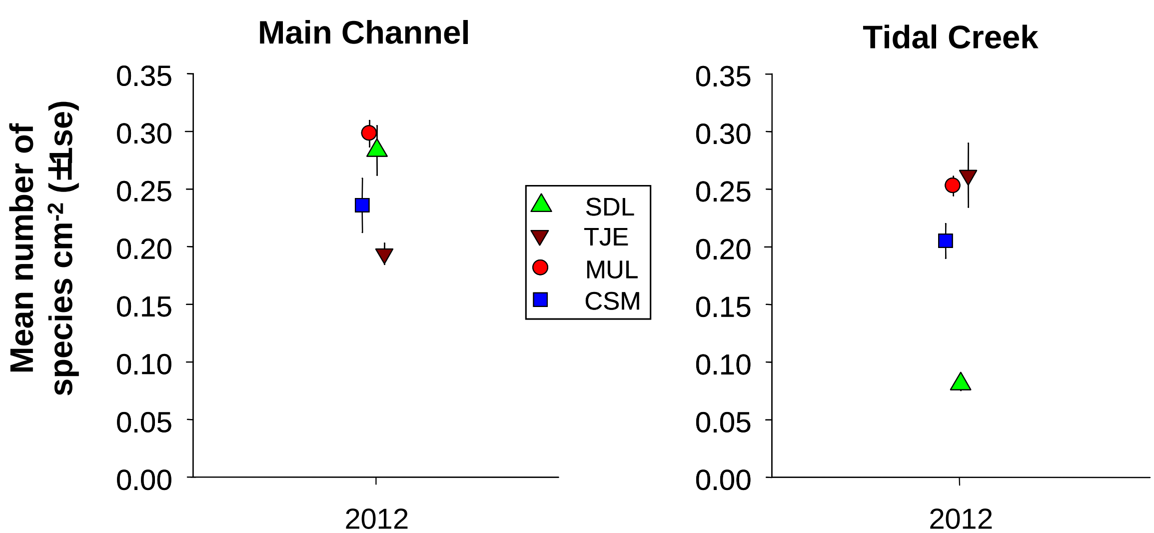


Figure 5.2.5. Comparison of macro-invertebrate species richness between San Dieguito Wetlands and the reference wetlands for Main Channel and Tidal Creek habitats.

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. 5.2.6 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 factors that might vary over time, such as weather, on bird density and species richness.

Figure 5.2.6. 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 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 bird density, but bird density in San Dieguito Wetlands was higher than both Tijuana Estuary and Carpinteria Salt Marsh (Fig. 5.2.7). San Dieguito Wetlands had the highest bird species richness of the four wetlands (Fig. 5.2.8). It should be noted that Figure 5.2.8 shows bird species density and not the total number of species recorded in wetland, which in the case of San Dieguito was 100 species.

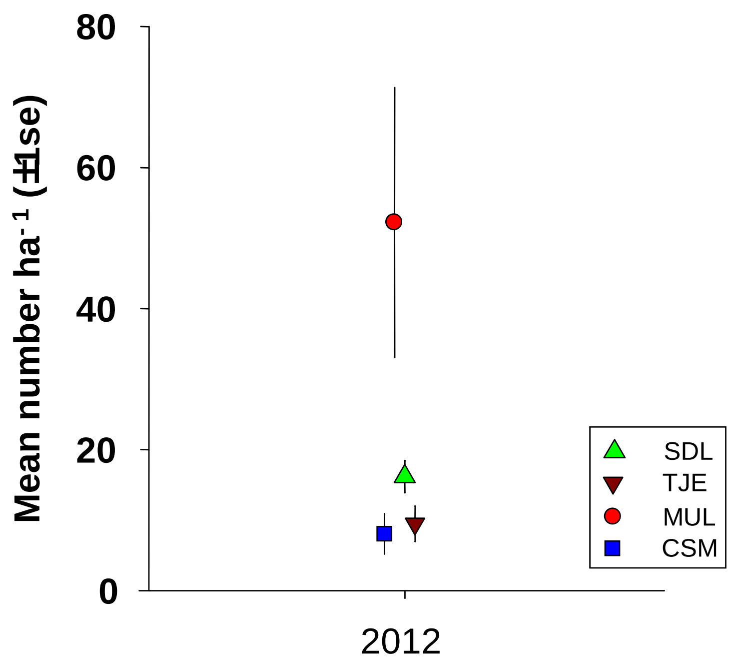


Figure 5.2.7. Comparison of bird total density between San Dieguito Wetlands (SDL) and Tijuana Estuary (TJE), Mugu Lagoon (MUL), and Carpinteria Salt Marsh (CSM).

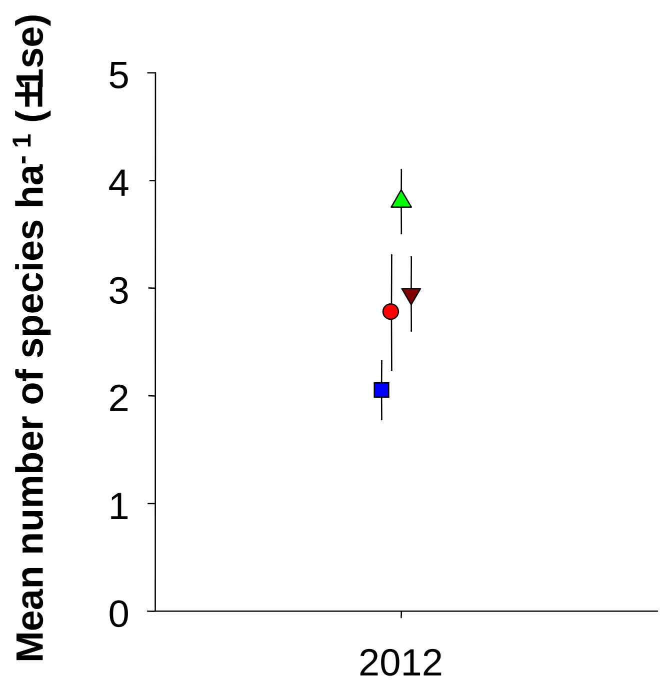


Figure 5.2.8. Comparison of bird species richness between San Dieguito Wetlands and the

three reference wetlands. Symbols as Fig. 5.2.7 above.

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

<u>Approach</u>: The proportion of total vegetation cover in the San Dieguito Wetlands and the reference wetlands is estimated using low-level multi-spectral aerial imagery acquired during low spring tides in late May-early June (Fig. 5.2.9). Wetland wide estimates of cover classes are then compared between San Dieguito Wetlands and the reference wetlands.

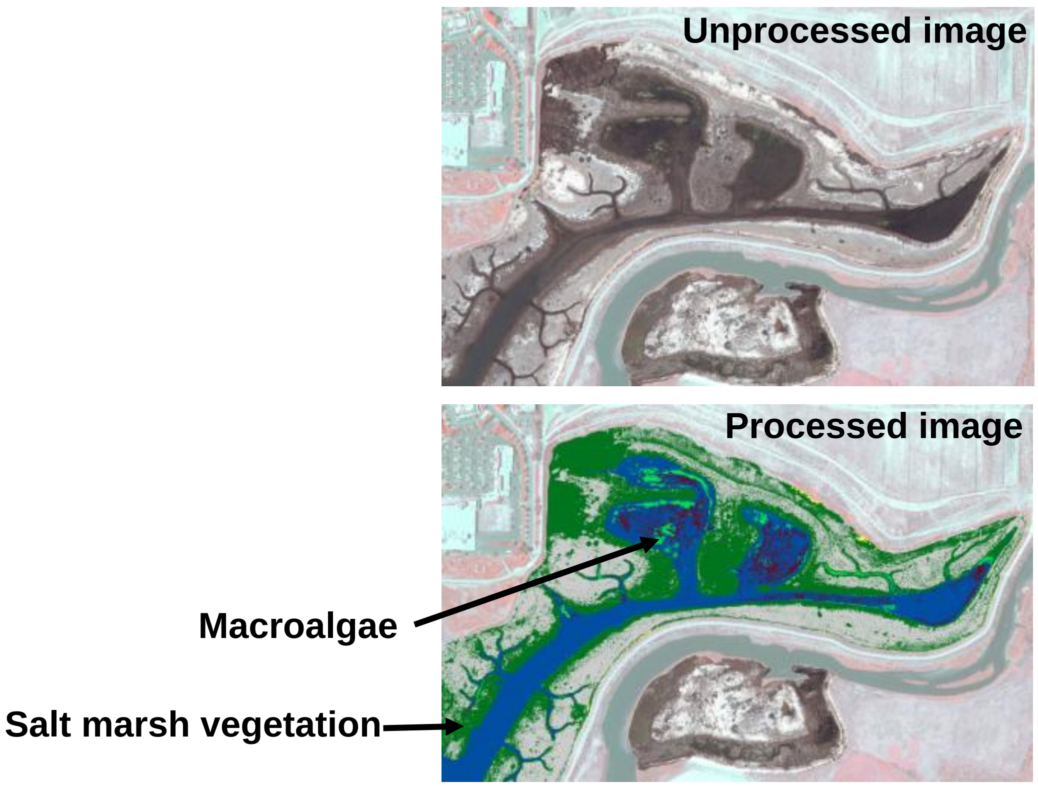


Figure 5.2.9. Example of an unprocessed image (top) and the processed image (bottom) from which the proportion of salt marsh vegetation and macroalgae (primarily *Ulva* spp.) in San Dieguito Wetlands is determined.

<u>Results</u>: The cover of vegetation in the San Dieguito Wetlands was the lowest of all four wetlands, and about 30% lower than at Mugu Lagoon, the reference site with the lowest cover (Fig. 5.2.10). As indicated earlier, the low cover of vegetation in San Dieguito Wetlands was due in large part to the poor establishment of vegetation at higher marsh elevations.

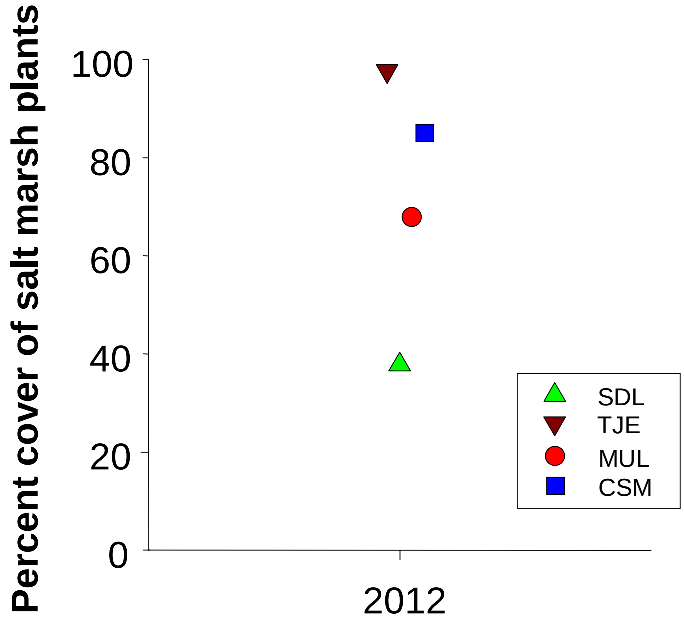


Figure 5.2.10. Comparison of the percent cover of salt marsh plants between San Dieguito Wetlands and the reference wetlands.

Algae

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

<u>Approach</u>: 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). Decomposing mats of macroalgae can also adversely affect water quality. 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.

<u>Results:</u>

Macro-algal cover (primarily *Ulva* spp.) at the San Dieguito Wetland was less than 2% and similar to values at Tijuana Estuary and Carpinteria Salt Marsh, and much lower than the value at Mugu Lagoon, which was about 10% (Fig. 5.2.11).

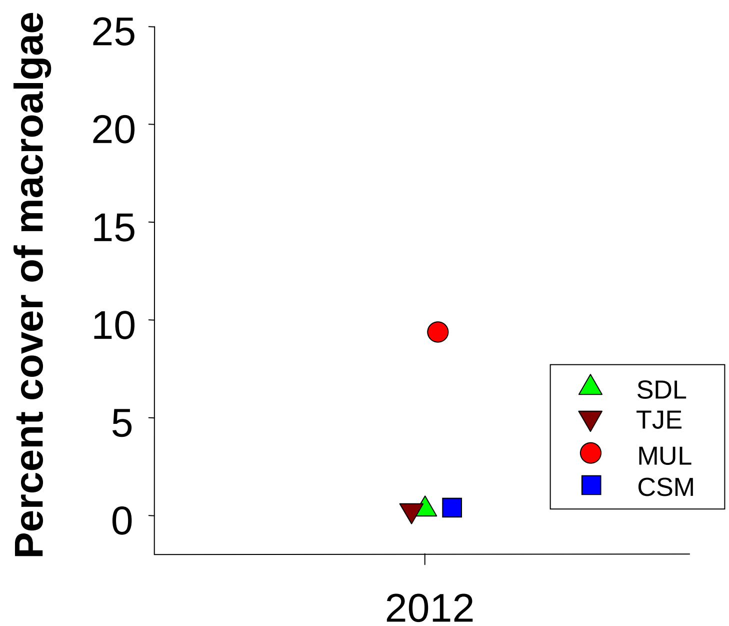


Figure 5.2.11. Comparison of percent cover of macroalgae between San Dieguito Wetlands and the reference wetlands.

***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 endangered 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 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 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. 5.2.12) and is based on the methods developed by Zedler (1993). From the sampling, the mean proportion of stems >3 feet tall (excluding flowering stalks) is determined for each cordgrass patch. The mean proportion of stems >3 feet (91 cm) tall is calculated using patches as replicates, and compared between wetlands.

Figure 5.2.12. View of sampling transect overlying a patch of cordgrass in module W4. Cordgrass is sampled in 10 x 10 cm quadrats placed every two meters along the transect line.

<u>Results</u>:

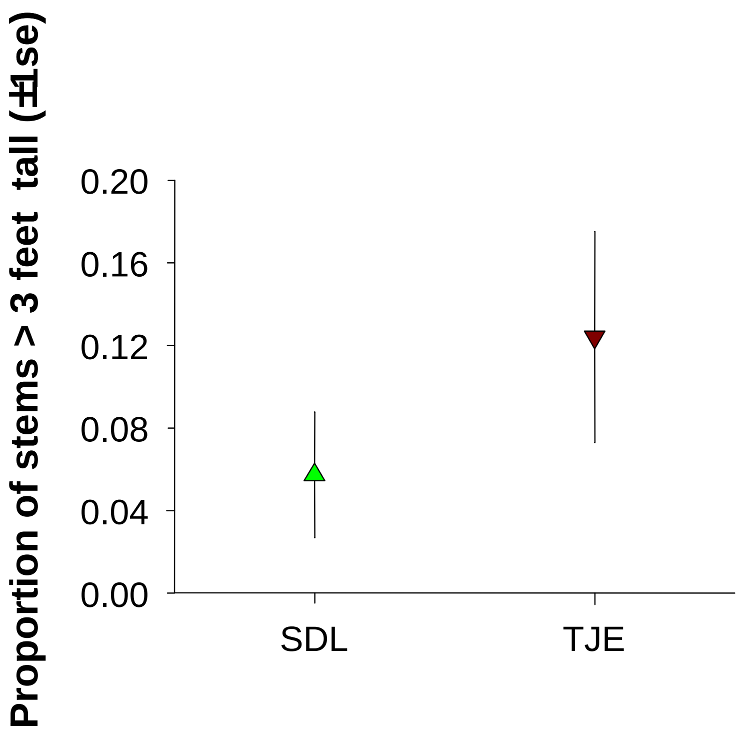


Figure 5.2.13. Comparison of the mean proportion of stems >3 feet tall between San Dieguito Wetlands and Tijuana Estuary.

The mean proportion of stems >3 feet tall was significantly lower in San Dieguito Wetlands than in Tijuana Estuary (Fig. 5.2.13). However, the growth of *Spartina* in the restoration site is encouraging.

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

Results: All seven species produced seed in 2012, which is consistent with the permit requirements (Table 5.2.1).

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

Table 5.2.1. Plant species evaluated for seed set.

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 density and species richness. This performance standard is evaluated using the density of birds feeding within available mudflat or unvegetated channel 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 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 analysis consists of the average across the 18 survey dates.

Results:

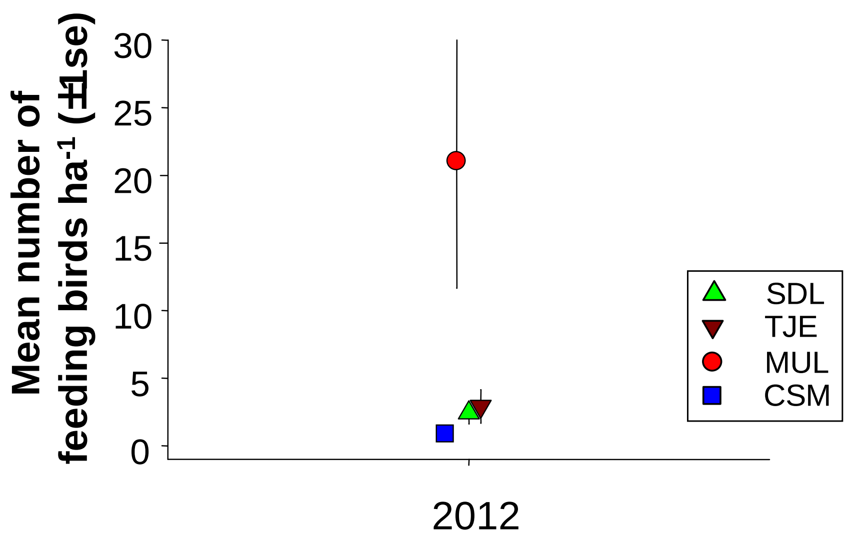


Figure 5.2.14. Comparison of the densities of feeding birds between San Dieguito Wetlands and the reference wetlands.

The highest density of feeding birds occurred in Mugu Lagoon (Fig. 5.2.14). However the density of feeding birds was higher in San Dieguito Wetlands than in Carpinteria Salt Marsh, which is encouraging for the restoration site.

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 evaluate this standard.

Figure 5.2.15. 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, to adaptatively manage for exotic species, a special survey that covers as much of the wetland as possible that looks for exotic species was conducted. This special survey focused on plants and non-cryptic macro invertebrates in intertidal and subtidal habitats (Fig. 5.2.15).

Results: Although the San Dieguito Wetlands underperformed the reference sites for some relative standards, there was no evidence from our sampling that exotic species were responsible. Densities of exotic species were very low and there was no evidence that exotic species impaired the important functions of San Dieguito Wetlands in 2012.

5.3 Summary of Assessment of Absolute and Relative Standards

	ABSOLUTE STANDARDS	SDL 2012
1	Habitat areas	YES
2	Tidal Prism	YES
3	Topography	YES
4	Plant Reproductive Success	YES
5	Exotic Species	YES

Table 5.3.1. Summary of assessment of the Absolute Standards.

Table 5.3.1 provides a summary assessment of the Absolute Standards for 2012. A "**YES**" indicates that the San Dieguito Wetlands Restoration met the required criteria for a given Absolute Standard. The San Dieguito Wetland Restoration was consistent with meeting all five absolute standards in 2012, which is very encouraging.

		Impact Site			
	RELATIVE STANDARDS	SDL	TJE	MUL	CSM
1	Water Quality	YES	YES	YES	NO
2	Bird Density	YES	YES	YES	YES
3	Bird Species Richness	YES	YES	YES	YES
4	Fish Density - Main Channels	YES	YES	YES	YES
5	Fish Species Richness - Main Channels	YES	YES	NO	YES
6	Fish Density - Tidal Creeks	YES	YES	YES	YES
7	Fish Species Richness - Tidal Creeks	YES	YES	YES	YES
8	Macro-invertebrate Density - Main Channels	NO	YES	YES	YES
9	Macro-invertebrate Species Richness - Main Channels	YES	YES	YES	YES
10	Macro-invertebrate Density - Tidal Creeks	NO	YES	YES	YES
11	Macro-invertebrate Species Richness - Tidal Creeks	NO	YES	YES	YES
12	Vegetation - Total Cover	NO	YES	YES	YES
13	Algae - Total Cover	YES	YES	NO	YES
14	Food Chain Support - Bird Feeding	YES	YES	YES	NO
15	Spartina Canopy Architecture*	NO	YES		
	TOTAL YES	10	15	12	12
	*Evaluated relative to Tijuana Estuary only				

Table 5.3.2. Summary assessment of the Relative Standards.

Table 5.3.2 provides a summary assessment of the relative performance standards for 2012. A "**YES**" indicates that the indicated response variable values at a particular wetland are similar to in the other wetlands. A "**NO**" indicates that the indicated response variable was statistically worse than the other wetlands. The Tijuana Estuary was the best performing wetland with 15 standards receiving a "**YES**", indicating that the value for these performance variables were as good, or better, than those in the other three wetlands. Mugu Lagoon and Carpinteria Salt Marsh performed equally well, meeting 12 standards, two more than were met at the San Dieguito Wetlands Restoration. Thus, the San Dieguito

Wetlands Restoration did not meet the general criteria for meeting the relative standards. Given that this is the first year after completion of construction, these results are nonetheless encouraging for the San Dieguito Wetlands given the early stage of the restoration. Standards in the San Dieguito Wetlands that will warrant close observation during the next year include macro-invertebrate density and species richness, and development of vegetation cover at high elevations.

6.0 References

Elwany, H., R. Flick, and J. Reitzel. 1998. Inlet channel maintenance plan for restored San Dieguito Lagoon. Prepared for Southern California Edison, Rosemead, California 91770, 1 June 1998, CE ref No. 98-8.

Everett, R. A. 1991. Intertidal distribution of infauna in a central California lagoon: the role of seasonal blooms of macroalgae. Journal of Experimental Marine Biology and Ecology 150:223-247.

Hume, T. M. 2005. Tidal prism. In M. L. Schwartz (Ed.). Encyclopedia of Coastal Science. Springer, Dordrecht, The Netherlands.

MEC Analytical Systems, Inc. 1993. San Dieguito Lagoon Restoration Project Biological Baseline Study, March 1992 - May 1993. Volume 1. Draft Technical Memorandum prepared for Southern California Edison.

Page, M., S. Schroeter, D. Reed, and M. Steele. 2011. Monitoring Plan for the SONGS' Wetland Mitigation Project. Report to the California Coastal Commission. 247 pp.

SCE (Southern California Edison Company). 2004. San Dieguito Wetlands Restoration Project: Final Restoration Plan. Submitted to the California Coastal Commission, August 2004.

Talley, T. S., J. A. Crooks, and L. A. Levin. 2001. Habitat utilization and alteration by the invasive burrowing isopod, *Sphaeroma quoyanum*, in California salt marshes. Marine Biology 138:561-573.

Zedler, J. B 1993. Canopy architecture of natural and planted cordgrass marshes – selecting habitat evaluation criteria. Ecological Applications 3:123-138.