

2020

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

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



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Table of Contents

1. Executive Summary	3
2. Introduction	6
2.1. Purpose of Report	6
2.2. Background	6
3. Project Description	9
4. Methods of Project Evaluation	14
4.1. Monitoring Plan	14
4.2. Performance Standards	14
4.3. Reference Wetlands	15
4.4. Determination of Similarity	15
5. Performance Assessment of the San Dieguito Wetlands Restoration Project	18
5.1. Absolute Performance Standards	18
5.2. Relative Performance Standards	26
6. Permit Compliance	46
6.1. Summary Assessment of the Absolute Performance Standards	46
6.2. Summary Assessment of the Relative Performance Standards	46
6.3. Project Compliance	48
7. Status of Salt Marsh Vegetation and Biological Communities	49
7.1. Overview	49
7.2. Salt Marsh Vegetation	49
7.3. Birds, Fish and Macro-invertebrates	55
7.3.1 Underperformance of macro-invertebrates	56
8. Progress Towards Compliance with the SONGS Permit	65
9. References	67

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. The monitoring is overseen by the California Coastal Commission (CCC) and is done independently of SCE. This report summarizes results from the ninth year of performance monitoring completed in 2020.

There are five absolute performance standards. Absolute standards are measured only in San Dieguito Wetlands and must be met every year for SCE to receive mitigation credit. San Dieguito Wetlands met the absolute standards for tidal prism, topography, plant reproductive success (measured by seed production) and exotic species in 2020. San Dieguito Wetlands has not yet met the habitat areas standard. Habitat assessed as salt marsh in San Dieguito Wetlands increased to 77.6 acres in 2020, but the wetland is still 5.7 acres below the minimum number of required acres (83.3 acres) of this habitat. However, the trajectory of increase in salt marsh over time is promising and it is anticipated that the minimum required acres of this habitat may be achieved in the foreseeable future.

There are 15 relative performance standards. Relative standards are measured in San Dieguito Wetlands and evaluated against natural wetlands in the region that serve as reference sites. San Dieguito Wetlands must be similar to the reference wetlands to satisfy the relative performance standard requirement. San Dieguito Wetlands passed the seven performance standards that pertain to water quality, bird density and species richness, fish species richness in tidal creek habitat, invertebrate species richness in main channel habitat, algal cover, and *Spartina* canopy architecture. San Dieguito Wetlands failed to pass the eight relative standards that pertain to invertebrate density in main channel and tidal creek habitats, invertebrate species richness in tidal creeks, fish density in main channel and tidal creek habitats, fish species richness in main channel habitat, cover of vegetation, and food chain support (bird feeding).

Vegetation cover is high in the three reference wetlands, Mugu Lagoon, Carpinteria Salt Marsh, and Tijuana Estuary. A goal of the restoration project is to not only achieve the required acreage of salt marsh habitat, but also the high cover of vegetation (typically > 85%) found in the reference wetlands. There was an

appreciable increase in the acres of > 85% cover to approximately 35 acres in 2018-2020, which is encouraging for eventually meeting the relative standard for vegetation cover. Of concern, is the continued deficit in invertebrates in main channel and tidal creek habitats and, more recently, the underperformance of fish density and richness in main channel and tidal creek habitats, and food chain support in San Dieguito Wetlands relative to the reference wetlands. The underperformance of these standards contributed to the failure of San Dieguito Wetlands to meet the relative standard requirement for 2020.

SCE has undertaken a planting program to facilitate vegetation development and address the failure of the restoration site to pass the absolute standard for habitat areas and the relative standard for vegetation cover. Two experiments were embedded within the larger planting effort in 2020 to inform SCE's planting program. The first experiment is designed to evaluate the effect of irrigation, soil decompaction, soil amendments, planting of potted plants, and seeding to increase plant cover in higher elevation, sparsely vegetated areas. The goal of the second experiment is to test the effect of planting versus seeding on filling in gaps in plant cover at lower elevations. These experiments are in progress, but preliminary data suggest no effect of seeding on plant cover in either experiment. There are no data to suggest that any of the treatments in the first experiment enhance plant cover or plant sizes. More promising is the increase in cover of three plant species in the second experiment, suggesting that planting to fill-in unvegetated gaps may facilitate an increase in vegetation cover at lower elevations. UCSB scientists will continue to monitor the experiment and the overall planting program to evaluate whether they achieve the desired goal of increasing vegetation cover.

The standards for invertebrate density were only met the first year in main channel habitat and have never been met in tidal creek habitat. There may be different reasons for the underperformance of invertebrates in tidal creek and main channel habitats. One possible hypothesis for the low densities of invertebrates in tidal creeks in San Dieguito Wetlands, which requires further exploration, is that tidal creek elevations are higher than in the reference wetlands and that invertebrate density varies inversely with elevation. This explanation does not apply to main channel habitat, where station elevations are similar among the wetlands. In this habitat, other variables, such as properties of the sediments, may contribute to the deficit in invertebrates in San Dieguito Wetlands. This possibility requires further study, which will involve the collection of new data and perhaps a targeted experiment to compare colonization of invertebrates in sediments from different locations.

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 in the SONGS permit. The San Dieguito Wetlands Restoration Project did not satisfy the absolute standard requirement, meeting four of the five absolute standards. The restored wetland also did not meet the success criteria for the relative standards, which require that at least the same proportion of relative standards be met in the San Dieguito Wetlands as are met in the worst performing

reference wetland. In 2020, 46.6% of the relative standards were met in the San Dieguito Wetlands compared with 92.9% of standards met in the worst performing reference wetland (Mugu Lagoon).

In order to receive mitigation credit for a given year, the wetland restoration project must meet all of the absolute standards and at least the same proportion of relative standards as the worst performing reference wetland. So far, the San Dieguito Wetlands has yet to meet the absolute standard for habitat areas and failed to meet the relative standard requirement except in 2013. Consequently, San Dieguito Wetlands has not yet satisfied the performance success criteria provided in the SONGS permit and has not yet received mitigation credit.

The progressive decline in the proportion of relative standards met in San Dieguito Wetlands relative to the reference wetlands is a concern. There is language in the SONGS permit that pertains to the responsibility of the permittee to meet the performance standards and the prescription of remedial measures should the standards not be met. The evaluation of potential remediation options will be a task within the 2022 - 2023 work plan. On-going activities and future plans include continued performance monitoring in 2021 as required by the SONGS permit, monitoring the planting program and experiments for vegetation, and further analysis of existing data, and the collection of additional data to assist in the determination of mechanisms underlying the under-performance of those relative standards not met in 2020.

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, CCC 1997), which pertains to mitigation for SONGS impacts to fish populations in the Southern California Bight. Southern California Edison (SCE) and the California Coastal Commission (CCC) have clear and distinct roles in the implementation of Condition A. Under the condition, SCE is required to construct or substantially restore a minimum of 150 acres of tidal wetlands, excluding the buffer zone and transition habitat. The CCC is to provide scientific oversight and monitoring of the wetland mitigation project that is independent of SCE. This report presents the results from the CCC's monitoring of the SONGS wetland mitigation project (hereafter referred to as the San Dieguito Wetlands) during 2020 (the ninth 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 (CCC 1997).

2.2. Background

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

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

Units 2 and 3 of SONGS are not currently producing power. Unit 2 was shut down in early January 2012 for routine refueling and replacement of the reactor vessel head.

On January 31, 2012, Unit 3 suffered a small radioactive leak largely inside the containment shell, with a release to the environment below allowable limits, and the reactor was shut down per standard procedure. On investigation, both units were found to show premature wear in 15,000 places on over 3,000 tubes in the replacement steam generators that were installed in 2010 and 2011. A decision to shut down the reactors was made on June 7, 2013 and a certification of permanent cessation of power operations was issued on July 22, 2013. The operating license was modified to “possession” only and SCE is no longer authorized to operate or place fuel in the reactors. Since the shutdown, the flow in each unit has been reduced to about 42 million gallons per day or roughly 3% of the normal operating flow. In March 2019, the Commission determined that the magnitude of the reduction in discharge makes it unlikely that this level of flow contributes to significant adverse ecological impacts and based on this determination they defined the end of the operating life of SONGS as the end of 2013, and set the full operating life of SONGS at 32 years.

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

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

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

In April 1997, the Commission revised Condition A to allow the permittee to meet its 150-acre wetland acreage requirement by receiving up to 35 acres enhancement

credit for the permittee's permanent maintenance of an open inlet that will produce continuous tidal flushing at San Dieguito Lagoon. The CCC also confirmed in April 1997 its previous finding that independent monitoring and technical oversight was required in Condition D to ensure full mitigation under the permit. Condition D requires SCE and its partners to fund scientific and support staff retained by the CCC to oversee the site assessments, project design and implementation, and monitoring activities for the mitigation projects. Scientific expertise is provided to the CCC by a small technical oversight team hired under contract. The technical oversight team members include three Research Biologists from UC Santa Barbara: Steve Schroeter, Ph.D., marine ecologist, Mark Page, Ph.D., wetlands ecologist (half time), and Dan Reed, Ph.D., kelp forest ecologist (half-time). In addition, a science advisory panel advises the CCC on the design, implementation, monitoring, and remediation of the mitigation projects. Current science advisory panel members include Richard Ambrose, Ph.D., Professor, UCLA, Peter Raimondi, Ph.D., Professor, UC Santa Cruz, and Russell Schmitt, Ph.D., Professor, UC Santa Barbara. In addition to the science advisors, the contract program staff is aided by a team of field assistants hired under a contract with the University of California, Santa Barbara to collect and assemble the monitoring data. Independent consultants and contractors also assist the contract program's staff when expertise for specific tasks is needed. The CCC's permanent staff also spends a portion of their time on this program, but their costs are paid by the CCC and are not included in the SONGS budget.

3.0 Project Description

The CCC decided that the goal of out-of-kind compensation for adverse effects on fish populations in the Southern California Bight due to SONGS operations will most likely be met if the wetland mitigation project: (1) is located near SONGS, but outside its influence to ensure that the compensation for lost resources will occur locally rather than at a distant location (Fig. 3.0.1), (2) creates or substantially restores 150 acres of wetlands, and (3) performs for a period of time equal to the operating life of SONGS Units 2 & 3, including the decommissioning period to the extent that there are continuing discharges (=32 years).



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

The restoration project included excavation and grading to create intertidal salt marsh, mudflat, and subtidal basin habitats (Fig. 3.0.2). In addition, four Least Tern nesting sites were constructed, which were not part of the SONGS mitigation requirement. Disposal sites to the northeast and southeast of the project site received most of the over 2 million cubic yards of material excavated during construction of the wetland.

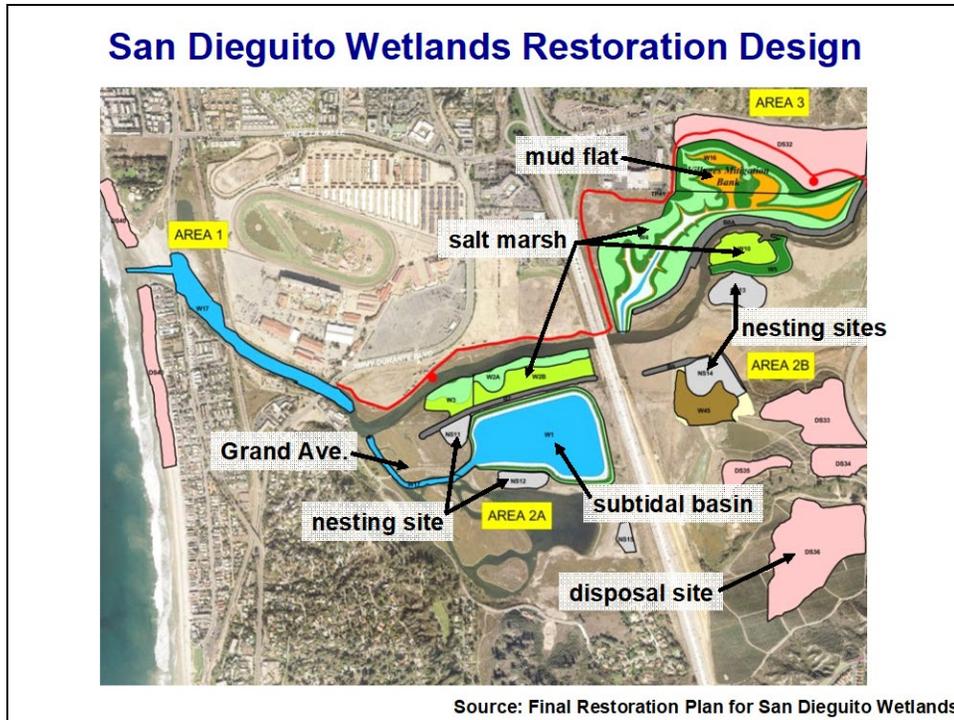


Figure 3.0.2. The design plan view of the restoration project that was approved by the CCC. The project included the creation of tidal salt marsh, indicated by shades of green, mudflat, indicated by the light brown and light blue, and subtidal basin, indicated by blue. In addition, four nesting sites, shown in gray, were constructed, which were not part of the SONGS mitigation requirement. The areas in pink are disposal sites. Dark gray linear features are berms along the effective flow area of the San Dieguito River. The yellow boxes that indicate Areas 1, 2a, 2b, and 3 pertain to the staging of construction activities.

Construction began in September with most excavation and grading completed by the end of 2008 (Fig. 3.0.3, 3.0.4a, b). 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 (modules W4/16) and these areas were opened to tidal exchange in December 2008. Grading of modules W2/3 in Area 2A was completed in November 2010 (Figs. 3.0.2, 3.0.3).

Timeline

Construction 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: 2008, 2009, 2011, 2016-2020

Inlet dredging: September 2011
Nov/Dec 2015, 2017, 2019

Performance monitoring January 2012 to present (9 years)



Figure 3.0.3. Timeline for the San Dieguito Wetlands Restoration Project.

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

Following excavation and grading, portions of the restoration project were planted with salt marsh plants. Planting of selected species (largely pickleweed) in high marsh habitat occurred in 2008. Test planting of cordgrass occurred in 2009. The largest planting of cordgrass throughout the restoration was done in November 2011 following initial post-construction inlet channel dredging, which was completed in September 2011. Some additional planting at high marsh tidal elevations occurred in 2016 - 2018 with planting at higher and lower elevations in 2019 and 2020 (see Section 7.0).

Material excavated from the construction site was deposited in upland disposal sites within the project area (Fig. 3.0.4b). Berms designed to constrain storm runoff were completed in February 2009 along the boundary of the effective flow area of the San Dieguito River. Maintenance dredging of the inlet was conducted in November-December 2015, 2017 and 2019. Performance monitoring began in January 2012, following the initial dredging of the inlet in September 2011.

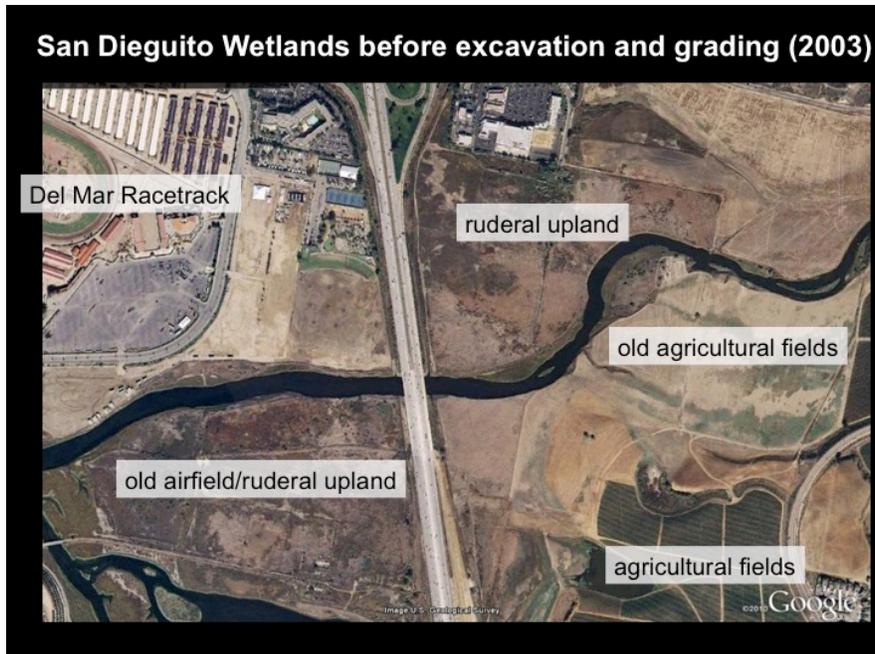


Figure 3.0.4a. Satellite view of the project site in 2003 before excavation and grading. Highlighted are the San Dieguito River and adjoining ruderal upland, including the site of an old WWII dirigible airfield, old agricultural fields, and visible at the bottom of the image, a portion of the Fish and Game Basin constructed in 1978.

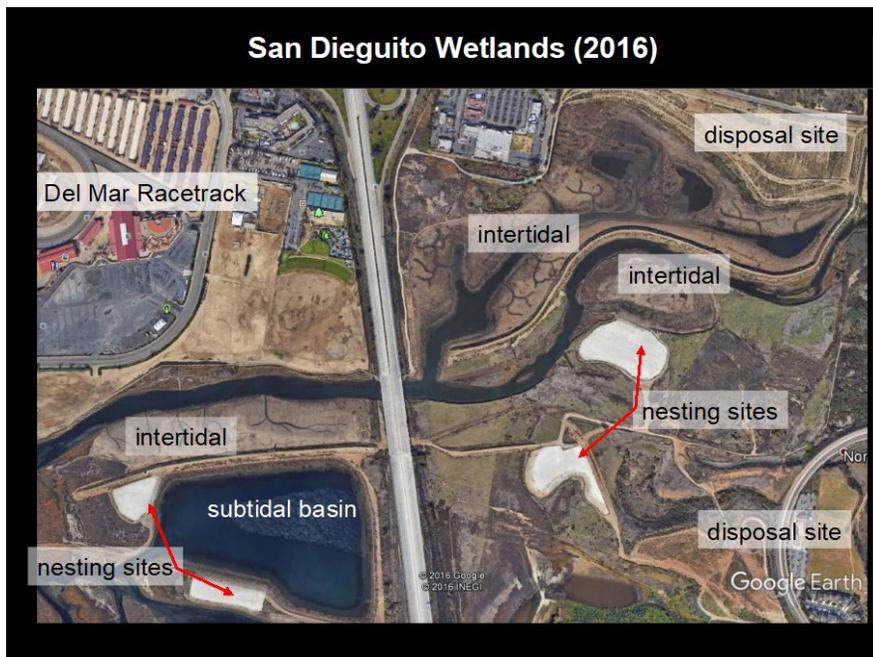


Figure 3.0.4b. During construction, the ruderal areas, old agricultural fields, and the WWII airfield were excavated and graded to create the planned intertidal and subtidal wetland habitats of the restoration project visible in this image taken in 2016.

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

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

In the ninth year of performance monitoring, the restored wetland continues to provide habitat for an array of invertebrates, fish, and birds, and wetland plants (Fig. 3.0.5), which includes species of conservation concern such as the endangered Ridgway's Rail and Belding's Savannah Sparrow. Although the wetland is providing resource value it has not yet met the performance criteria required for successful mitigation, as discussed in Section 5.0 that reviews the results from performance monitoring in 2020.



Figure 3.0.5. Examples of biological resources supported by the San Dieguito Wetlands.

4.0 Methods of Project Evaluation

4.1. Monitoring Plan

Condition A of the SONGS permit (CCC 1997) 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 (CCC 1997). 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 (CCC 1997) 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 are 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, July 2016, August 2017, August 2018, and [June 2021](#) as more information became 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 (CCC 1997) 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 (CCC 1997) 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 are 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 a given performance variable be similar to that measured in reference wetlands in the region. The performance standards include long-term physical standards pertaining to topography (i.e., erosion, sedimentation), water quality (i.e., oxygen concentration), tidal prism (which affects tidal flushing), and habitat areas, and biological performance standards pertaining to biological communities (i.e., fish, invertebrates, and birds), cover of salt marsh vegetation, *Spartina* canopy architecture, reproductive success of marsh plants, food chain support provided to birds, and exotic species.

The evaluation of each absolute performance standard in any given year is assessed by 1) a comparison of the value obtained from monitoring to a fixed value (i.e., for Habitat Areas, Tidal Prism, Plant Reproduction) or to other performance monitoring data (i.e., for Topography, Exotic Species). All absolute standards must be met in a given year in order for that year to receive mitigation credit and 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. Use of a short-term (4-year) running average accounts for natural variation over time that could affect the performance of the restoration site relative to the reference wetlands. For example, invertebrate, fish, and bird populations can vary in their species numbers and abundance from year to year and, given this variation, it is likely that the reference wetlands (much like the San Dieguito Wetlands) would not consistently meet all the relative standards in a given year.

4.3. Reference Wetlands

The SONGS permit (CCC 1997) specifies that successful achievement of the relative performance standards will be measured in comparison to reference wetlands. Ideally, the biological assemblages in a successfully restored wetland should vary in a manner similar to those in the natural wetlands used for reference. Temporal variability, especially of the sort associated with weather (e.g., air temperature, rainfall) or oceanographic conditions (e.g., swell height, water temperature, sea level) can be accounted for by sampling the restored and natural reference wetlands concurrently. Concurrent monitoring of the restored and natural wetlands will help ensure that regional changes in weather and oceanographic conditions affecting the restored wetland will be reflected in the performance standards, since the reference wetlands should be subjected to similar conditions.

The permit requires that the wetlands chosen for reference be relatively undisturbed, natural tidal wetlands within the Southern California Bight. Relatively undisturbed wetlands have minimal human disturbance to habitats (e.g., trampling of vegetation, boating, fishing). Natural tidal wetlands appropriate as reference sites are not constructed or substantially restored, are continuously open to the ocean, and receive regular tidal inundation. The Southern California Bight extends from Point Conception to the US/Mexico border. After evaluating 46 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 (CCC 1997) 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 the mean value for the performance variable at San Dieguito Wetlands not be significantly worse than the mean value for the worst performing of the three reference wetlands. A one sample, one tailed statistical test is used to evaluate all such comparisons. Significance is determined using an approach that utilizes both a formal probability value and an effect size. Generally, this is done by means of a t-test except in the case of the performance standards pertaining to vegetation and algae. For these standards, only the mean values are compared because the values are wetland wide censuses made using aerial imagery and thus there is no variability around a mean value. The performance for a particular relative performance variable at San Dieguito Wetlands is considered to be worse than the 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 rationale 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, 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 similar to the reference wetlands when it is not (Type II error).

To ensure that the San Dieguito Wetlands are not held to a higher standard than the reference wetlands, the above procedure is also applied to the three reference wetlands (Tijuana Estuary, Mugu Lagoon, and Carpinteria Salt Marsh) to evaluate whether they would have met the relative performance standards. This is done by treating each reference wetland as the mitigation wetland and using the other wetlands as the three reference wetlands. The San Dieguito Wetlands are considered similar to the reference wetlands if the proportion of relative standards met by the San Dieguito Wetlands is equal to or greater than the proportion of relative standards met by any of the reference wetlands. The above approach ensures that the assessment of similarity is consistent with the SONGS permit (CCC 1997) requirement that the performance standards be met without the unreasonable requirement that the San Dieguito Wetlands outperform the reference wetlands (Tijuana Estuary, Mugu Lagoon, and Carpinteria Salt Marsh) for every performance standard. Importantly, this approach deals realistically with the

inherent variability of nature in a manner that best serves the interests of both the public and SCE.

5.0 Performance Assessment of the San Dieguito Wetlands Restoration Project

Listed below are the performance standards that are used to evaluate whether the San Dieguito Wetlands Restoration meets the goals and objectives of the wetland mitigation set forth in Condition A of the SONGS coastal development permit, the methods used to evaluate each performance standard, and the results from the ninth year of monitoring. More detailed methods, including monitoring metadata can be found in the Monitoring Plan for the SONGS Wetland Mitigation Project.

5.1. Absolute Performance Standards

5.1.1. Tidal Prism

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

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

Since tidal prism can influence the area of wetland habitat inundated by the tides, the tidal prism standard is evaluated, in part, using criteria set forth in the habitat areas standard, which provide that the areas of the different habitats (subtidal, intertidal mudflat, vegetated salt marsh) shall not vary by more than 10% from the areas in the Final Restoration Plan. The planned tidal volume-elevation relationship indicated that a decrease in tidal prism of greater than 12% could result in a reduction in the area of tidally inundated planned salt marsh habitat (1.3 to 4.5' NGVD) of greater than 10%. Since the area of planned intertidal salt marsh habitat may not differ by more than 10% from the as-built area (see Section 5.1.2, Habitat Areas), the tidal prism cannot be less than 88% of the as-built prism to ensure no more than 10% of planned salt marsh habitat remains exposed during a 4.5' tide. However, since a larger than planned tidal prism could potentially increase erosion within the restored wetland, the prism shall also not be larger than 112% of the as-built prism.

Tidal prism is calculated by cumulating values of tidal flow volumes measured over an entire incoming (flood) tide for a range of maximum high tides using a portable Acoustic Doppler Current Profiler (ADCP) system (SonTek River Surveyor, Fig. 5.1.1.1). The performance standard is met if the regression line fit through the prism measurements taken during the monitoring year falls within 12% of the as-built prism value.

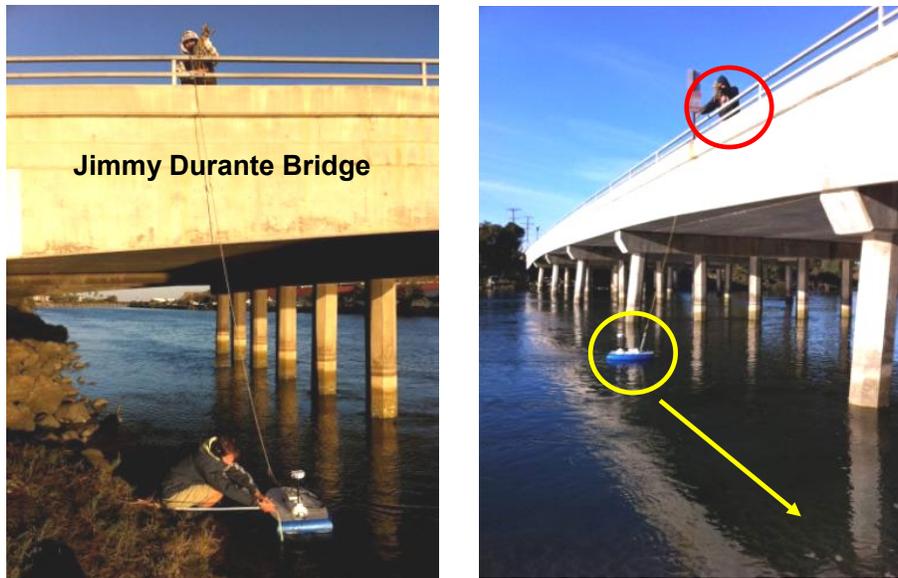


Figure 5.1.1.1. Measurements of tidal flows are taken at Jimmy Durante Bridge (0.9 km from the inlet) using a portable Acoustic Doppler Profiler/discharge measurement system (yellow circle) that is towed back and forth across the width of the channel by monitoring staff (red circle) every 15 minutes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

The 22nd Agricultural District completed the final phase of a restoration project within a parcel adjacent to the Grand Avenue Bridge in 2017. Excavation completed as part of this restoration project added approximately 45 acre-feet to the as-built tidal prism. Tidal prism measurements for 2020 were adjusted downward to take into consideration the increase in prism resulting from the 22nd Agricultural District restoration project, and then evaluated against the as-built prism measured in 2012.

Results: The regression fit to the adjusted tidal prism measurements for 2020 falls between the dashed green lines, indicating that the tidal prism at the San Dieguito Wetlands was maintained in 2020 (Fig. 5.1.1.2). Therefore, this performance standard is met for 2020.

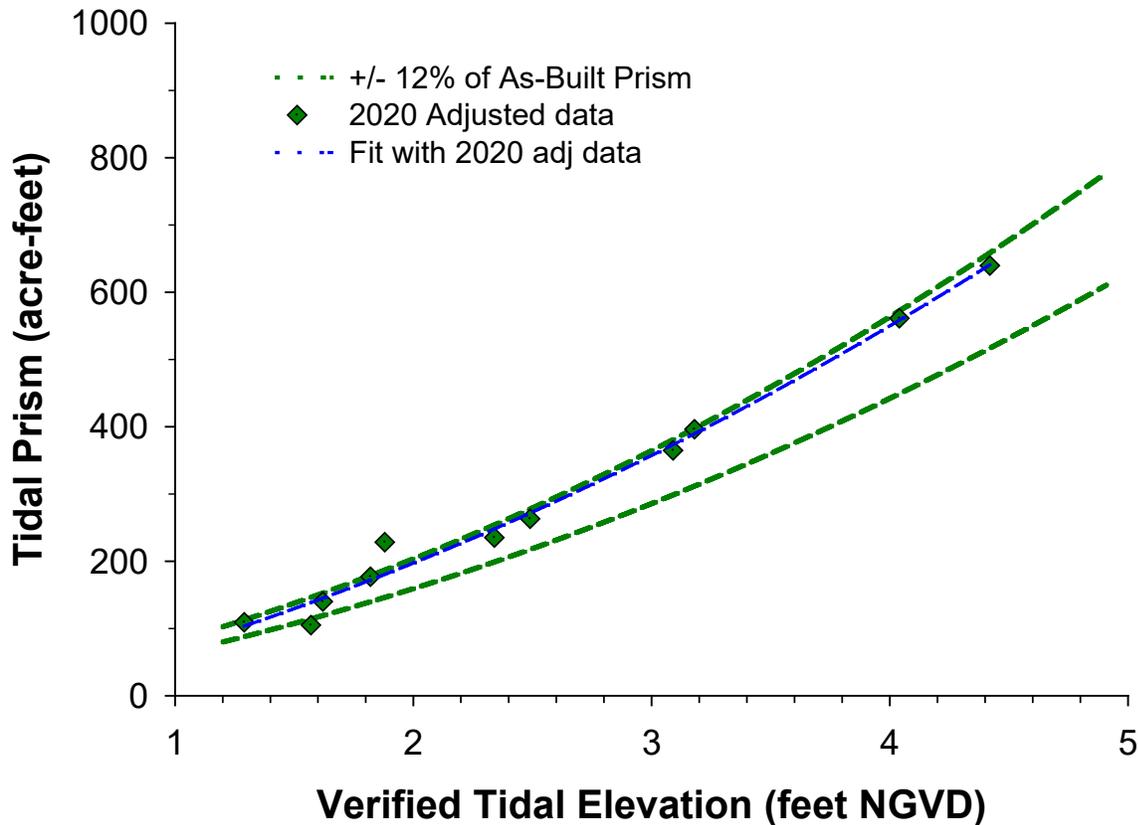


Figure 5.1.1.2. The regression fit to the tidal prism measurements taken January-December 2020 (blue dashed line) must fall within the two dashed green lines, which represent 88% and 112% of the as-built prism, for the tidal prism to be maintained. Tidal prism measurements for 2020 were adjusted for the excavation of additional wetland by the 22nd Agricultural District adjacent to the Grand Avenue Bridge.

5.1.2. Habitat area

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

Approach: The habitat areas standard, as an absolute standard, is applied only to the San Dieguito Wetlands restoration. This performance standard is designed to preserve the mix of habitats specified in the Final Restoration Plan (SCE 2005) and to guard against large scale conversions of one habitat type to another, for example of vegetated marsh to mudflat. The Final Restoration Plan indicates that subtidal habitat will occur at elevations of < -0.9' NGVD, intertidal mudflat will occur from -0.9 to 1.3' NGVD, and intertidal salt marsh will extend from 1.3 to 4.5' NGVD and specifies acreages of the different habitats (Fig. 5.1.2.1). While this is useful for planning the acreages and distributions of the proposed habitats, salt marsh and mudflat habitats may not be constrained by these elevation boundaries. As a result, areas of the three habitats are assessed using criteria based on inundation, elevation, and cover of vegetation. Subtidal habitat is defined as continuously submerged. Mudflat habitat is defined as intertidal, occurring lower than 3.5' NGVD to provide for frequent tidal inundation, and

as sparsely vegetated (< 5% cover of vegetation) since mudflats are by definition unvegetated (Fig. 5.1.2.2).

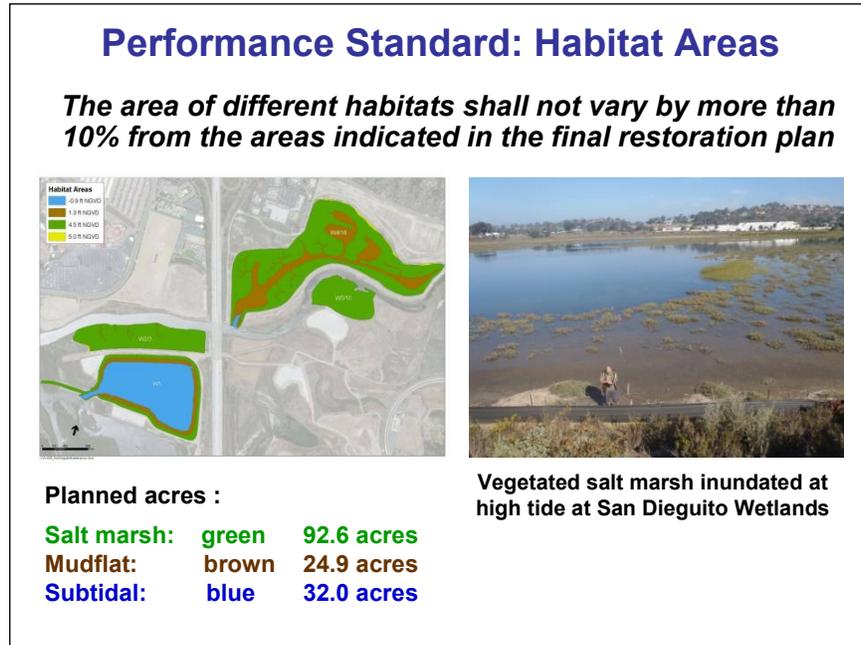


Figure 5.1.2.1. Panel on the left shows areas of planned salt marsh (green), mudflat (brown), and subtidal (blue) habitats as provided in the Final Plan for the restoration project. The photo on the right shows marsh vegetation inundated during a high tide.

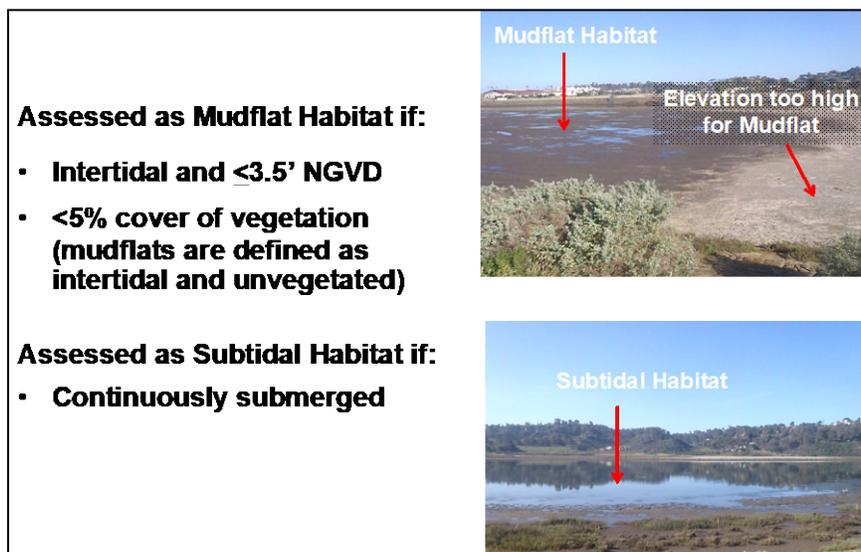


Figure 5.1.2.2. Criteria used to classify areas of the restoration project as mudflat and subtidal habitat.

The upper elevation limit for mudflat was based on the observation of surface salt deposits above this level in some areas of San Dieguito Wetlands indicating infrequent tidal inundation. The upper elevation boundary of subtidal habitat is determined using

continuously recording data loggers that measure water level height. Salt marsh habitat is defined as intertidal, occurring at or below 4.5' NGVD, the upper elevation limit of tidally influenced habitat for this project, and as vegetated by at least 30% cover of salt marsh plants (Figs. 5.1.2.3). 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. Areas that do not meet the criteria for subtidal, mudflat, and salt marsh habitat are designated as "other", not a planned habitat. 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 m x 10 m grid plots that cover the entire wetland and are superimposed on multispectral aerial images of the restoration site taken annually in late spring to early summer. The acreages of subtidal, mudflat, and salt marsh habitats are computed with the aid of ArcMap and ArcGIS software and compared to the planned acreages in the Final Plan to determine whether they are within 10% of planned values.

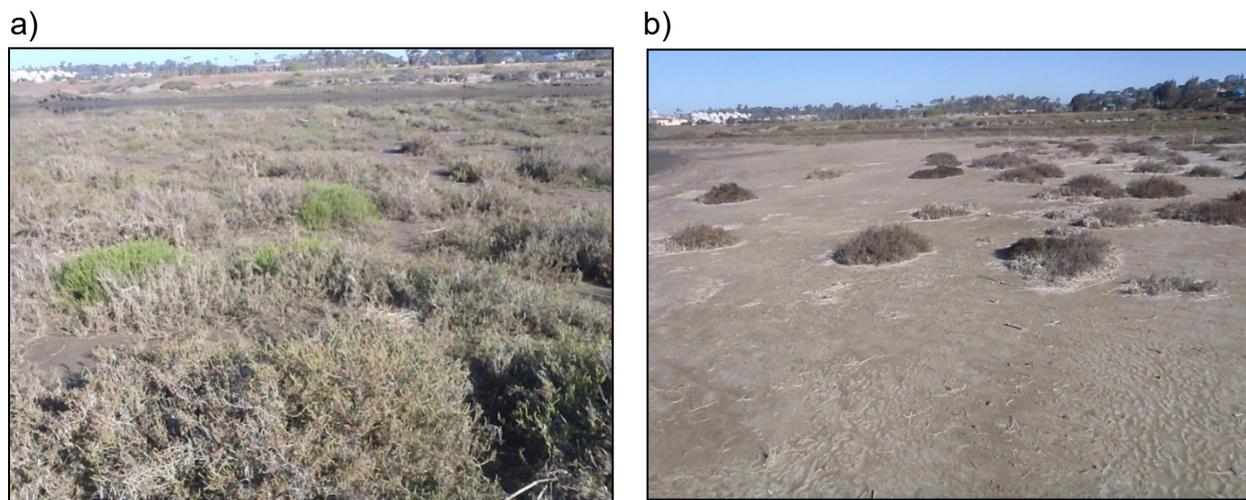


Figure 5.1.2.3. Examples of an area assessed as a) salt marsh habitat, where cover of salt marsh vegetation was $\geq 30\%$, and b) an area assessed as "Other", not a planned habitat that is too high in elevation to be assessed as mudflat and too sparsely vegetated to be assessed as salt marsh.

Results: The solid bars in Figure 5.1.2.4 indicate the acreages determined in the 2020 survey. While the area of subtidal habitat was within $\pm 10\%$ of the planned acreage in 2020, the area of mudflat was less than 10% of the planned acreage (-26.6%), as was the deficit in salt marsh habitat (-16.2%). Salt marsh acreage in 2020 was 77.6 acres, 5.7 acres below the lower 10% limit of the designed acreage. As a result, the San Dieguito Wetlands did not meet the performance standard for Habitat Areas in 2020.

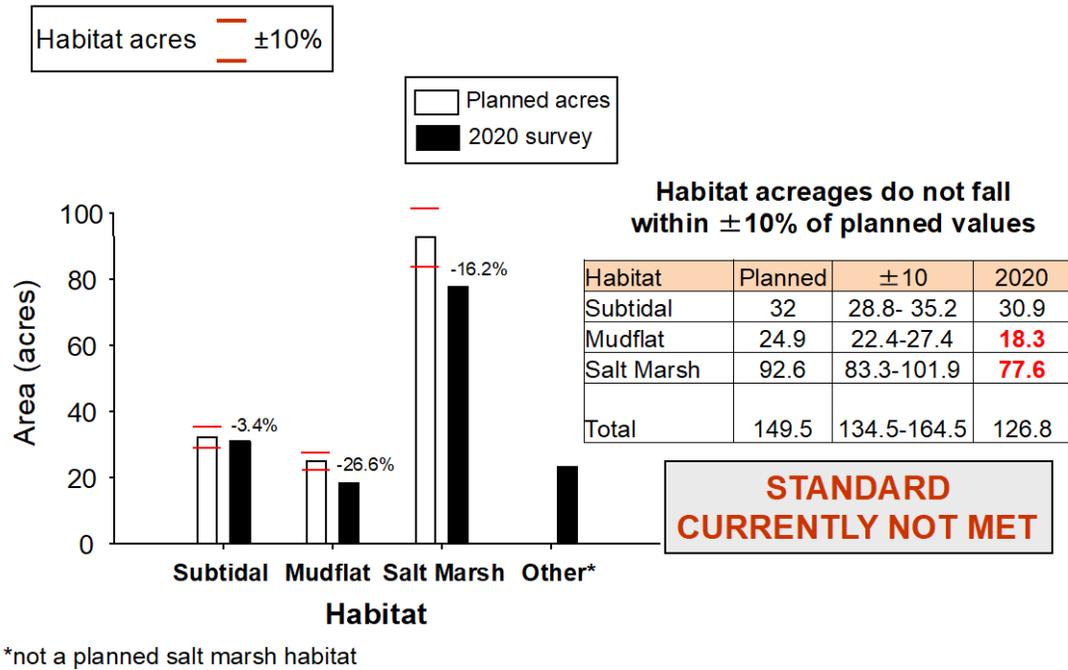


Figure 5.1.2.4. Comparison of the areas of subtidal, mudflat, and salt marsh habitat in the Final Restoration Plan to the 2020 survey. Areas assessed as “other” were not assessed as one of the planned habitats provided in the Final Restoration Plan and are not included in the total acres of planned habitat.

Figure 5.1.2.5 shows the trend over time in acres of the salt marsh, mudflat, and subtidal habitat categories and the “other” category, which is not a planned habitat. There has been a slow but general increase in salt marsh habitat since 2012, and a more encouraging increase from 2018 to 2020, perhaps engendered by the rainfall of 2018. Also encouraging is the continued decrease in other in 2020, which reflects the filling in of vegetation, particularly at lower elevations. One development that may lead to failure to meet the habitat areas standard is the decrease in mudflat such that the acres of mudflat are now below 10% of the planned acres. This is due in part to the encroachment of *Spartina* into areas that are planned mudflat.

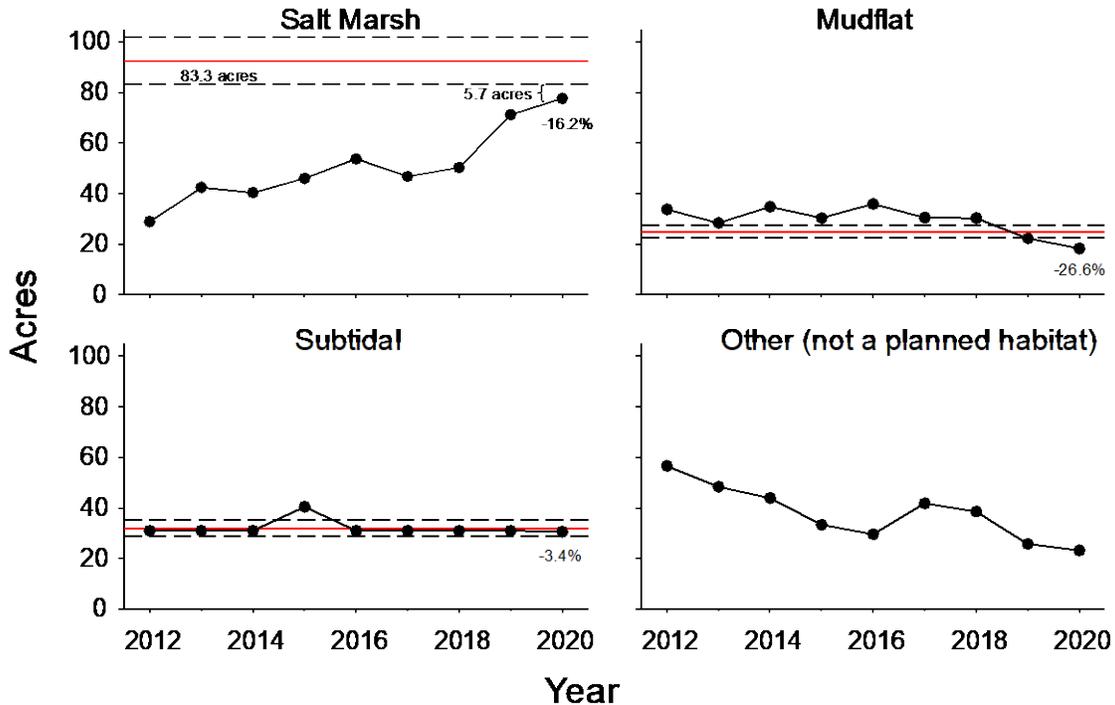


Figure 5.1.2.5. Comparison of the areas of salt marsh, mudflat, and subtidal habitat determined in the 2012 through 2020 surveys to the planned areas in the Final Restoration Plan (solid red line, black dashed lines $\pm 10\%$). Also shown is the change in acres of “other”, not a planned habitat.

5.1.3. Topography

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

Approach: The intent of the topography standard is to ensure that the expected functions of the wetland are not affected by excessive erosion or sedimentation. Topographic changes resulting from excessive erosion or sedimentation could impede tidal flow within the wetland, altering tidal prism and the areas of planned wetland habitat. Erosion or sedimentation within the restored wetland may result from high volumes of storm run-off, littoral movement of sand that blocks the inlet channel, slumping of banks or berms, or other causes.

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

Results: Survey data and field observations indicated that the expected functions of the San Dieguito Wetlands were not affected by excessive erosion or sedimentation in 2020 and therefore this performance standard is currently met.

5.1.4. Reproductive success

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

Approach: The reproductive success of salt marsh plants is evaluated by measuring whether seeds are produced for seven common species found in the mid to high salt marsh: Parish’s Glasswort (*Arthrocnemum subterminale*), Pickleweed (*Salicornia virginica* = *Salicornia 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 2018 through 2020, which is consistent with the permit requirements (Fig 5.1.4.1). Since all seven species produced seed within three years, the standard for reproductive success is met for 2020.

Plant	2018	2019	2020
Parish’s Glasswort	yes	yes	yes
Saltgrass	yes	yes	yes
Alkali Heath	yes	yes	yes
Marsh Jaumea	yes	yes	yes
Spiny Rush	yes	yes	yes
California Sea Lavender	yes	yes	yes
Pickleweed	yes	yes	yes

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

5.1.5. Exotics

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

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

a)

b)



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

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

Results: Densities of exotic species were very low and there was no evidence that exotic species impaired the important functions of San Dieguito Wetlands in 2020. Notably, the Yellowfin Goby, an exotic species that was the fifth most abundant fish as determined from our fish sampling in 2013 has not been abundant the last seven years.

5.2. Relative Performance Standards

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

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



MC=Main Channel, TC=Tidal Creek

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

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

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

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

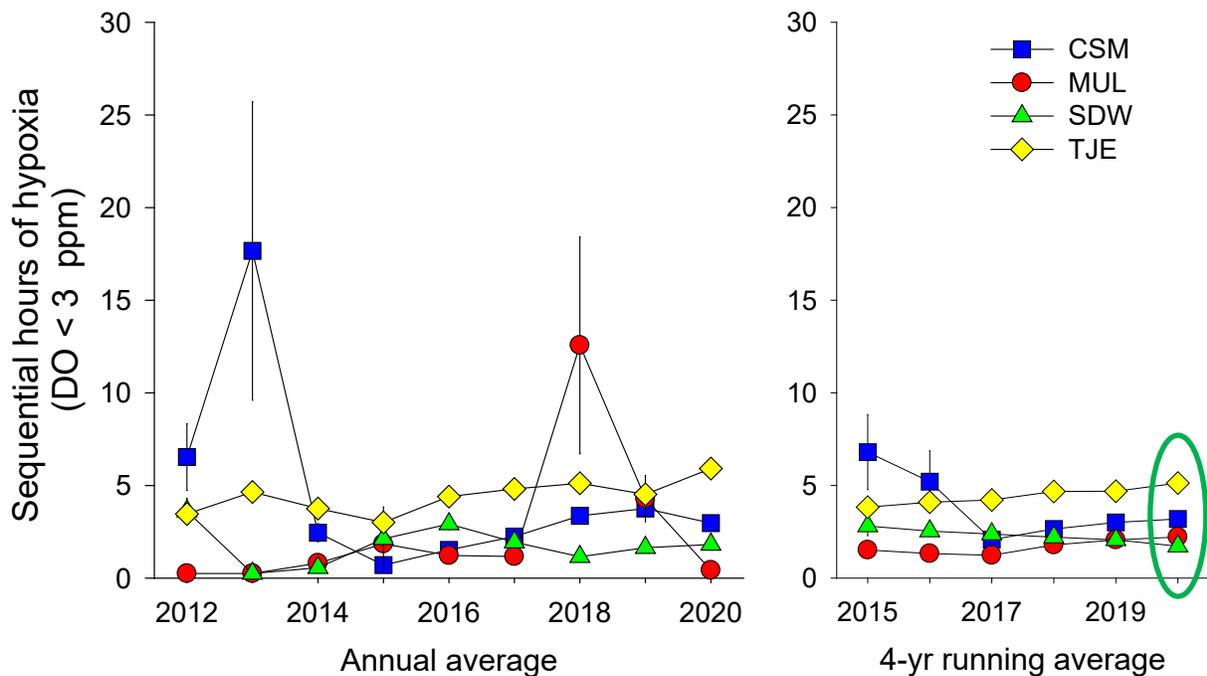


Figure 5.2.1.1. Mean length in hours of continuous hypoxia ($[O_2] < 3$ mg/l (ppm) in the San Dieguito Wetlands compared with the three reference wetlands. Abbreviations used in this and subsequent figures: CSM=Carpinteria Salt Marsh, MUL=Mugu Lagoon, SDW=San Dieguito Wetlands, and TJE=Tijuana Estuary. Mean values ± 1 SE are shown in this and subsequent figures. Green ellipse indicates standard was met.

Results: Figure 5.2.1.1 shows the mean number of hours of continuous hypoxia at the San Dieguito Wetlands compared with the three reference wetlands annually from 2012 through 2020, and the four-year running average, which is used to evaluate the standard. Again, this standard is evaluated by comparing values in San Dieguito Wetlands to the reference wetland with the highest value of sequential hours of hypoxia. For the four-year running average, the value for sequential hours of hypoxia at San Dieguito was lower than the reference wetland with the highest value (Tijuana Estuary) and therefore San Dieguito Wetlands met the Water Quality standard in 2020.

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

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

assemblages were similar in basin and main channel habitats and thus it was biologically reasonable to treat the constructed basin as main channel habitat in post-construction monitoring. The six sampled creeks or sections of the main channel or basin habitat (in the case of San Dieguito) are treated as replicates in subsequent analysis.

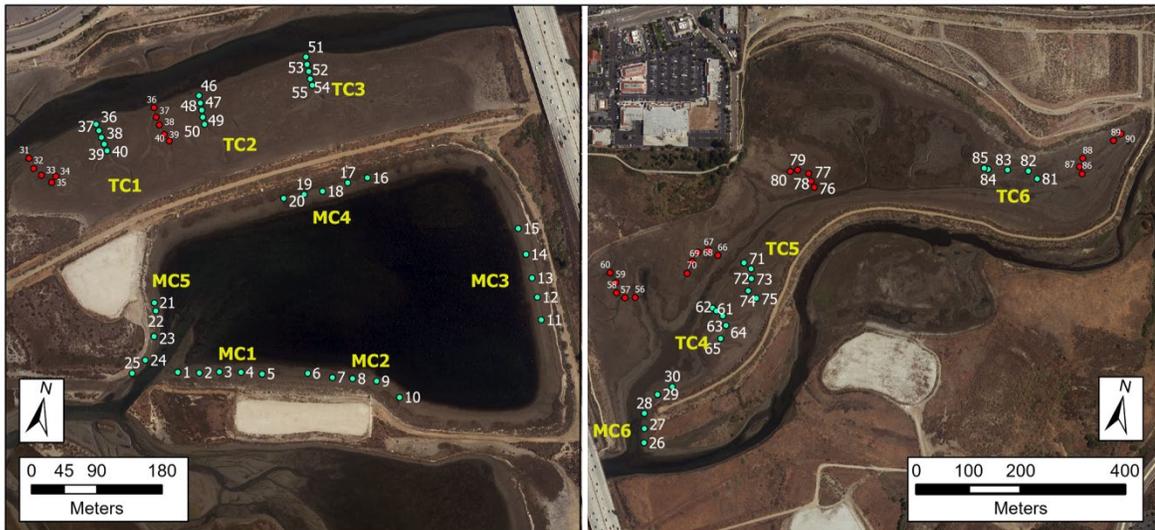


Figure 5.2.2.1. Location of tidal creeks (TC) and sections of main channel and basin (MC) sampled for fish and macro-invertebrates in San Dieguito Wetlands. Cyan colored dots indicate stations sampled for macro-invertebrates within each TC and MC replicate in 2020. Red dots indicate tidal creek stations that are less suitable for sampling because of the encroachment of *Spartina* into these areas.

5.2.3. Fish

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

Approach: Data on the density and numbers of species of fish are collected using 0.43 m² circular enclosure traps and larger beach seines (2 m x 7.6 m). Enclosure traps are used to sample gobies, which are small, numerically abundant fishes that are poorly sampled by other methods (Steele et al 2006a). Beach seines in combination with blocking nets are used to sample larger more mobile fishes (Steele et al 2006b). Fish captured by both methods are identified and counted in the field and returned to the water alive.

The total number of fish is standardized to 1 m² for each enclosure or beach seine sample. The averages for enclosures and beach seines are averaged to produce a combined estimate of total density (average number per 1 m²) for each tidal creek or main channel-basin replicate. Species richness is determined as the number of unique species for each tidal creek or main channel replicate in enclosure trap and seine sampling per 1 m². These replicate values for density and species richness are used to calculate the means and standard errors used to evaluate similarity in total density and

species richness of fish in tidal creeks and main channel-basin habitats between the restored and reference wetlands in a given year. Ridgway's Rail (formerly the Light-footed Clapper Rail) nesting in Tijuana Estuary prevented sampling using seines in 2012 so that year is not included in the running average calculation of fish density and richness.

Results: Fish density increased dramatically from 2013 to 2015 in Carpinteria Salt Marsh in both main channel and tidal creek habitats (Fig. 5.2.3.1) and smaller peaks in fish density were evident in the other wetlands in main channel, including San Dieguito. For the 4-year running averages including 2020, fish density in main channel habitat in San Dieguito Wetlands was significantly lower than Mugu Lagoon, the lowest performing reference wetland for this standard in 2020 (Fig 5.2.3.1). Similarly, the 4-year running average of fish density in tidal creek habitat in San Dieguito Wetlands was significantly lower than Mugu Lagoon in 2020 (Fig 5.2.3.1). The 4-year running average of fish density in both main channel and tidal creek habitat in San Dieguito Wetlands has declined over the past 3 years and these standards were not met in 2020.

A relative standard that was met in 2018, but not met in 2019 or 2020 is fish species richness in main channel habitat. The annual values show that richness declined in San Dieguito Wetlands from 2016 to 2020 although fish richness in San Dieguito Wetlands was higher than Tijuana Estuary in 2020. The 4-year running average in San Dieguito Wetlands was not similar to the lowest performing reference site and as a result this standard was not met for 2020 (Fig. 5.2.3.2).

There has been a general decline in the running average for fish species richness in tidal creeks at all wetlands from 2018 through 2020. The precipitous decline in richness in Tijuana Estuary in 2020 resulted in the 4-year running average of fish species richness in tidal creeks being similar in San Dieguito Wetlands to Tijuana Estuary in 2020 leading to this standard being met in 2020.

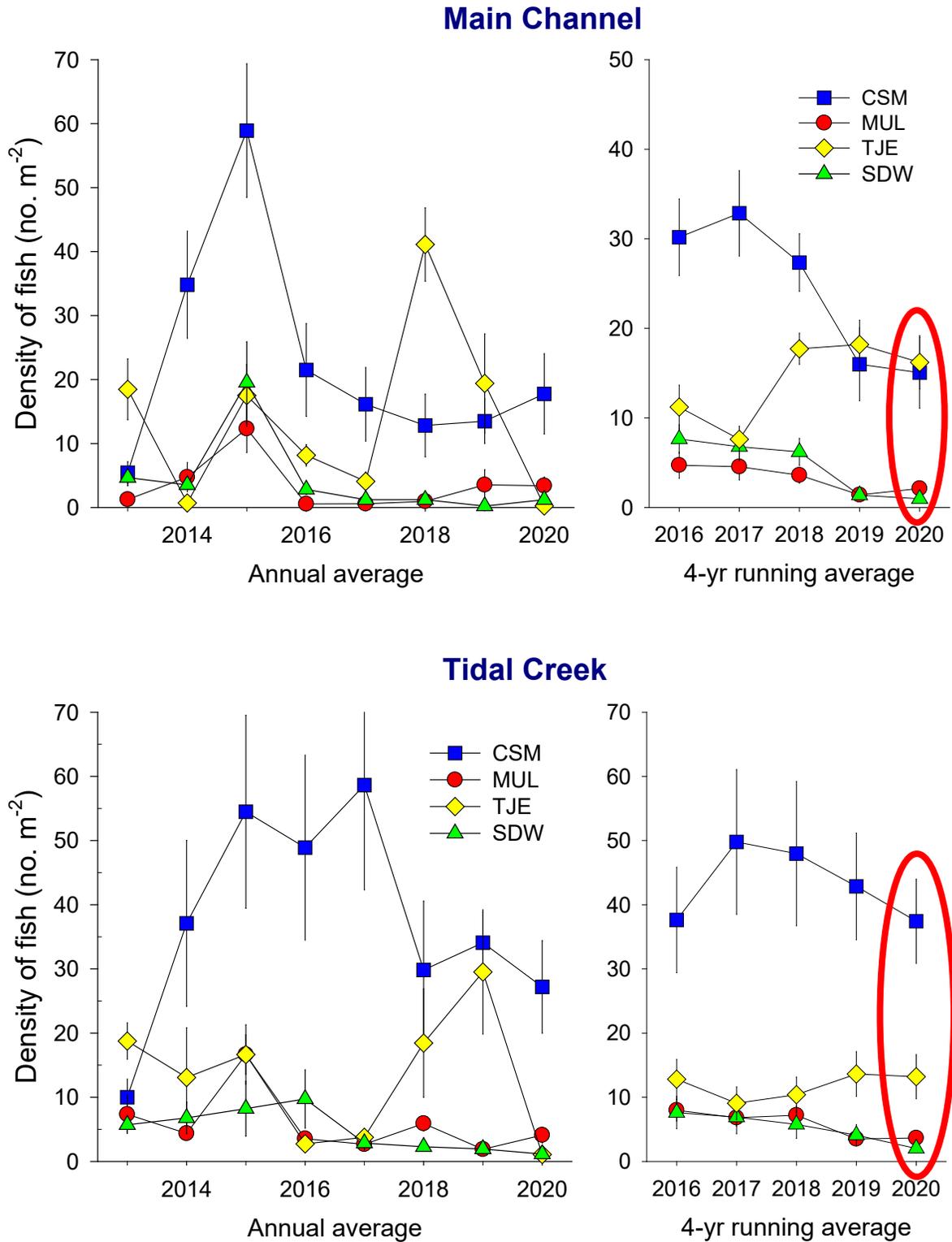


Figure 5.2.3.1. Comparison of annual fish density (left) and the 4-year running average used to evaluate the standard (right) between San Dieguito Wetlands and the reference wetlands in main channel and tidal creek habitats. Section of main channel-basin or individual tidal creek is the unit of replication (n = 6 in each habitat type). Red ellipses indicate standard was not met.

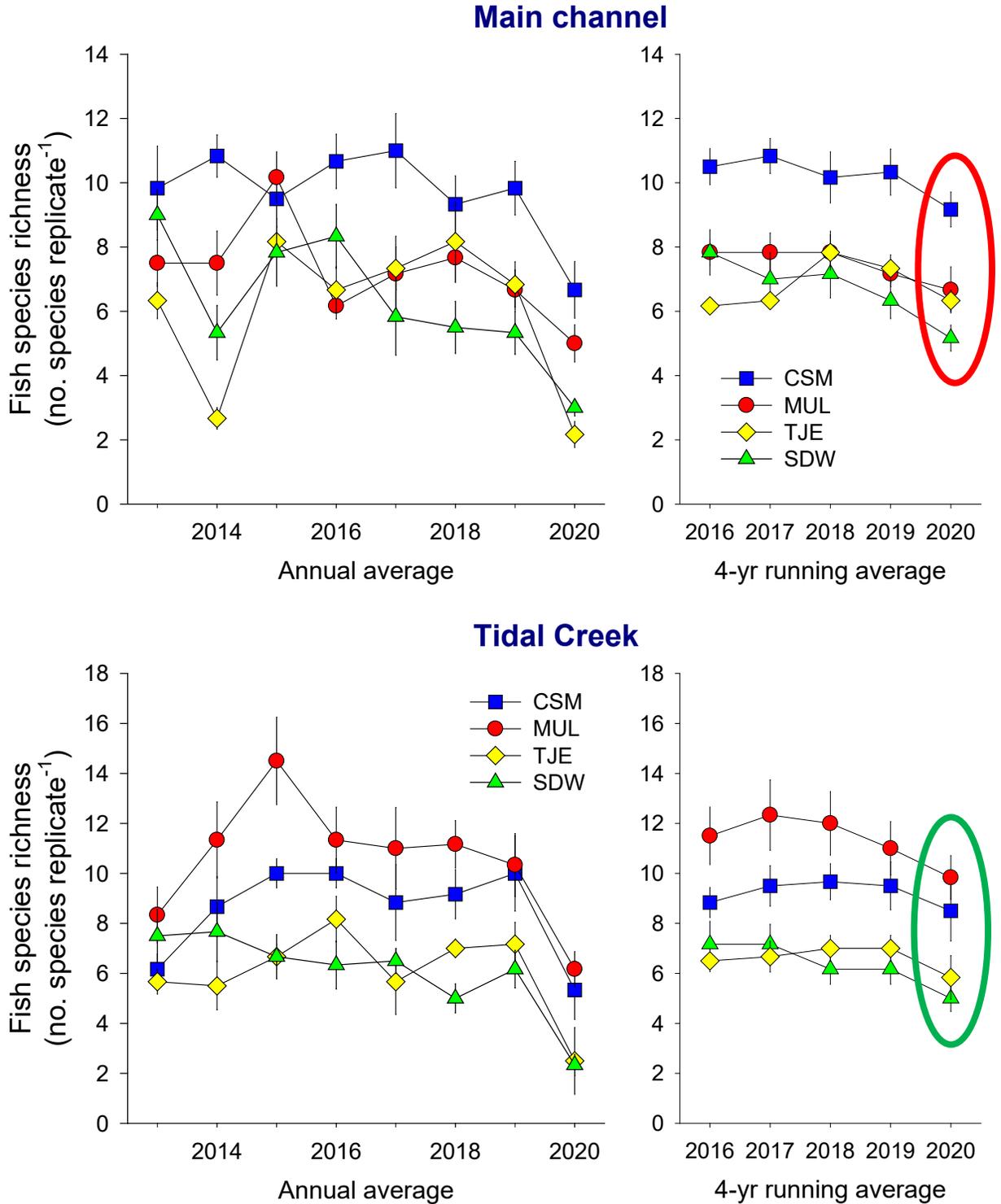


Figure 5.2.3.2. Comparison of annual fish species richness (left) and the running average used to evaluate the standard (right) between San Dieguito Wetlands and the reference wetlands for main channel and tidal creek habitats. Section of main channel-basin or individual tidal creek is the unit of replication (n=6 in each habitat type). Green ellipses indicate standard was met; red ellipses indicate standard was not met.

5.2.4. Macro-invertebrates

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

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

Densities of macro-invertebrates sampled using each method are standardized to number per 100 cm² and then combined to obtain a density value for each of the 5 stations within a tidal creek or section of main channel-basin. These station values are then averaged for each tidal creek or section of main channel-basin, which are the units of replication, giving 6 replicate estimates of macroinvertebrate density in each habitat per wetland. Species richness of macro-invertebrates is evaluated by recording the number of unique species per tidal creek or section of main channel-basin obtained using all sampling methods, including any invertebrate species noted in the enclosure traps and beach seines used to sample fish. Species richness is assessed as the mean number of species per replicate main channel or tidal creek using the 6 replicate tidal creeks and sections of main channel-basin for each wetland in a year. These replicate values are used to calculate the means and standard errors used to evaluate similarity in total density and species richness of macro-invertebrates in tidal creeks and sections of channel/basin between the restored and reference wetlands in a given year.

Results: The annual density and running average of density of macro-invertebrates has generally been highest in main channel and tidal creek habitats in Mugu Lagoon and Carpinteria Salt Marsh from 2012 to 2020 (Fig. 5.2.4.1). The 4-year running average of the density of macro-invertebrates in main channel and tidal creek habitat of San Dieguito Wetlands has been consistently lower than the density in the lowest performing reference wetland, which has been Tijuana Estuary. This was the case in 2020 when

the running average for macro-invertebrate densities in San Dieguito Wetlands continued to remain well below the lowest performing reference site and thus the standards for macro-invertebrate density in main channel and tidal creek habitats were not met in 2020 (Fig. 5.2.4.1).

The annual mean and running average for species richness in main channel and tidal creek habitat has been highest in Mugu Lagoon and Carpinteria Salt Marsh. In 2020, the 4-year running average of species richness of macro-invertebrates in the main channels of San Dieguito Wetlands was similar to Tijuana Estuary, the lowest performing reference wetland. Therefore, the performance standard for macro-invertebrate species richness in main channel habitat of San Dieguito Wetlands was met in 2020 (Fig. 5.2.4.2).

The standard for species richness of macro-invertebrates in tidal creek habitat was met in 2018, but there has been a general decline in richness and the running average was below the lowest performing reference site, Tijuana Estuary, in 2019 and again in 2020 (Fig. 5.2.4.2). As a result, this standard was not met in 2020.

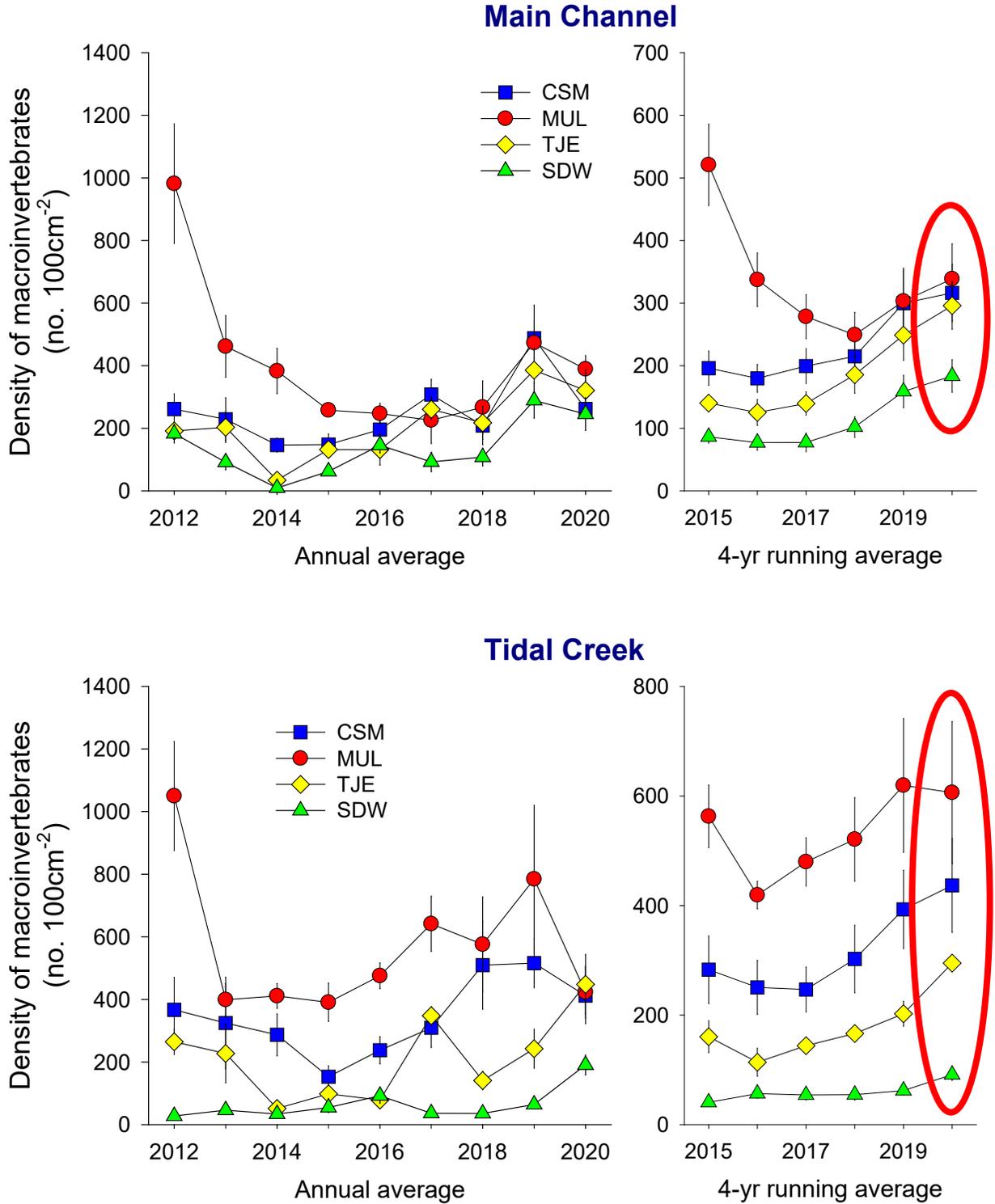


Figure 5.2.4.1. Comparison of macro-invertebrate density between San Dieguito Wetlands and the reference wetlands for main channel and tidal creek habitats. Section of main channel-basin or individual tidal creek is the unit of replication. Red ellipses indicate standard not met.

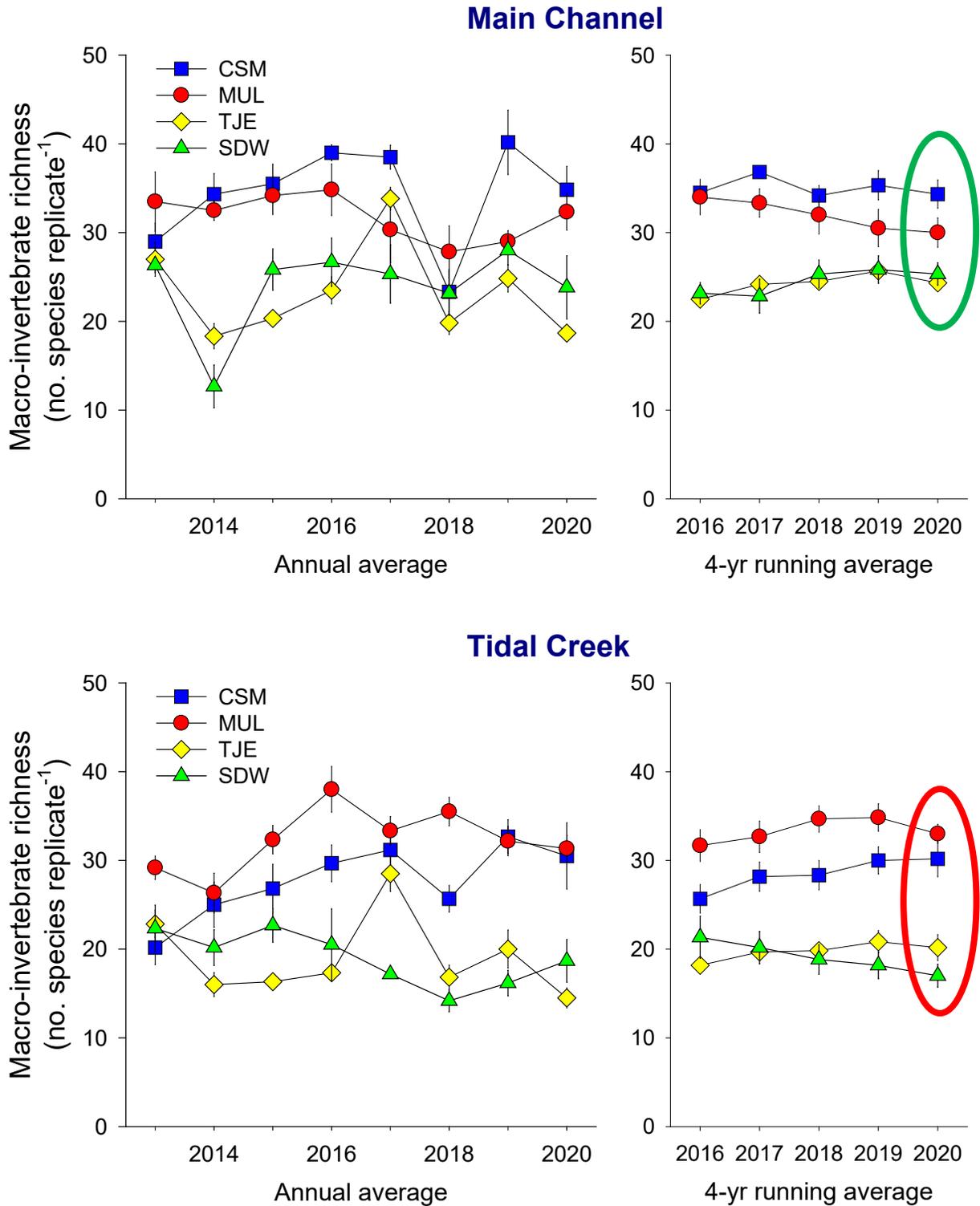


Figure 5.2.4.2. Comparison of macro-invertebrate species richness between San Dieguito Wetlands and the reference wetlands for main channel and tidal creek habitats. Section of main channel-basin or individual tidal creek is the unit of replication. Complete sampling was not conducted for invertebrate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

5.2.5. Birds

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

Approach: Birds are sampled by walking within clear viewing distance (using binoculars or a spotting scope) of 20 replicate rectangular plots of 100 x 150 m spread throughout the wetlands (Fig. 5.2.5.1, shows plots for 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. Birds overflying the plots are counted if they are within approximately 30 m above the plot. All wetlands are sampled within a few days of one another to reduce the potential effects of weather and other factors that might vary among wetlands over time on bird density and species richness.

Bird assemblages in coastal wetlands of southern California exhibit 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 number of birds within each of the 20 plots are averaged by plot across the 18 survey dates to provide a mean value of density for each plot and 20 mean values per wetland. Yearly mean total densities within each wetland are computed using the 20 plots as replicates for each wetland and these values are used for evaluating similarity in bird density between the restored and reference wetlands. Species richness is determined as the total number of unique bird species recorded in each of the 20 plots across the 18 survey dates for each wetland. These 20 replicate values for species richness are used to calculate the means and standard errors used to evaluate similarity in species richness of birds between the restored and reference wetlands in a given year.



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

Results: Mugu Lagoon had the highest bird density from 2012 through 2020 and the highest 4-year running average for bird density over the same time period. There had been a general decline in the 4-year running average of bird density in San Dieguito Wetlands, but the annual density value was higher than Carpinteria Salt Marsh in 2020 (Fig. 5.2.5.2). While the running average fell below Carpinteria Salt Marsh in 2019, the lowest performing reference wetland, the increase in bird density in 2020 elevated the 4-year running average such that San Dieguito Wetlands was similar to the reference wetlands in 2020. As a result, the standard for bird density in San Dieguito Wetlands is currently met.

The 4-year running average of bird species richness remained highest in Mugu Lagoon and Tijuana Estuary in 2020 (Figure. 5.2.5.3). There had been a general decrease in the 4-year running average for bird species richness in San Dieguito Wetlands from 2012 - 2018, followed by an increase from 2018 - 2020. As a result, the 4-year running average for bird species richness in San Dieguito Wetlands remained above Mugu Lagoon and Carpinteria Salt Marsh and similar to the value in the Tijuana Estuary; consequently, San Dieguito Wetlands met the performance standard for bird species richness in 2020.

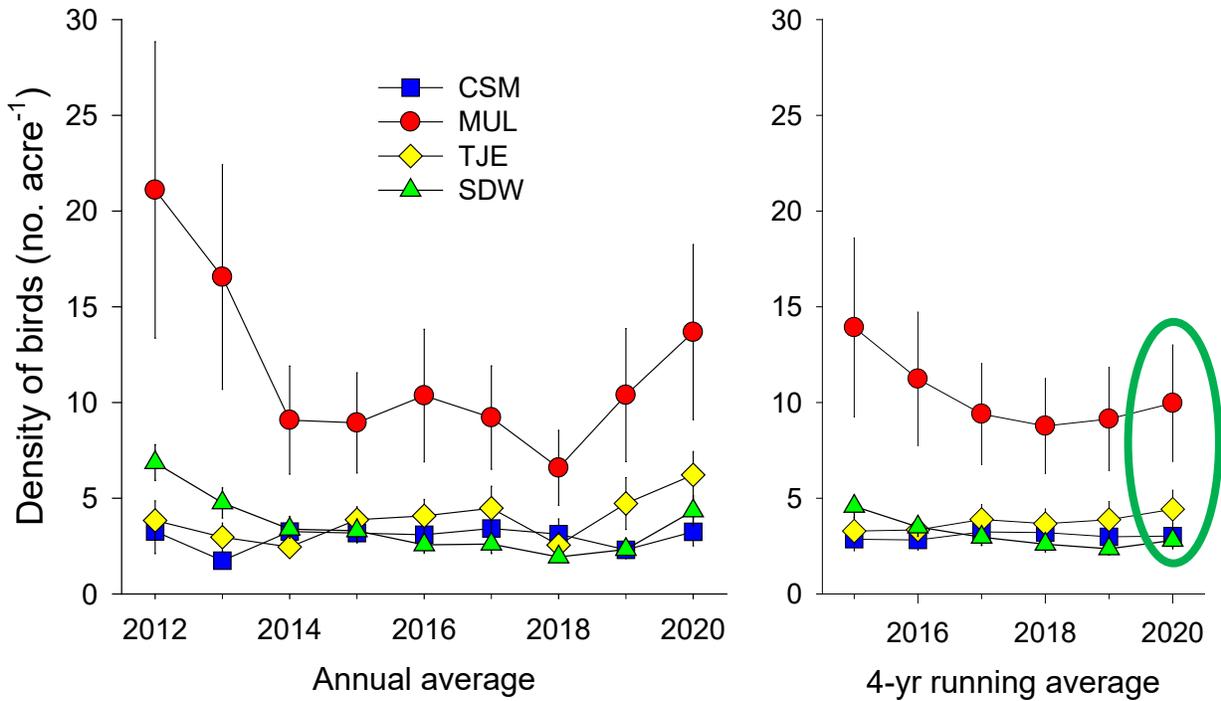


Figure 5.2.5.2. Comparison of bird density between San Dieguito Wetlands and Tijuana Estuary, Mugu Lagoon, and Carpinteria Salt Marsh. Green ellipse indicates standard was met for 2020.

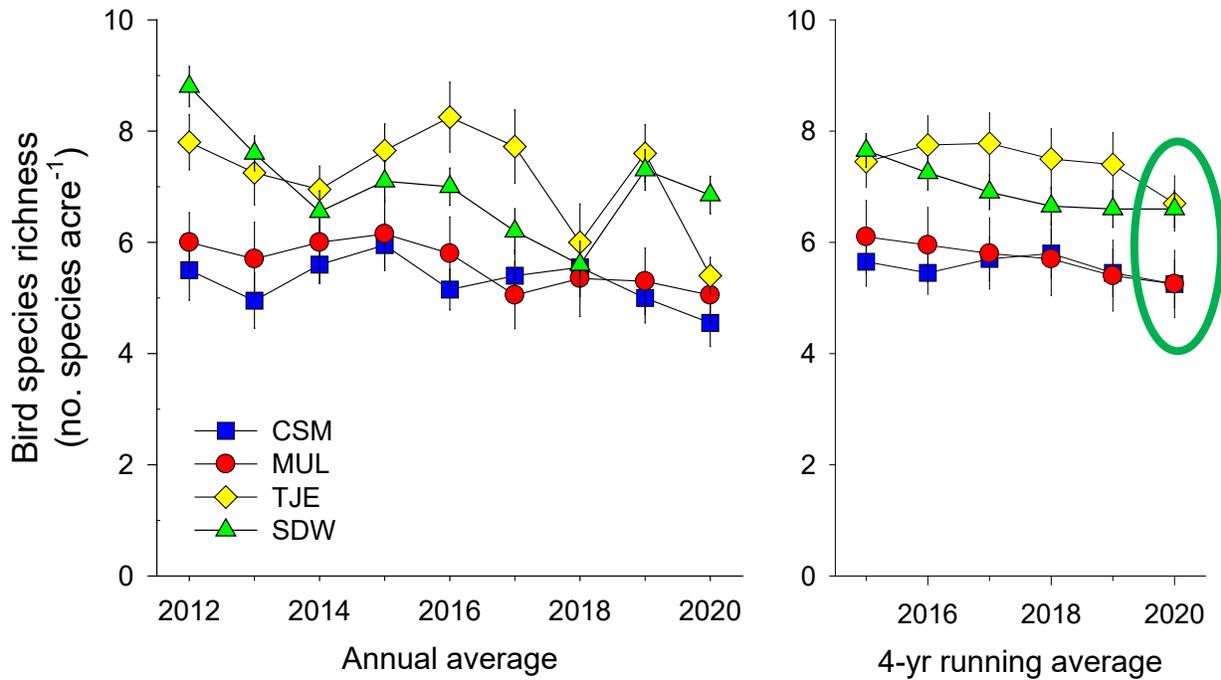


Figure 5.2.5.3. Comparison of bird species richness between San Dieguito Wetlands and the three reference wetlands. Green ellipse indicates standard was met.

5.2.6. Vegetation

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



Figure 5.2.6.1. View of San Dieguito Wetlands modules W4 & W16 taken in 2020 showing extensive stands of cordgrass. Member of UCSB staff in foreground.

Approach: The percent cover of salt marsh vegetation and open space is evaluated in the restored and reference wetlands in 10 m x 10 m plots forming grids that entirely cover salt marsh habitat as defined above (see Habitat Areas). Estimates of the percent cover of salt marsh vegetation in San Dieguito Wetlands and the reference wetlands are made using aerial imagery taken in the late spring or summer. Mean percent cover of vegetation in salt marsh habitat (habitat with at least 30% cover) in the restored and reference wetlands is computed using the 10 m x 10 m plots as replicates. Since percent cover of vegetation is evaluated for all salt marsh habitat in each wetland, comparisons are made only using mean values. This performance standard is met if the average percent cover of vegetation in salt marsh habitat within the restored wetland is not lower than that in the reference wetlands with the lowest percent cover of vegetation.

Results: Salt marsh vegetation in San Dieguito Wetlands has slowly increased in distribution and cover (Fig. 5.2.6.2, see Section 7.0). However, the annual and 4- year running average of percent cover of vegetation in salt marsh habitat remains lower than the reference wetlands (Fig. 5.2.6.2). The decrease in cover of vegetation in Carpinteria Salt Marsh in 2017-18 was associated with the debris flow from the Thomas Fire. The cover of vegetation in San Dieguito Wetlands, although on a promising trajectory of increase, is not yet similar to the reference wetlands and consequently the performance standard for cover of vegetation was not met in 2020. A planting program and experiments underway to improve the performance of wetland vegetation is described in Section 7.0.

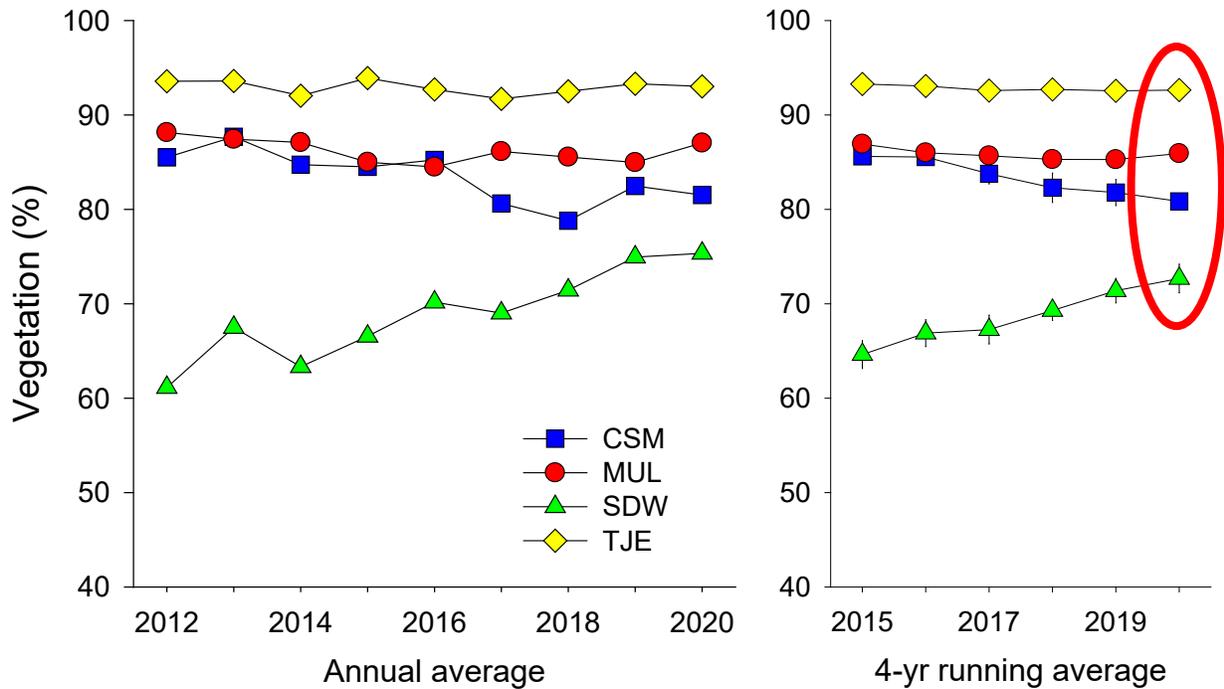


Figure 5.2.6.2. Comparison of the percent cover of salt marsh vegetation between San Dieguito Wetlands and the reference wetlands. Percent cover is evaluated in areas assessed as salt marsh habitat (at least 30% cover of vegetation). Red ellipse indicates standard was not met.

5.2.7. Algae

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

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

Results: The annual percent cover of macroalgae in San Dieguito Wetlands was lower than that in the reference wetland with the highest value (Mugu Lagoon) in 2012, 2013, and 2015 through 2020, but slightly higher than the reference wetland with the highest value (Carpinteria Salt Marsh) in 2014 (Fig. 5.2.7.1). The 4-year running average of macroalgal cover in San Dieguito Wetlands has been lower than the value in the reference wetland with the highest cover (Mugu Lagoon) from 2015 to the present and the relative standard for algae is met for 2020 (Fig. 5.2.7.1).

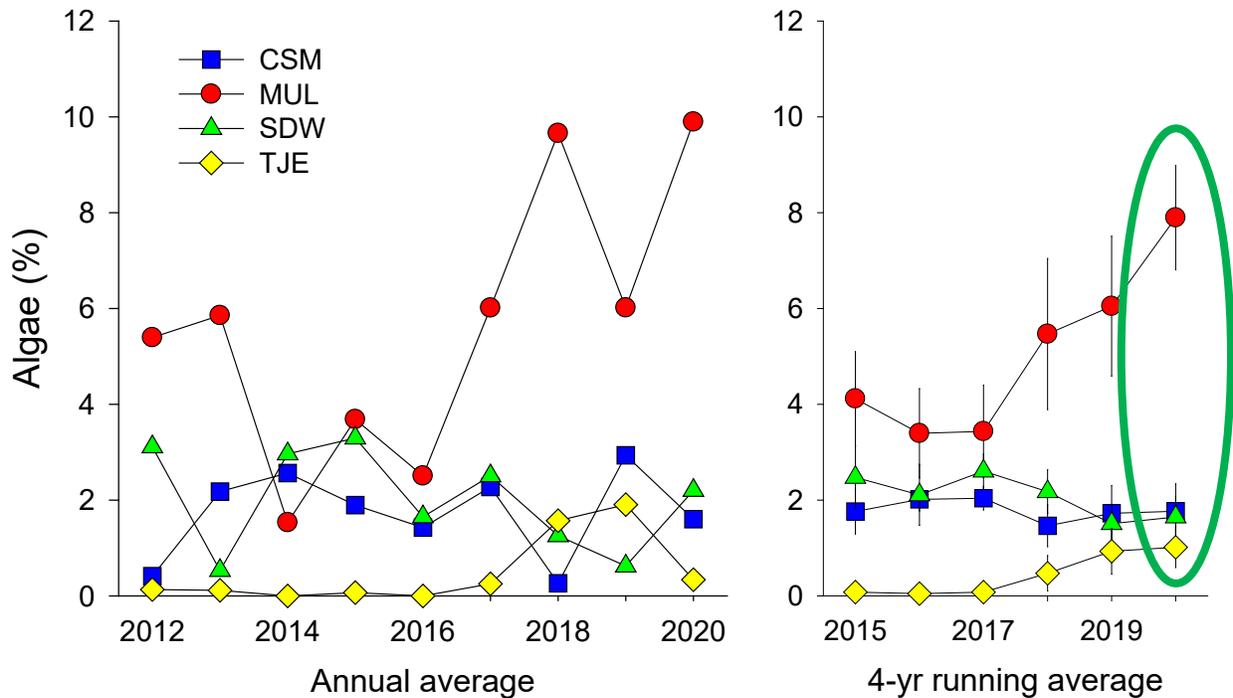


Figure 5.2.7.1. Comparison of percent cover of macroalgae between San Dieguito Wetlands and the reference wetlands. Green ellipse indicates standard was met.

5.2.8. *Spartina* canopy architecture

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

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

Spartina is sampled in replicate 0.1 m² circular quadrats placed over the cordgrass every 2 m along a 20 m long transect line extending parallel to the water line in each patch (Fig. 5.2.8.1) following methods developed by Zedler (1993) in Tijuana Estuary. From the sampling, the mean proportion of stems > 3 feet (91 cm) tall (excluding flowering stalks) is determined for each cordgrass patch. The mean proportion of stems >3 feet tall for each wetland is calculated using four sampled patches per wetland as replicates, and this value is compared between wetlands.



Figure 5.2.8.1. View of a sampling transect overlying a patch of cordgrass in module W4. Cordgrass is sampled in 0.1 m² quadrats placed every two meters along the 20 m long transect line. There are four transect lines per wetland.

Results: The annual mean proportion of stems > 3 feet (or 91 cm) tall in San Dieguito Wetlands and Tijuana Estuary has been variable over time, including a drop in this value in San Dieguito Wetlands from 2014 to 2016 (Fig. 5.2.8.2). The decline in the height of stems in San Dieguito from 2014 to 2016 was possibly due to increased stress experienced by the plants associated with higher water levels in the wetland in 2014-2015 and the associated increase in tidal inundation of the plants. However, the average annual proportion of stems > 3 feet tall has increased from 2017 to 2020 in San Dieguito Wetlands, whereas this value has been more variable in Tijuana Estuary. The 4-year running average dampens the annual variability and the mean proportion of stems > 3 feet was similar between San Dieguito Wetlands and Tijuana Estuary in 2020 and the relative standard for *Spartina* canopy architecture is currently met.

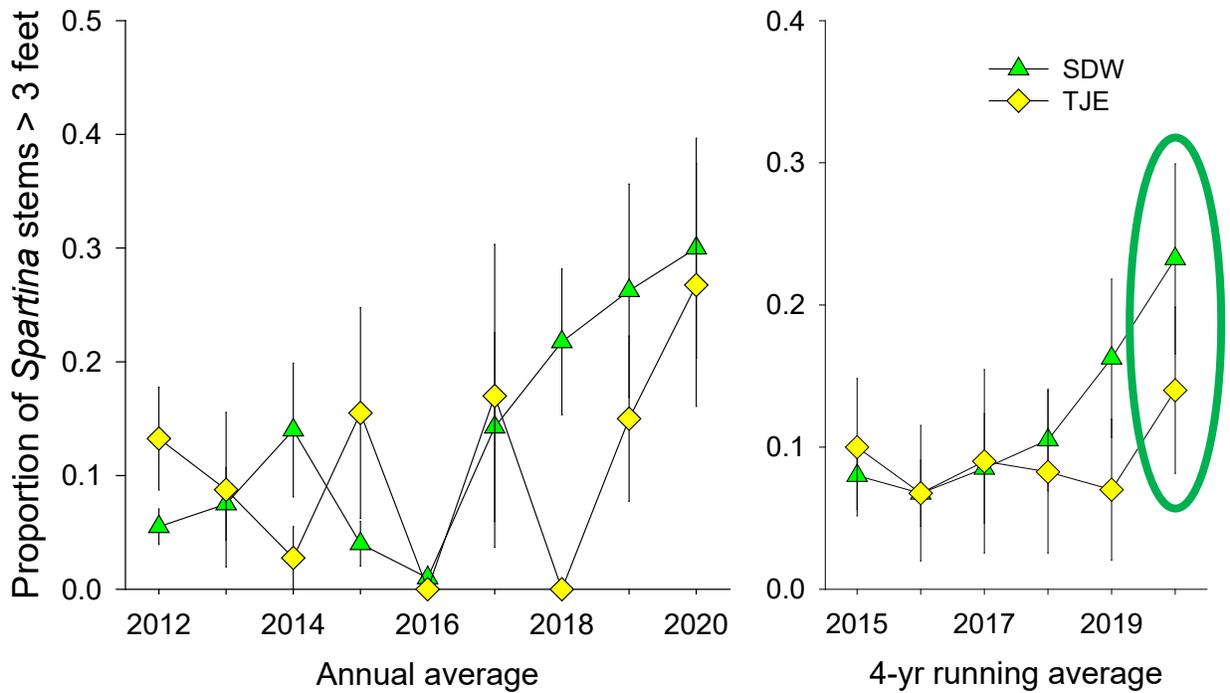


Figure 5.2.8.2, Comparison of the mean proportion of stems > 3 feet (91 cm) tall between San Dieguito Wetlands and Tijuana Estuary. Green ellipse indicates standard was met.

5.2.9. Food chain support

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

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

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

The 4-year running median of the FCS values for each wetland is calculated using a 4-year mean of each iteration based on the current year and the previous three years

producing 1000 values of the 4-year average of the FCS values for each wetland. The 4-year median and standard deviation of the FCS values for each wetland is calculated from the resampled distribution of these 1000 values. The four-year running median of the FCS value at San Dieguito Wetland must be similar to that at the lowest performing reference wetland in order for the San Dieguito Wetlands to meet this performance standard for any given year. The effect size for the FCS standard is the proportional difference between the median of the San Dieguito Wetlands and the reference wetland with the lowest FCS value. The p-value for the FCS standard is calculated as the percentile in the distribution of FCS values at San Dieguito Wetlands corresponding to the mean value of the lowest performing reference wetland (which was the Carpinteria Salt Marsh in 2020).

Results: The highest annual density of feeding birds occurred in Mugu Lagoon in 2012 through 2020 (Fig. 5.2.9.1) although there was a general decline in the running average of the density of feeding birds in this wetland through 2018. The running average of FCS in San Dieguito Wetlands was significantly lower than Carpinteria Salt Marsh, the lowest performing reference wetland in 2017-2019 and remains lower than this reference site in 2020. Therefore, the relative standard for FCS was not met in 2020.

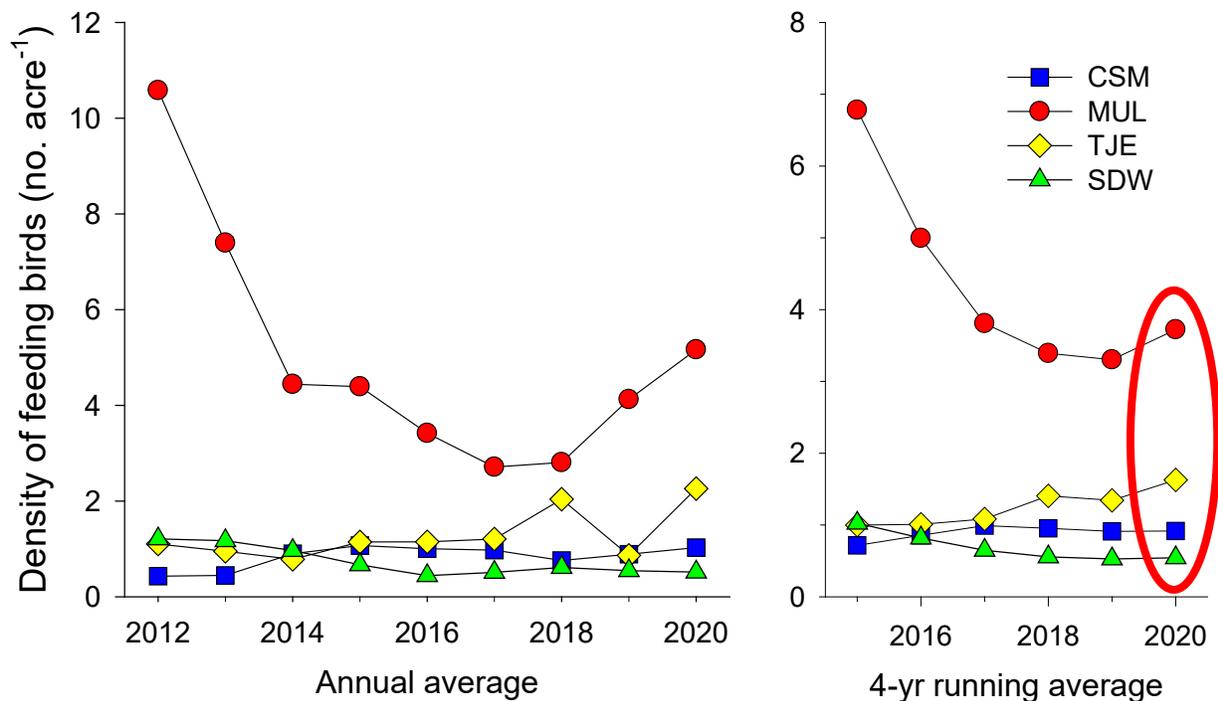


Figure 5.2.9.1. Comparison of the densities of feeding birds between San Dieguito Wetlands and the reference wetlands. Red ellipse indicates standard was not met.

6.0 Permit Compliance

6.1. Summary Assessment of the Absolute Performance Standards

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

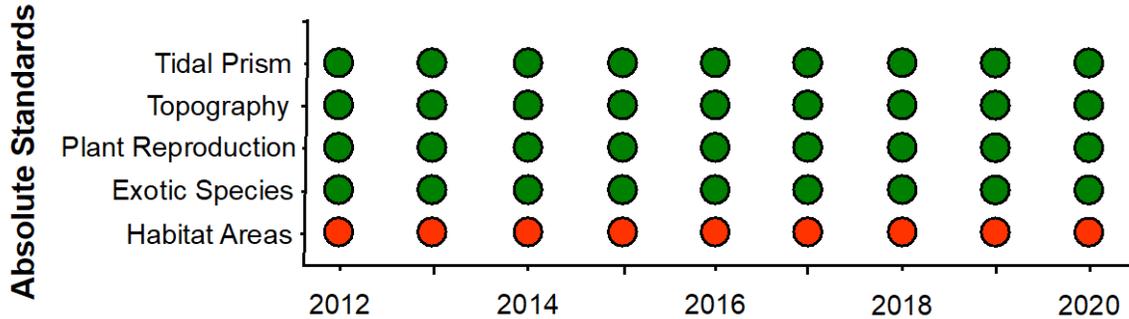


Figure 6.1.1. Summary of assessment of the absolute standards from 2012 through 2020. A [green](#) dot indicates that the San Dieguito Wetlands Restoration met the required criteria for a given absolute standard; a [red](#) dot indicates that it did not.

The San Dieguito Wetlands Restoration has met 4 of the 5 absolute standards from 2012 - 2020, but has consistently failed to meet the requirement of the habitat areas standard during this period (Fig. 6.1.1). Since the habitat areas standard was not met in 2020, and all absolute standards must be met in the current year to receive credit, the San Dieguito Wetlands did not receive mitigation credit for 2020.

6.2. Summary Assessment of the Relative Performance Standards

A requirement of the SONGS permit (CCC 1997) is that the response variables used to assess the relative performance standards of the San Dieguito Wetlands Restoration Project be “similar” to those of the reference wetlands (Section 4.4). To be considered similar to the reference wetlands, the mean value for each relative performance variable at San Dieguito Wetlands is compared to the mean value for that variable in the reference wetlands to determine whether the value for that variable is significantly worse in San Dieguito Wetlands than in the three reference wetlands (Section 4.4). The relative performance variables measured in San Dieguito Wetlands are compared to the reference wetlands using a 4-year running average. Then, these determinations for each performance variable are used in the assessment of the relative standards, which require that the proportion of relative standards met by the San Dieguito Wetlands be equal to or greater than the proportion of relative standards met by any of the reference wetlands. See Section 4.4 for details on the rationale and methodology of this approach.

Figure 6.2.1 summarizes the annual assessment of the relative standards from 2012 through 2020 for San Dieguito Wetlands. The project met 7 of 15 standards in 2020, which was similar in its performance to 2019.

Comparing the proportion of relative standards met among wetlands, Mugu Lagoon, was the worst performing reference wetland (0.929) in 2020. San Dieguito Wetlands had a lower proportion of standards met (0.466) than Mugu Lagoon (Fig. 6.2.2).

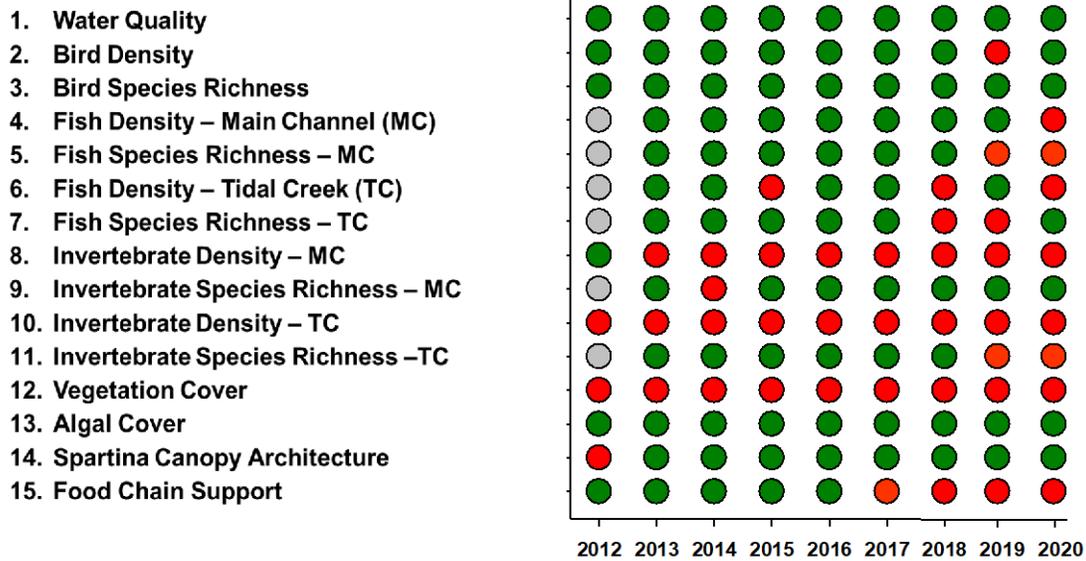


Figure 6.2.1. Summary of the assessment of the Relative Standards from 2012 through 2020. A **green** dot indicates that the San Dieguito Wetlands Restoration was similar to the reference wetlands for that standard in that year; a **red** dot indicates that it was not similar to the reference wetlands.

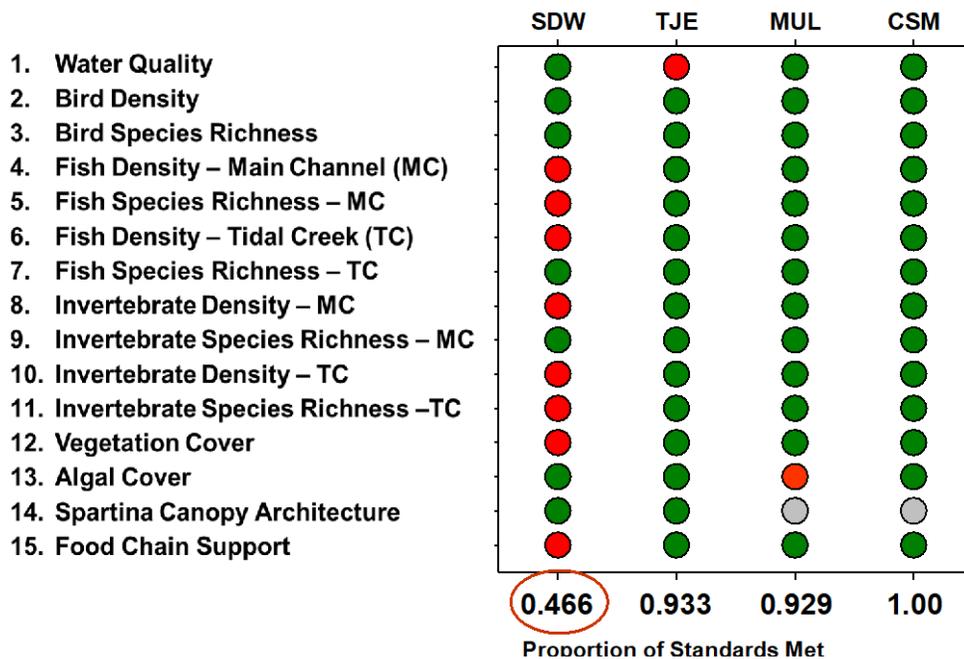
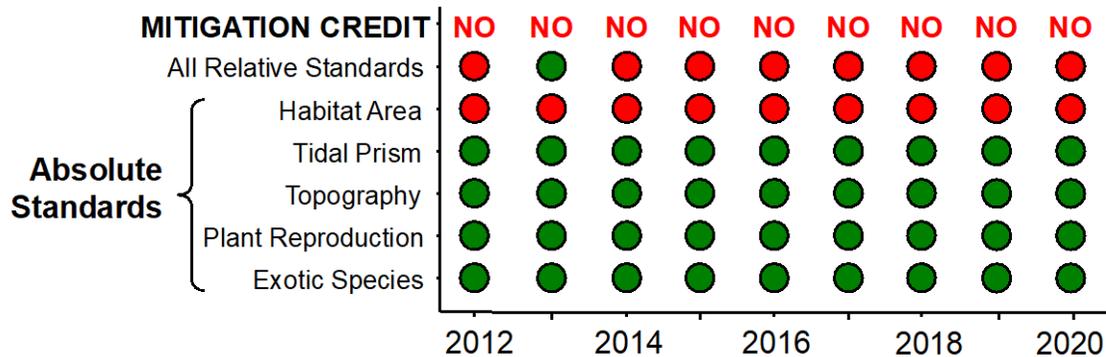


Figure 6.2.2. Summary evaluation of the Relative Standards for 2020. A **green** dot indicates that the value for the indicated response variable at a particular wetland is similar to the other wetlands. A **red** dot indicates that the indicated response variable was statistically worse or lower than the other wetlands. *Spartina* canopy architecture was only measured at San Dieguito Wetlands and the Tijuana Estuary.

6.3. Project Compliance

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

In order for the San Dieguito Wetlands to receive mitigation credit for a given year, it must also meet as many of the relative performance standards (as measured by the proportion of standards met) as the lowest performing reference wetland. The project has failed to meet the relative standard requirement in 8 out of 9 years (Fig. 6.3.1). While there are signs that the San Dieguito Wetlands Restoration Project is providing habitat for wetland plants and animals, it has not yet satisfied the performance success criteria provided in the SONGS permit (CCC 1997) and has not yet received mitigation credit.



Number of years of credit needed = 32

Number of years of credit earned = 0

Figure 6.3.1. Status of compliance of San Dieguito Wetlands with the performance standards provided in the SONGS Permit. A green dot indicates that standard was met, a red dot indicates that a standard was not met.

7.0 Status of Salt Marsh Vegetation and Biological Communities

7.1. Overview

Multiple standards have consistently underperformed in San Dieguito Wetlands over the past nine years (Fig. 7.1.1). Two of these standards depend on the development of salt marsh vegetation. The first of these is the absolute standard pertaining to habitat areas, which as an absolute standard must be each year for the restoration project to receive mitigation credit for that year. This is the only absolute standard that has yet to be met. The second is the relative standard pertaining to the cover of salt marsh vegetation, which has also not yet been met. Because of the importance of vegetation development to meeting these two standards, discussion and adaptive management activities to increase vegetation cover has been a focus of efforts by UCSB scientists, CCC staff, and SCE over the past several years.

Salt Marsh Vegetation & Biological Standards Status Update

Standards that have consistently underperformed over multiple years in San Dieguito Wetlands:

- | | Status |
|-----------------------------|------------------------------|
| • Salt marsh vegetation | |
| - Habitat areas | Standard has yet to be met |
| - Vegetation cover | Standard has yet to be met |
| • Biological standards | |
| - Invertebrate density (MC) | Standard met once in 9 years |
| - Invertebrate density (TC) | Standard has yet to be met |

Other standards that have underperformed in San Dieguito Wetlands:

- Fish density, richness (MC,TC) Standards not met in 2020
- Food chain support (bird feeding) Not met in last 4 years

Figure 7.1.1. Summary of performance standards that have underperformed in San Dieguito Wetlands.

Among the other standards that have underperformed are the relative standards pertaining to the densities of invertebrates in main channel-basin and tidal creek habitats. The standard for invertebrate density in main channel habitat has only been met once over the past nine years. The standard for invertebrate density in tidal creek habitat has never been met. A second group of standards have underperformed more recently. These include the relative standards for fish density and richness in main channel and tidal creek habitats. None of these standards were met in 2020, and were not consistently met over the past three years. In addition, food chain support, evaluated as the density of feeding birds, has not been met in the past four years.

The sections below discuss the current status of vegetation in San Dieguito Wetlands, activities underway to facilitate vegetation development, and some analyses and observations pertaining to factors that might be contributing to the low densities of invertebrates. Since invertebrates are important in food chain support to fish and birds, these factors may also apply, at least in part, in explaining the underperformance of those standards.

7.2. Salt Marsh Vegetation

Current status of vegetation

In many areas of the restoration project, vegetation is well established. These areas include, in particular, lower tidal elevations planned for cordgrass, *Spartina foliosa*. Figure 7.2.1 shows that cordgrass patches are located primarily in modules W4/16 and W5 on the east side of the I5 freeway, with additional occurrence around the basin module W1 on the west side of the I5 freeway.

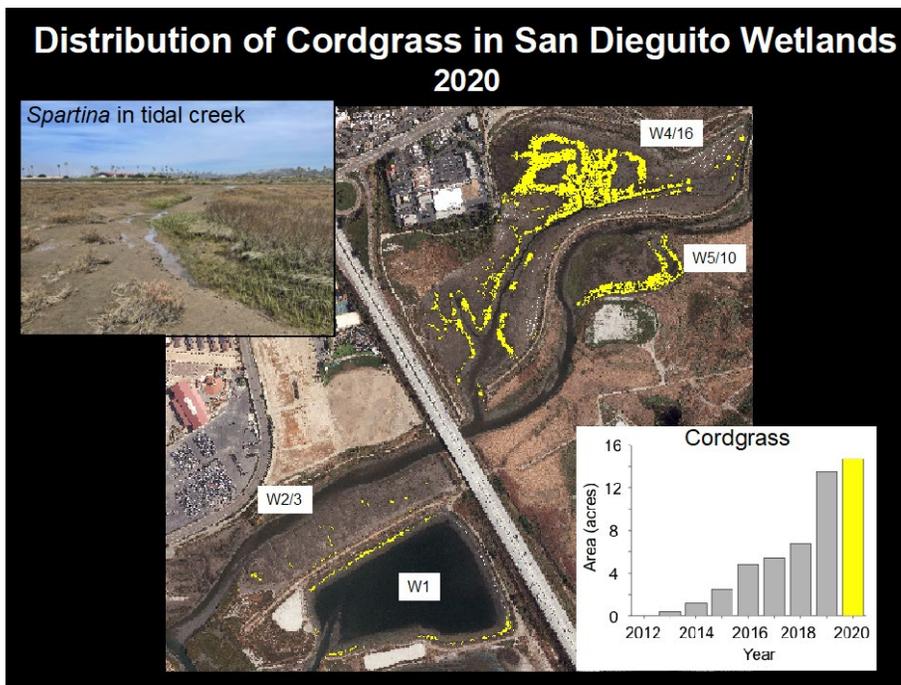


Figure 7.2.1. Distribution of cordgrass *Spartina foliosa* in San Dieguito Wetlands in 2020 (yellow) and increase in acres of cordgrass over time from 2012 to 2019 (gray).

Cordgrass has also colonized the upper reaches of some tidal creeks, including those in module W2/3. After a period of slow establishment following its most recent planting in 2011, cordgrass now occupies a total of about 14.7 acres, an increase of 1.3 acres from 2019.

However, after nine years, vegetation is still underperforming although there was an appreciable increase in the acreage of salt marsh habitat over the past two years (Fig. 7.2.2), likely facilitated by the higher levels of rainfall in 2018 relative to the previous years. Although San Dieguito Wetlands was 5.7 acres short of the minimum number of

required acres of salt marsh habitat (83.3 acres) in 2020, the trend moving forward in attaining the minimum number of acres in the foreseeable future is promising.

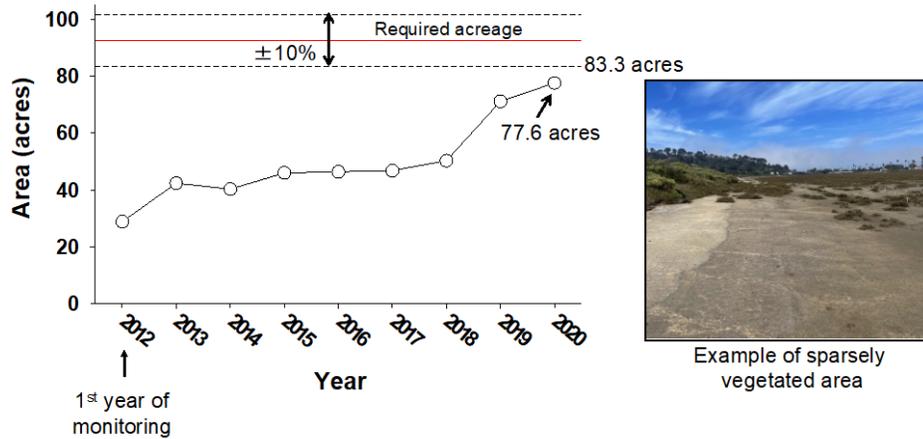


Figure 7.2.2. Change in acres of salt marsh habitat over time and the required acreage $\pm 10\%$ in San Dieguito Wetlands. San Dieguito Wetlands had a deficit of 5.7 acres of salt marsh habitat in 2020. The minimum required acreage of salt marsh habitat is 83.3 acres (10% lower than the design acreage of 92.6 acres).

The goal of the restoration project is to achieve not only a minimum of 83.3 acres of salt marsh habitat, but also to attain a high cover of vegetation similar to the reference wetlands (i.e. $\geq 85\%$ cover). Figure 7.2.3 shows the change in vegetation cover over time in San Dieguito Wetlands by cover classes. The monitoring data from 2012 to 2020 reveal that the overall rate of increase in cover in the higher cover classes has been very slow with only approximately 18 acres of 85% cover as of 2018 (Fig. 7.2.3). However, there was an appreciable increase in the acres of $\geq 85\%$ cover to approximately 30 acres in 2019, and that has increased to close to 35 acres in 2020, which is encouraging. Cover in the 60 – 85% cover class is also increasing as is cover of the 30 – 60% cover class.

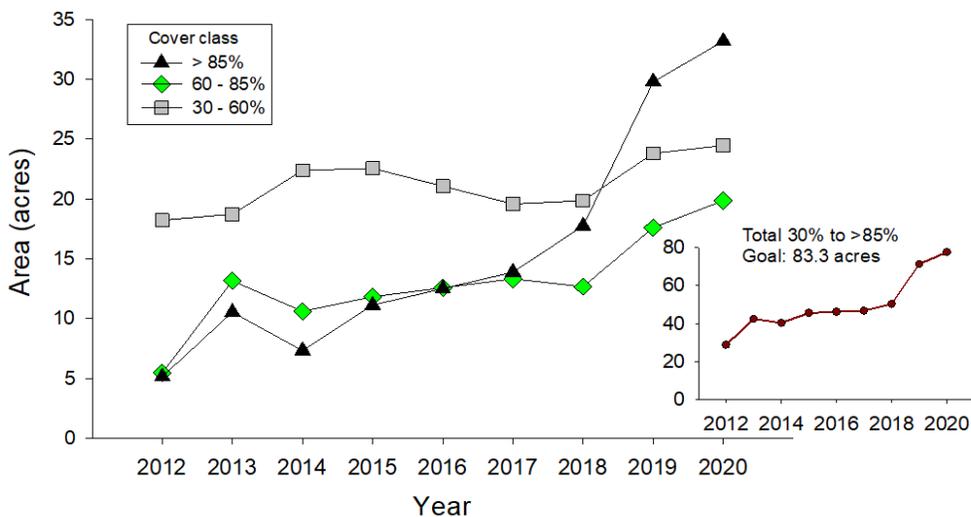


Figure 7.2.3. (Top) Change in acres of salt marsh vegetation as a function of cover class over time (left graph) and total acres of all cover classes combined from 2012 – 2020 (right graph). (Bottom) View of the high cover of vegetation in the reference wetlands.

Data collected to evaluate the performance standards for habitat areas and vegetation cover can be used to identify specific areas in the wetland where vegetation is underperforming and in need of intervention to facilitate plant establishment.

Figure 7.2.4 shows vegetation cover in 2020 assessed within 10 m x 10 m grids using aerial imagery (see methods in Section 5.1.2) for the wetland modules on the east side of the freeway (W4/16, W5/10). The inset in this figure, extracted from the San Dieguito Wetlands Final Restoration Plan (2005), illustrates that most of these modules are planned vegetated salt marsh habitat (shades of green) together with some planned mudflat (brown, light blue). Vegetation cover in 2020 determined using aerial imagery is binned into cover classes with warm colors (red, orange, yellow) showing areas that were classified as other (i.e., habitat with insufficient vegetation cover to be assessed salt marsh). Areas of the restoration site that meet the Habitat Areas standard (i.e., cover \geq 30%) are indicated by shades of green, with the darkest green showing areas that are \geq 85% cover. Also provided are the estimated acres of these cover classes. As of 2020, about 16 acres of other (red, orange, and yellow) that might benefit from some form of intervention to achieve at least 30% plant cover, and increase cover towards the 85% or higher cover seen in the reference wetlands, are located at the higher elevations and in the eastern portion of W4/16 with another 2 acres located in modules W5/10.

Similarly, Figure 7.2.5 shows the modules on the west side of the freeway, which consists of W2/3 and the basin, W1. The inset shows that modules W2/3 are planned

vegetated salt marsh habitat, whereas module W1 is a planned subtidal basin bordered by a narrow strip of mudflat and vegetated marsh.

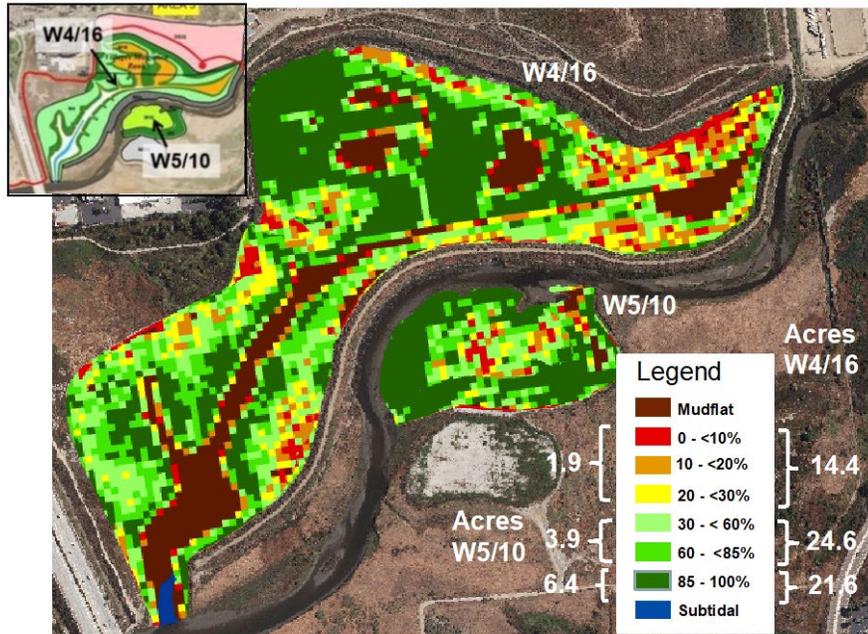


Figure 7.2.4. Cover of vegetation in the eastern modules of San Dieguito Wetlands in 2020 binned into cover classes, and the acres of each class by module. Inset in upper left shows planned habitats from the Final Restoration Plan.

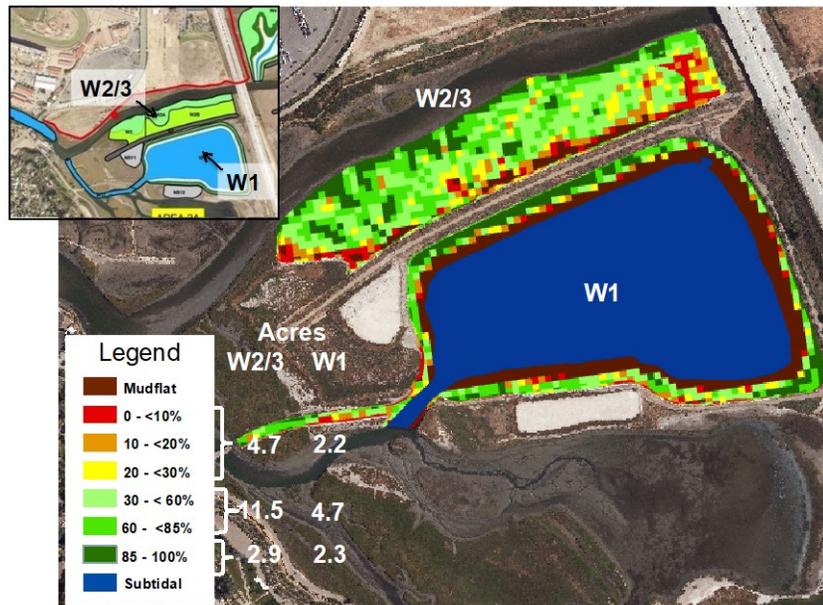


Figure 7.2.5. Cover of vegetation in the western modules of San Dieguito Wetlands in 2020 binned into cover classes. Inset in upper left shows planned habitats from the Final Restoration Plan.

Approximately 14 of 20 acres of W2/3 had achieved at least 30% cover in 2020 and 5 acres of sparse vegetation remain, particularly at the higher elevations and eastern end. About 5 out of the 20 total acres in W2/3 have achieved at least 85% cover.

Experiments to inform the planting program (2020)

SCE supported some experiments embedded within their larger planting program to inform this program moving forward. The overall goal of these experiments is to investigate factors that could facilitate the successful establishment and growth of planted plants, leading to an increase in the cover of salt marsh vegetation that will bring the restored wetland into compliance with the SONGS permit (CCC 1997). The specific plant species used in the experiments, number of replicates, configuration of the planting, and location of the experiments is constrained by the species and number of plants that were available, location of the irrigation system, and logistics of the planting process.

Two experiments are embedded within SCE's 2020 planting program (Figs. 7.2.6, 7.2.7). The goal of the first experiment is to test the effect of irrigation (I), soil decompaction (D), and soil amendments (A) on the growth and survival of potted plants (P) and of seeds (S), the so-called IDAPS design. This experiment is being conducted at higher elevations where vegetation cover is less than approximately 10%. The goal of the second experiment (the Fill-in design) is to test the effect of planting versus seeding on filling in gaps in plant cover at lower elevations where existing cover exceeds 10%, but is insufficient to meet the habitat areas standard of at least 30% cover. No soil amendments or irrigation were applied in the second experiment.

Experiment locations & timetable

Experiment started: March 3, 2020
End date: Summer 2021
Sampling quarterly
Most recent data collection: January 19, 2021 (10.7 months)

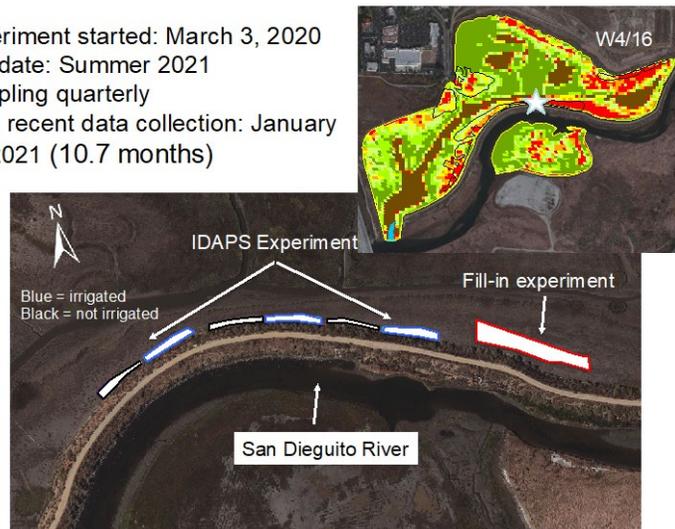


Figure 7.2.6. The location, indicated by the star, and layout of the two experiments undertaken in 2020: Experiment 1 at high elevation (4.25 – 3.5 feet NGVD) and the fill-in- experiment at lower elevation (< 3.5 feet NGVD) in Module W4 east of the I-5 freeway. Another fill-in experiment is located on the west side of freeway in Module W2/3.



Figure 7.2.7. Images showing a tractor de-compacting soil to a depth of approximately 1.5 feet, the manual addition of soil amendments (gypsum, soil conditioner), and the arrangement of experimental quadrats and plants within each quadrat in the IDAPS experiment.

Vegetation cover within the experimental quadrats, and overall SCE planting area, are being measured from images collected by drone quarterly for at least one year beginning in early March 2020. Vegetation cover is also assessed by sampling 98 uniform points quarterly within each quadrat, which will provide ground-truth data for the drone flights and detect any effects of seeding where sprouts would be hard to detect using aerial imagery.

Although these two experiments are ongoing, data collected as of January 2021 show no effect of seeding on plant cover in either the IDAPS or Fill-in experiments. In the planted treatments of the IDAPS experiment, there has been no effect of any of the manipulations (i.e., soil amendments, decompaction, irrigation) on plant cover or plant sizes. Plant cover has remained low in Planted (3-7%) versus Control (1-6%) plots. In the Fill-in experiment, the data to date suggest that the slow growth of *Arthrocnemum* (6-7% cover) does not recommend the use of this plant, in comparison with the other species, if the goal is to increase plant cover quickly. The two other species tested, *Frankenia* and *Salicornia*, look more promising in increasing plant cover with significantly higher % cover for *Frankenia* (14-22%) and *Salicornia* (26-28%) versus Control plots.

Underperformance of vegetation has led to a short-fall in salt-marsh habitat and vegetation cover. Vegetation development currently appears on a more promising trajectory towards meeting the vegetated salt marsh acreage requirement for habitat areas. Experiments started in 2020 are currently underway to evaluate the effect of irrigation, decompaction, soil amendments, planting, and of seeding on the development of plant cover. UCSB scientists will continue to monitor the experiment and the overall planting program to evaluate whether they achieve the desired goal of increasing vegetation cover.

7.3. Status of macro-invertebrates, fish, and birds

The success of San Dieguito Wetlands in supporting biological communities of macro-invertebrates and fish is evaluated under the relative standards by comparing the densities and numbers of species within these groups to the densities and numbers of

species in the reference wetlands. Biological standards not met in San Dieguito Wetlands in 2020 included invertebrate density in main channel and tidal creek habitat and species richness in tidal creeks, fish species richness in main channel and tidal creek habitat, and food chain support measured as the density of feeding birds.

The following sections review the status of macro-invertebrates, fish, and food chain support (bird feeding) in San Dieguito Wetlands and prioritize plans to explore possible reasons for the underperformance of these groups.

7.3.1. Underperformance of macro-invertebrates over time

To review, the standards for invertebrate density were only met the first year in main channel habitat and have never been met in tidal creek habitat (Fig. 7.3.1.1). The standards for invertebrate species richness have generally been met in tidal creek and main channel habitat, although the standard for richness in tidal creek habitat was not met in 2019 or 2020.

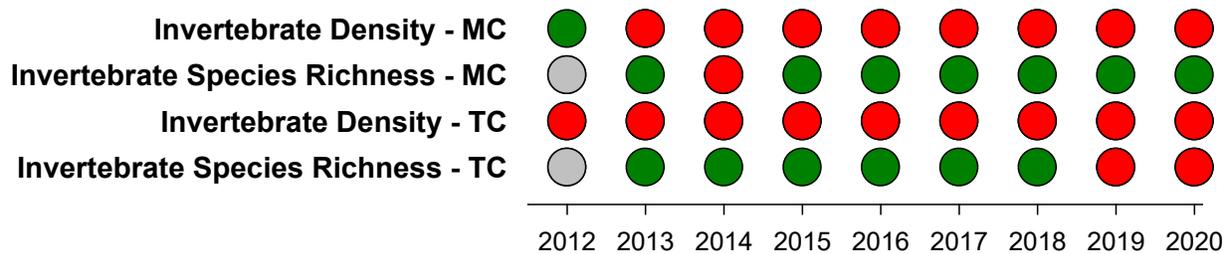
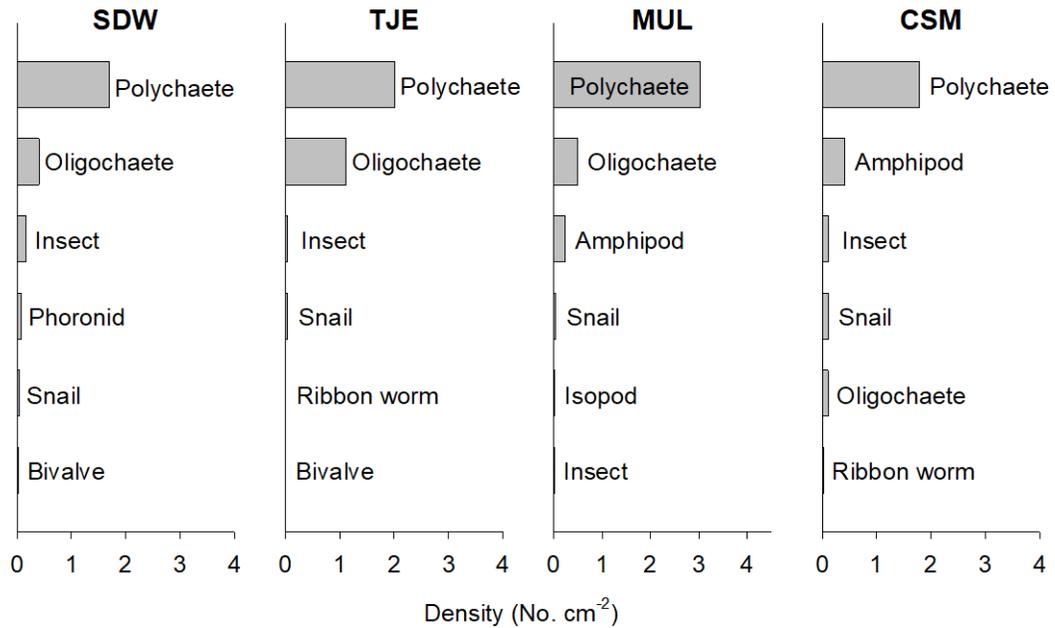


Figure 7.3.1.1. Performance of invertebrate density and species richness in main channel and tidal creek habitat over time. A [green](#) dot indicates that standard was met, a [red](#) dot indicates that a standard was not met. A [grey](#) dot indicates that the standard was not assessed.

In 2020, the most abundant invertebrates in main channel and tidal creek habitats in San Dieguito Wetlands and the reference wetlands were small worms in the classes Polychaeta and Oligochaeta (Fig. 7.3.1.2). In main channel habitat, polychaete worms were followed in abundance by oligochaete worms in San Dieguito Wetlands, Tijuana Estuary, and Mugu Lagoon and by amphipods in Carpinteria Salt Marsh. In tidal creeks, polychaete worms were most the abundant taxon in San Dieguito Wetlands, Mugu Lagoon, and Carpinteria Salt Marsh, but oligochaetes were most abundant in Tijuana Estuary.

Main Channel



Tidal Creek

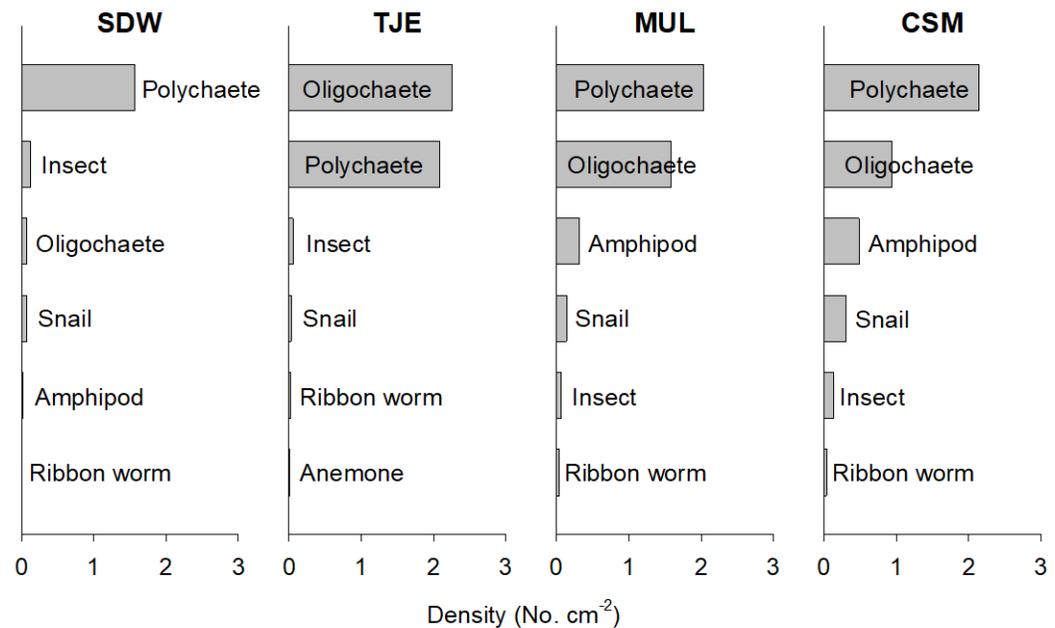


Figure 7.3.1.2. The six most abundant invertebrate taxa in main channel and tidal creek habitat in the restored wetland (SDW) and reference wetlands (TJE, MUL, CSM) in 2020.

Across all years of monitoring, the densities of both polychaete and oligochaete worms have been lower in San Dieguito Wetlands compared with the reference wetlands (Fig. 7.3.1.3), contributing to the failure of San Dieguito Wetlands to meet the relative standard for invertebrate density in both main channel and tidal creek habitats in 2020 (see Section 5.2.4 Macro-invertebrates).

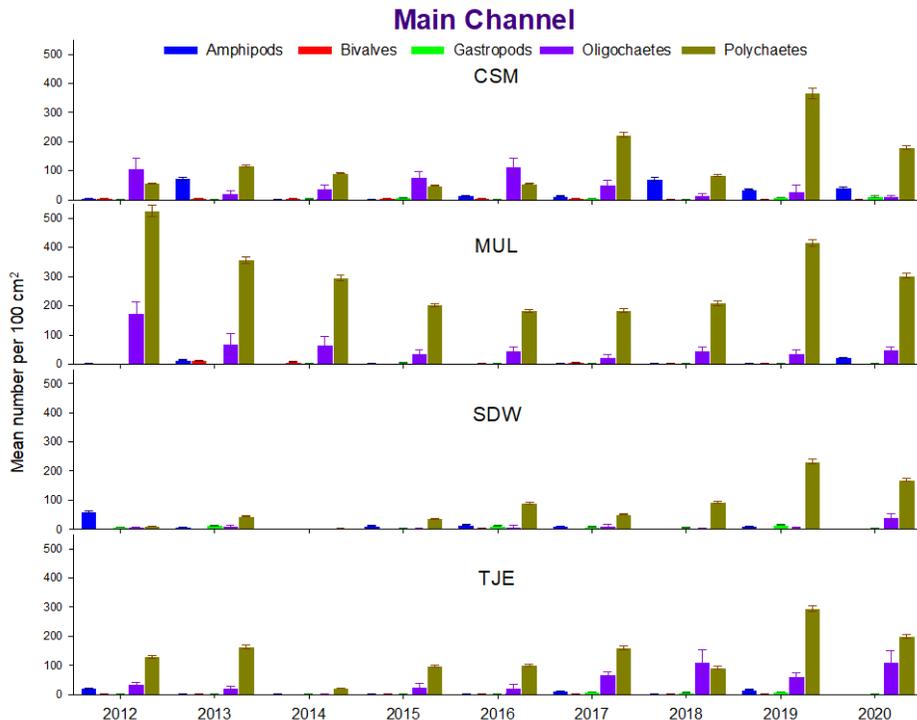


Figure 7.3.1.3. Densities of the most abundant invertebrate groups over time in main channel habitat in SDW and the reference wetlands (CSM, MUL, TJE). Densities of these groups in main channel habitat have remained low and relatively constant over the past nine years of monitoring in SDW except for polychaete worms, which increased in abundance in all wetlands in 2019 and 2020.

Although the abundances of polychaetes and oligochaetes were higher in 2019 and 2020 in main channel habitats in San Dieguito Wetlands than previous years (Fig. 7.3.1.3), and elevated in tidal creeks in San Dieguito Wetlands in 2020 relative to previous years (Fig. 7.3.1.4), the overall densities of invertebrates remain low in San Dieguito and it appears that there may be some physical or biological factor that is contributing to the low abundance of invertebrates, and worms, in particular, in this wetland.

While the mechanisms responsible for the underperformance of vegetation appears obvious (i.e., highly saline soils, infrequent tidal inundation and poor drainage), the mechanisms responsible for the underperformance of invertebrates in San Dieguito Wetlands are not. UCSB scientists are exploring possible mechanisms contributing to the deficit of invertebrates by looking at patterns in the abundance of various groups in the monitoring data. This work is ongoing, but initially there does not appear to be a particular invertebrate group or feeding guild, for example, that is absent in San Dieguito Wetlands compared with the reference wetlands that could suggest an obvious reason behind the deficit in invertebrates in San Dieguito Wetlands. A deficit in oligochaete worms, which are deposit feeders and lack planktonic larvae, could suggest low particulate organic matter content in the sediments that provides food for these organisms and/or poor dispersal into the wetland. However, polychaete worms, which

include both deposit and suspension feeding taxa and have planktonic larvae are also depressed in San Dieguito Wetlands.

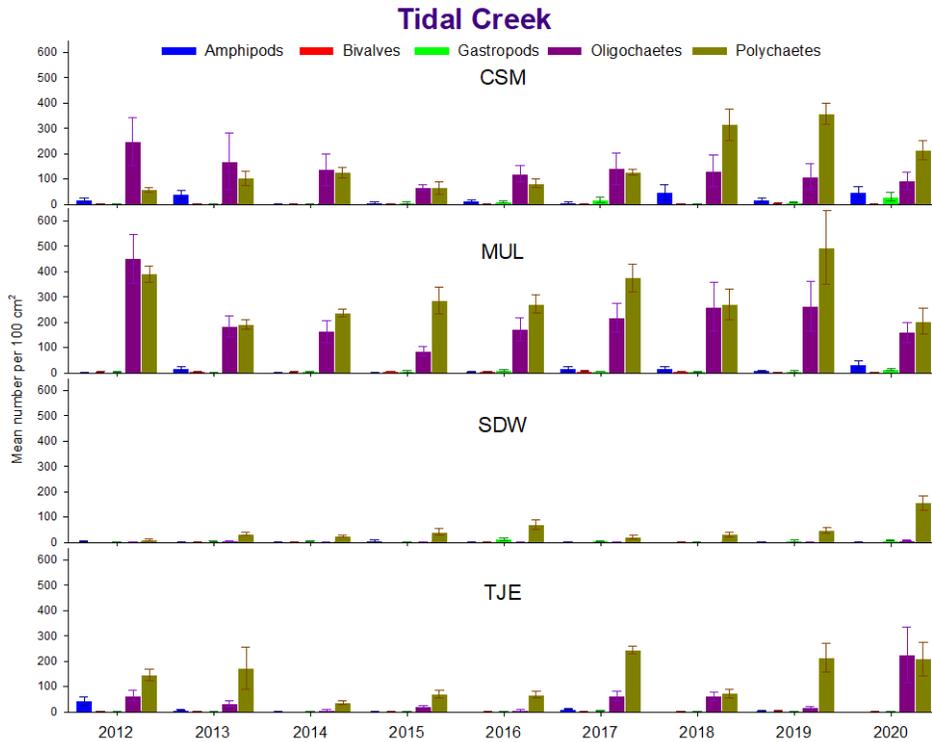


Figure 7.3.1.4. Densities of the most abundant invertebrate groups over time in tidal creek habitat in SDW and the reference wetlands (CSM, MUL, TJE). Densities of these groups in SDW tidal creeks have remained low and relatively constant over the past nine years of monitoring in SDW compared with the reference wetlands.

One possible hypothesis for the low densities of invertebrates in tidal creeks is that the density of invertebrates varies inversely with elevation and that the elevations of this habitat are higher in San Dieguito Wetlands than the reference wetlands. UCSB scientists measured the elevation of all of the invertebrate sampling stations in San Dieguito Wetlands and the reference wetlands in 2020. These measurements revealed that the mean elevation of tidal creek stations in San Dieguito Wetlands is approximately one foot higher than in the reference wetlands, which are comparable (Fig. 7.3.1.5a). In addition, there is a negative relationship between tidal elevation and density of invertebrates in San Dieguito Wetlands (Fig. 7.3.1.5b), which supports the hypothesis that the higher elevation of the tidal creeks in San Dieguito Wetlands is negatively influencing invertebrate density. Tidal creek elevation in some areas is within the range of planned low marsh, and *Spartina* has colonized portions of some creeks (Fig. 7.3.1.5c). The hypothesis that higher tidal creek elevations are influencing invertebrate density will be further evaluated in 2021.

Tidal Creek Habitat

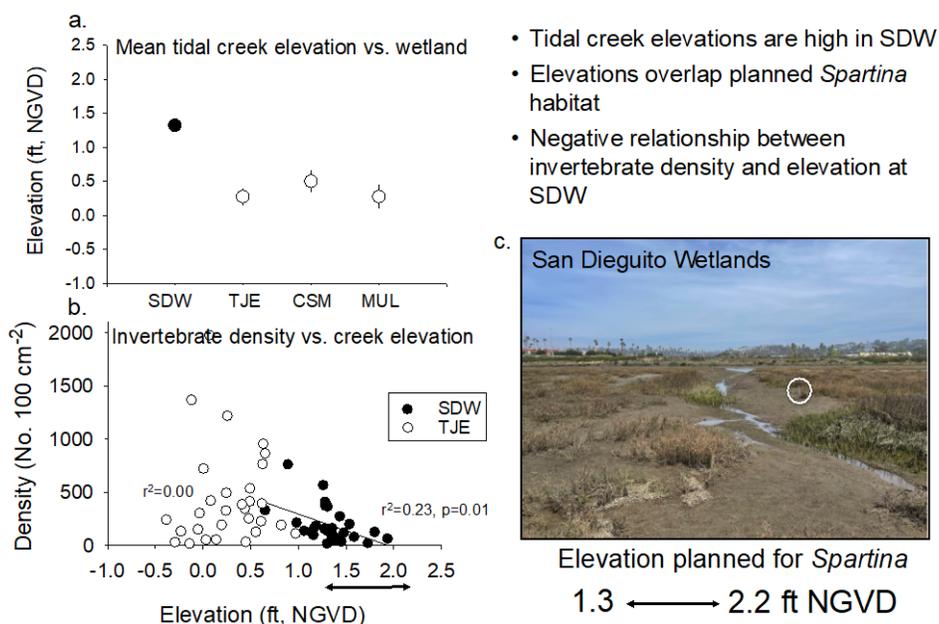


Figure 7.3.1.5. a) Mean tidal creek elevation for each of the wetlands $\pm 95\%$ confidence interval, b) relationship between invertebrate density and elevation, and c) photo showing the colonization of *Spartina* in tidal creek habitat near one of the invertebrate and fish sampling stations (white circle).

Main Channel Habitat

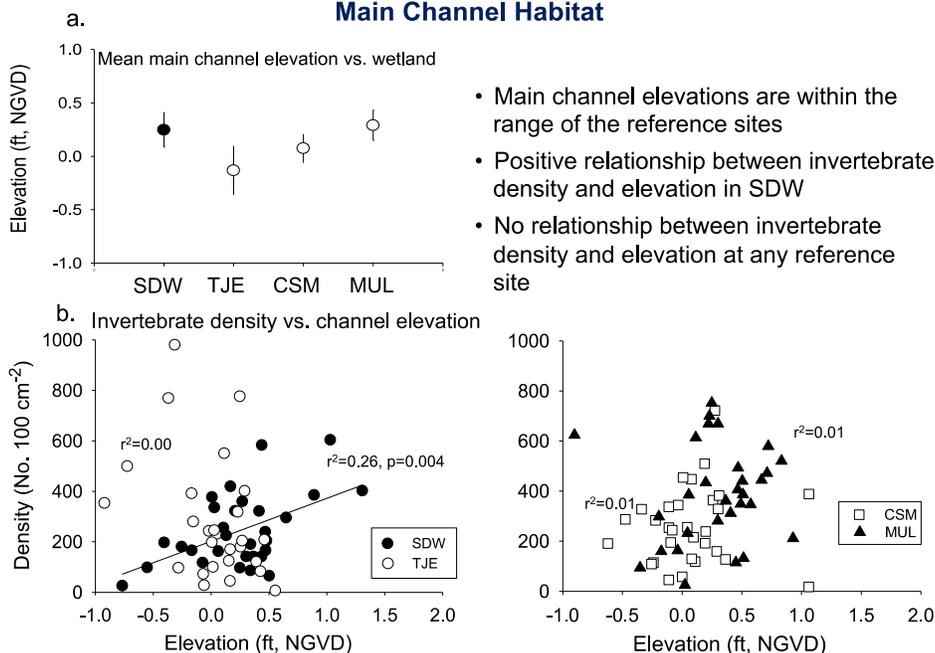


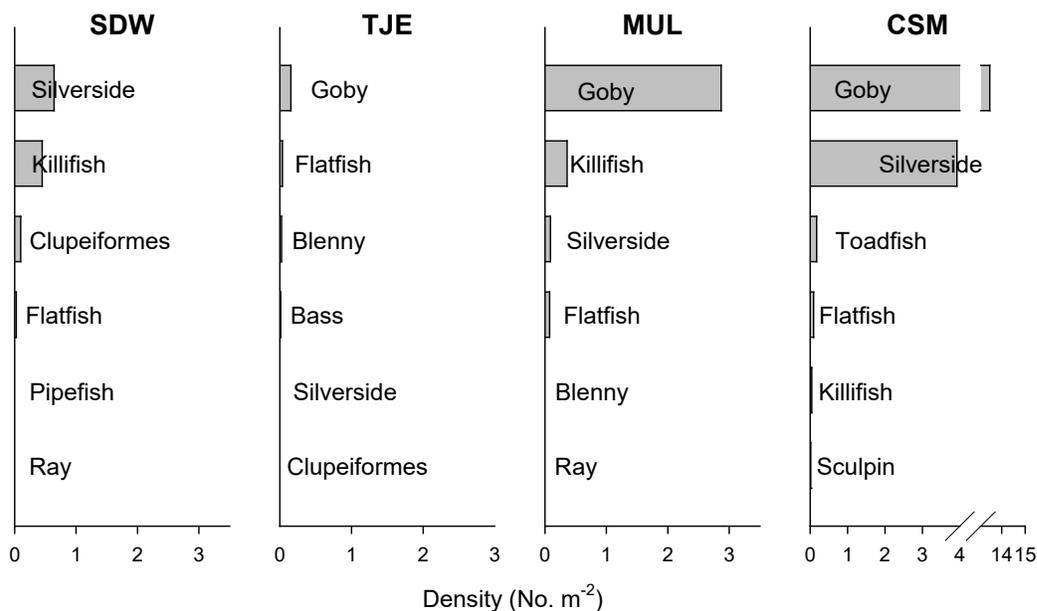
Figure 7.3.1.6. a) Mean main channel-basin elevation of stations for each of the wetlands $\pm 95\%$ confidence intervals and b) relationship between invertebrate density and elevation in SDW and TJE (left) and CSM and MUL (right).

However, high tidal elevation is not a satisfactory explanation for the low densities of invertebrates in main channel-basin habitat of San Dieguito Wetlands (Fig. 7.3.1.6ab). Main channel elevations in San Dieguito Wetlands are within the range of the reference sites and there is a positive relationship between invertebrate density and elevation in San Dieguito Wetlands, although not in any of the reference wetlands. One possible factor that may explain the underperformance of invertebrates in main channel habitat is the effect of physical properties of the sediments on invertebrate density. There are no comprehensive data currently available that explore the relationship between sediment properties, such as grain size or organic matter content and the abundance of invertebrates in San Dieguito Wetlands or the reference wetlands. Core sediment samples will be taken in conjunction with invertebrate sampling during performance monitoring in 2021 and these samples will be analyzed for grain size and organic matter content to examine this possibility.

7.3.2 Underperformance of fish and food chain support standards

During monitoring surveys in 2020, the top three fish groups in San Dieguito Wetlands were silversides (topsmelt, grunion), killifish and Clupeiformes (e.g., anchovies) (Fig. 7.3.2.1). Gobies were most abundant in both main channel habitat in Carpinteria Salt Marsh, Mugu Lagoon, and Tijuana Estuary, in contrast to the near absence of this group in San Dieguito Wetlands. Gobies were most abundant in tidal creek habitat in San Dieguito Wetlands, Carpinteria Salt Marsh, and Mugu Lagoon, but the third ranked group in Tijuana Estuary. It is worth noting that although the abundance of the top five fish species in San Dieguito wetlands are much less than in Mugu Lagoon or Carpinteria Salt Marsh, collectively, their densities are as great or greater than those in Tijuana Estuary (Figs. 7.3.2.1).

Main Channel



Tidal Creek

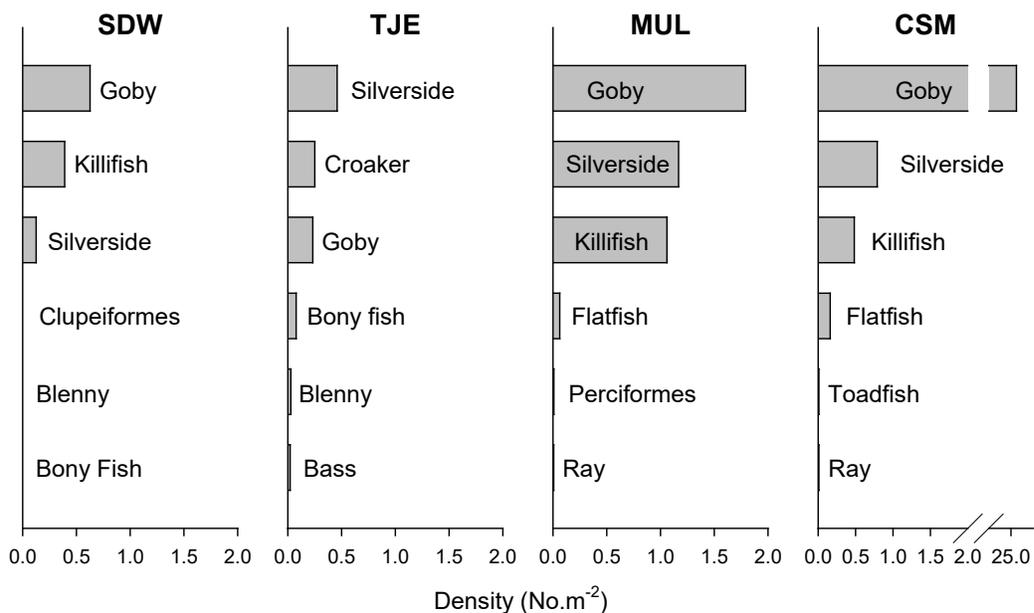


Figure 7.3.2.1. The six most abundant fish in SDW and the reference wetlands in main channel and tidal creek habitat in 2020. Note the differences among wetlands in the scale of the x-axis to accommodate the wide disparity in the densities of gobies among sites.

One issue of potential concern that could affect fish abundance and species richness in San Dieguito Wetlands is the encroachment of cordgrass, *Spartina foliosa*, into tidal creek habitat. The colonization of tidal creeks by cordgrass suggests that these areas were graded too high during construction, and may be becoming shallower, allowing

cordgrass to become established. This habitat change could be a possible mechanism that explains the paucity of fish in San Dieguito Wetlands, at least in tidal creeks.

The relative standard for food chain support incorporates both the densities of shorebirds and their feeding activity. San Dieguito Wetlands has failed this standard the past four years. Although San Dieguito Wetlands passed the performance standard for overall bird density in 2020, the density of shorebirds, used to evaluate the food chain support standard was lower in San Dieguito Wetlands than the reference wetlands (Fig. 7.3.2.2). The next most abundant group was waterfowl in San Dieguito Wetlands, Tijuana Estuary, and Mugu Lagoon, and upland birds in Carpinteria Salt Marsh, and waterfowl were more abundant in San Dieguito in 2020 than the previous four years. Over time, there has been a deficit in shorebird density in San Dieguito Wetlands relative to the reference sites (Figs. 7.3.2.2 and 7.3.2.3). Thus, one explanation for the failure of San Dieguito Wetlands to pass the food chain support standard could be the low density of shorebirds, and there may be something about the restored wetland that is affecting shorebird abundance. A lower proportion of birds feeding in San Dieguito Wetlands relative to the reference wetlands due to insufficient food resources (e.g., worms) might seem to be a reasonable explanation. However, this explanation is not compelling because invertebrate densities have been consistently low in San Dieguito Wetlands, including during periods when the wetland passed the standard for food chain support. Further analyses of existing data are required to identify the reasons for the underperformance of the food chain support standard in San Dieguito Wetlands.

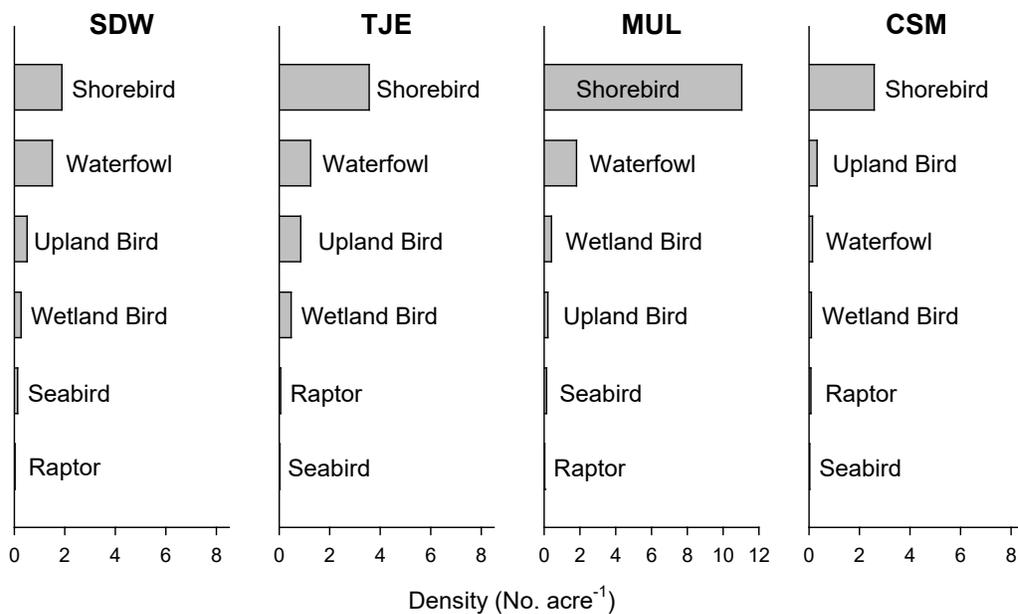


Figure 7.3.2.2. The six most abundant bird guilds in SDW and the reference wetlands in 2020. Note the differences among wetlands in the scale of the x-axis in to accommodate the wide disparity in the densities of shorebirds among sites.

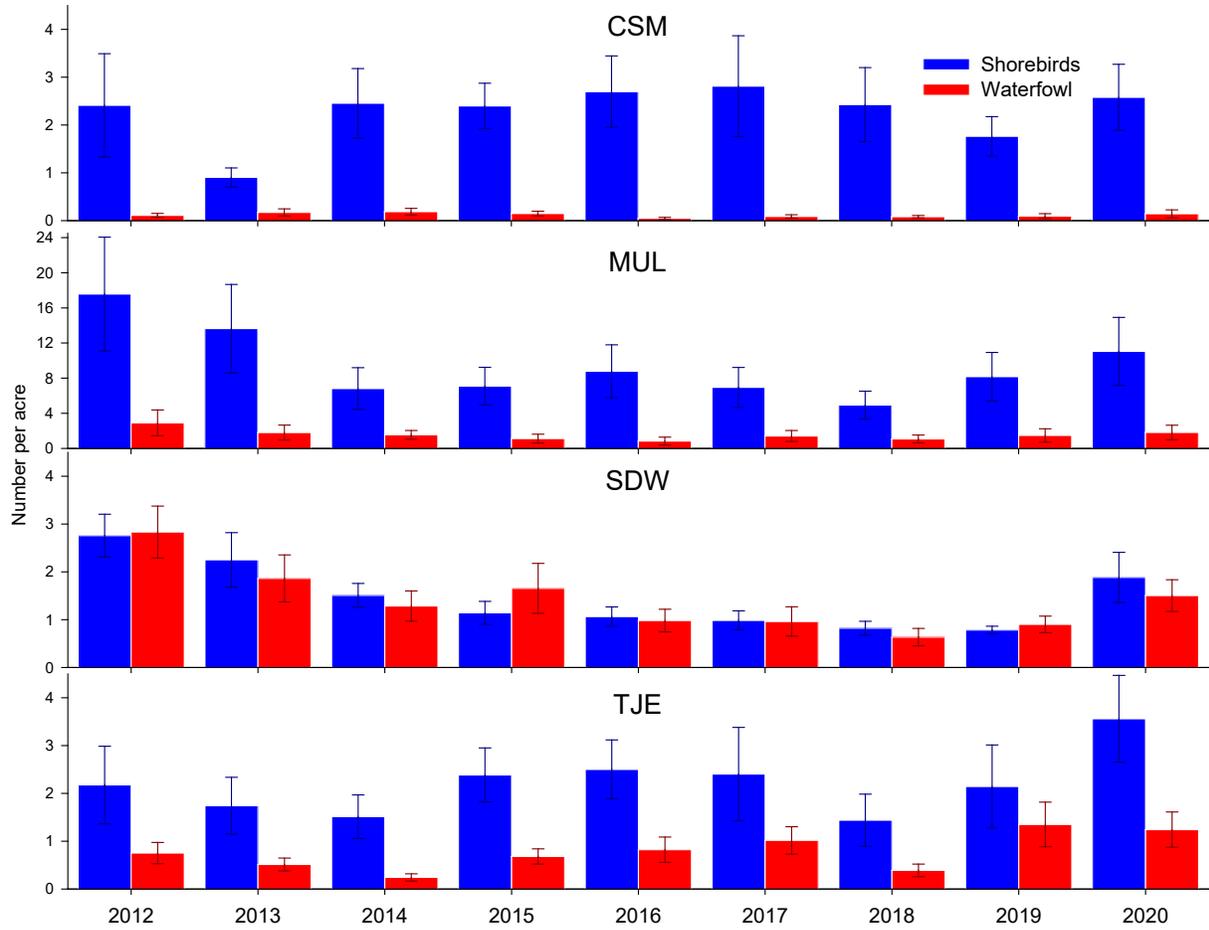


Figure 7.3.2.3. Densities of shorebirds and waterfowl in SDW and the reference wetlands over time. Note the differences among wetlands in the scale of the y-axis in to accommodate the wide disparity in the densities of birds among sites.

8.0 Progress Towards Compliance with the SONGS Permit

In examining the overall progress of San Dieguito Wetlands towards compliance with the requirements of the SONGS permit (CCC 1997), the cover of salt marsh vegetation is on a promising trajectory and there is reason to be cautiously optimistic that San Dieguito Wetlands will meet the performance criteria for salt marsh habitat in the near term. UCSB scientists, CCC staff, and members of the SAP have put considerable effort into understanding the reasons behind the slow development of vegetation over the previous years, and SCE has engaged in activities to improve vegetation development, from regrading part of the wetland to increasing tidal inundation and drainage of the marsh surface to an extensive and on-going planting program, and experiments to better understand factors that influence the growth and survival of nursery grown plants.

More perplexing moving forward is the underperformance of relative standards relating to densities and species richness of invertebrates and fish, and bird feeding and the progressive decline in proportion of relative standards met in San Dieguito Wetlands over time (Fig. 8.0.1). It is concerning that some of these standards that were met in 2019 were not met in 2020.

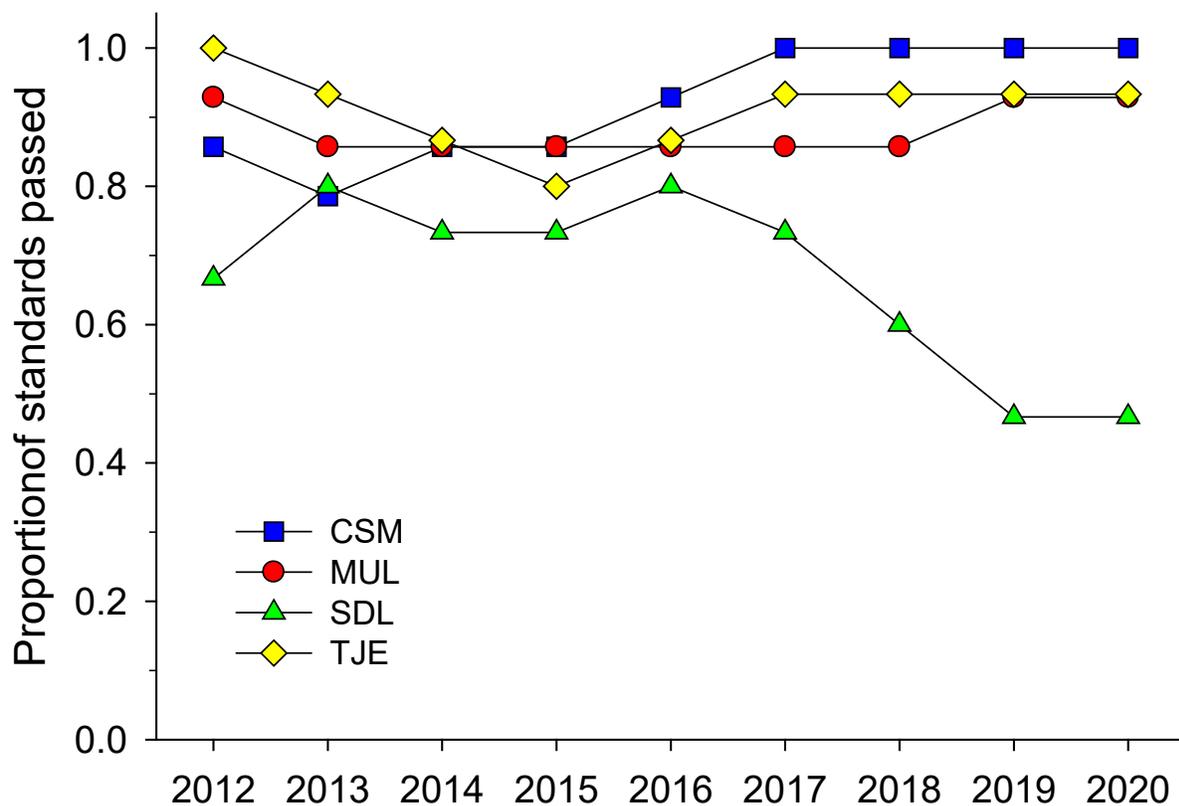


Figure 8.0.1. Progressive decline in the proportion of standards met in San Dieguito Wetlands relative to the reference wetlands over time.

There is a requirement that the absolute and relative performance standards must be met by 10 years after the initiation of Fully Implemented Monitoring (“Definition of Compliance in the Context of the SONGS Mitigation Projects”, Monitoring Plan for the

SONGS Wetland Mitigation Project). Furthermore, three consecutive years of compliance must occur by 12 years or remediation may be required at the discretion of the Coastal Commission's Executive Director. Given this deadline, there is an urgency to determine the reasons for the underperformance of these biological standards.

On-going activities and future plans moving forward include continued performance monitoring in 2021 as required by the SONGS permit (CCC 1997), monitoring SCE's adaptive management program for vegetation, further analysis of existing data, and the collection of additional data, if necessary, to assist in the determination of mechanisms underlying the under-performance of macro-invertebrates, fish, and Food Chain Support (i.e. Bird Feeding). Coastal Commission staff and SCE will be consulted regarding next steps to address the decline in proportion of standards met in San Dieguito Wetlands relative to the reference wetlands to bring the project into compliance with the SONGS permit (CCC 1997).

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