

Annual Public Wetland Workshop Agenda

San Onofre Nuclear Generation Station Mitigation Monitoring Program
May 21, 2026

1:30 – 2:30 Introduction and Overview – Dr. Kathryn Beheshti, UCSB

**Performance Evaluation of the San Dieguito Wetlands Restoration
Project: Absolute Standards – Dr. Kathryn Beheshti, UCSB**

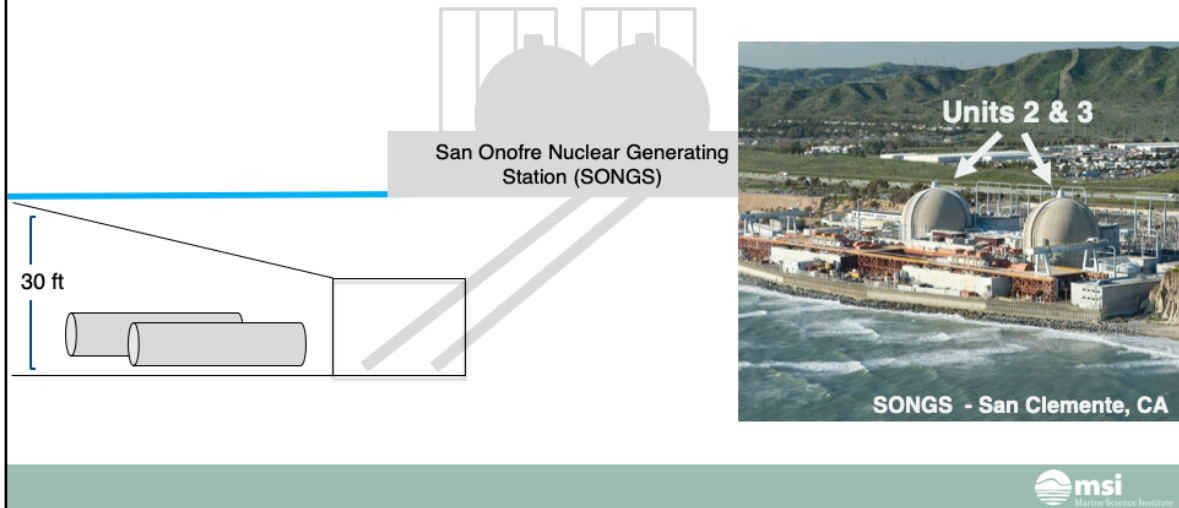
**Performance Evaluation of the San Dieguito Wetlands Restoration
Project: Relative Standards – Dr. Rachel Smith, UCSB**

2:30 – ? General Questions & Discussion



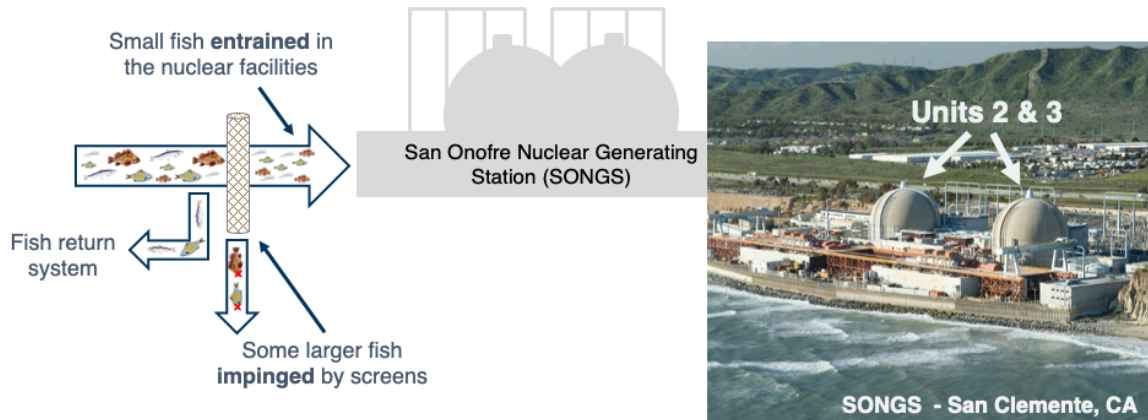
- Good afternoon everyone and welcome to the Annual Public Wetland Workshop for the San Onofre Nuclear Generating Station Mitigation Monitoring Program. I am Kathryn Beheshti, one of the 4 Principal Investigators leading the SONGS MMP. Today's workshop will begin with an introduction and overview followed by results from the performance evaluation of absolute standards led by myself and we will conclude with a presentation on the relative standards led by Dr. Rachel Smith. Please hold your questions and comments for after the presentation. We are here to answer any questions our in person or remote audience may have. This workshop is designed to be interactive and we are here to facilitate a dialogue between our program and all of you.

SONGS Units 2 & 3 intake found to negatively impact nearshore fish populations



- It is useful to review the purpose and rationale beyond the SONGS wetland mitigation project
- The SONGS reactors were cooled by a single pass seawater system
- Units 2 and 3 had separate intake lines located in about 30 feet of water offshore of the power plant
- When operational, the water pumped into the plant was elevated about 19 degree F above ambient in the plant, and then discharged through an extensive diffuser system designed to dissipate the heat

SONGS Units 2 & 3 intake found to negatively impact nearshore fish populations



- Power plant heated cooling water and turbulence was found to kill fish eggs, larvae and small immature fish; these losses were projected to cause substantial reductions in populations of adult fish in the Southern California Bight
- Construction of Units 2 and 3 was found to be consistent with the Coastal Act only if these significant adverse impacts to fish were mitigated

California Coastal Commission required Southern California Edison to restore wetland habitat as out-of-kind mitigation for fish losses

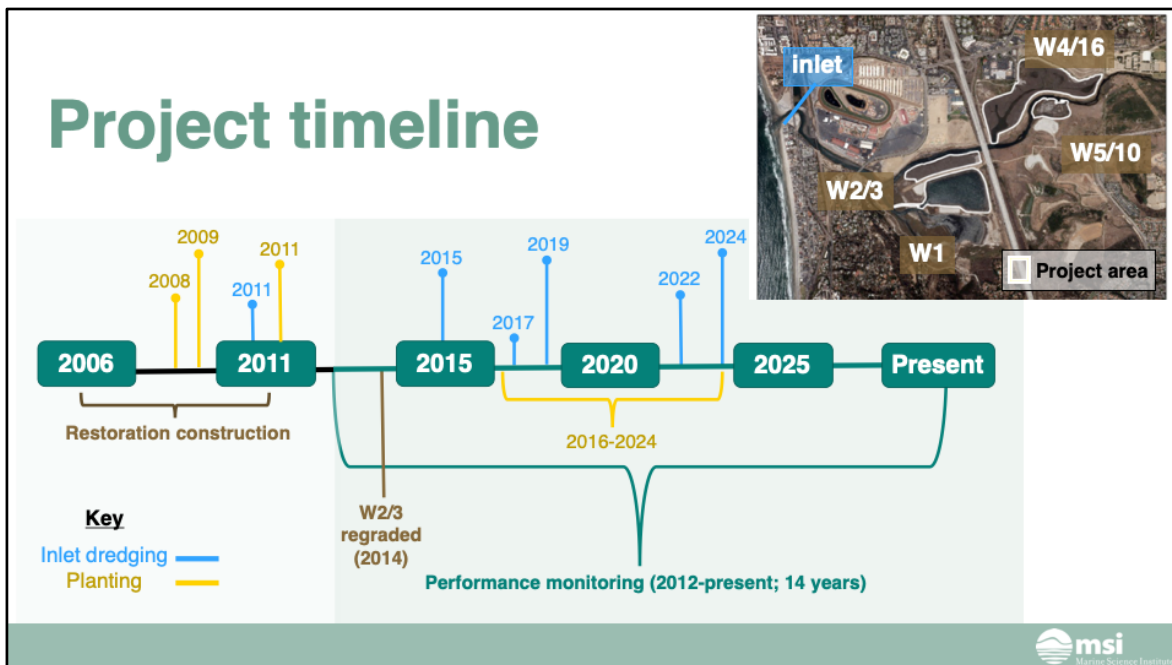


- The California Coastal Act requires the mitigation of impacts to the marine environment
- Enforcement of the Coastal Act resides with the California Coastal Commission (CCC)
- As mitigation for the impacts to larval and juvenile fish caused by SONGS the CCC required SCE to:
 - Create or substantially restore a minimum of 150 acres of wetlands, excluding buffer zone and upland transition area
 - Provide funding for scientific oversight and monitoring of the restoration project that is *independent* of SCE

150-acre San Dieguito Wetlands Restoration Project constructed from 2006–2011



- San Dieguito Lagoon was the site chosen for restoration as out-of-kind compensation for in-plant losses of larval and juvenile fish caused by the 32 years of operation of SONGS Units 2 & 3
- You can see the San Dieguito River and adjoining ruderal upland, including the site of an old WWII airfield, and old agricultural fields
- During construction, the ruderal areas and old agricultural fields were excavated and graded to create the planned intertidal and subtidal wetland habitats of the restoration project visible in this image taken in 2016
- In addition, you can see nesting sites that are not part of the mitigation requirement, and upland disposal sites that received the majority of the ~2.2 million yd³ of material excavated during construction



- This slide summarizes the project timeline
- I first want to review the locations of the various modules, W2/3 and W1 are located west of the I-5 and W4/16 and W5/10 east of the I-5.
- Here we have color coded the two routine management activities—inlet dredging in blue and planting in gold
- Construction began in September of 2006
- Most excavation and grading was completed by 2008, with the addition of tidal creeks in W2/3 completed in November 2010, and re-grading of this area to lower elevations in March 2014
- Large scale planting of salt marsh plants, including cordgrass (*Spartina*) in the low marsh was completed in 2011, with additional planting of other species throughout the mid to high marsh
- Inlet channel dredging was completed in September 2011, with follow-up maintenance dredging approximately every 2-3 years to maintain tidal exchange as required by the permit
- Performance monitoring began in the year 2012, following the initial September 2011 dredging
- We will be reporting on the fourteenth year of performance monitoring

Fulfilling mitigation requirement

- Physical and biological standards evaluated within the restored wetland and relative to natural reference wetlands
 - Annual mitigation credit is earned if standard requirements are met



- Physical and biological standards were established to evaluate the performance of the wetland restoration project to ensure that the restored wetland provides ecosystem functions that are similar to relatively undisturbed tidal wetlands in the region
- Fulfillment of the SONGS wetland mitigation requirement occurs when the number of years of mitigation credit accrued by the San Dieguito Wetlands Restoration Project equals the 32 total years of operation of SONGS Units 2 & 3.

Fulfilling mitigation requirement

- Physical and biological standards evaluated within the restored wetland and relative to natural reference wetlands
 - Annual mitigation credit is earned if standard requirements are met

Standard	Sampling location	To earn mitigation credit	Evaluation method
Absolute	Restored wetland	All absolute standards must be met each year	Based on the current year
Relative	Restored and reference wetlands	Proportion of relative standards met at restored wetland must equal or exceed the lowest performing reference wetland	Based on 4-year running average



- Absolute standards are sampled only at the restored San Dieguito Wetlands
- To earn mitigation credit, all absolute standards must be met
- Evaluation of absolute standards is based on the current year

Fulfilling mitigation requirement

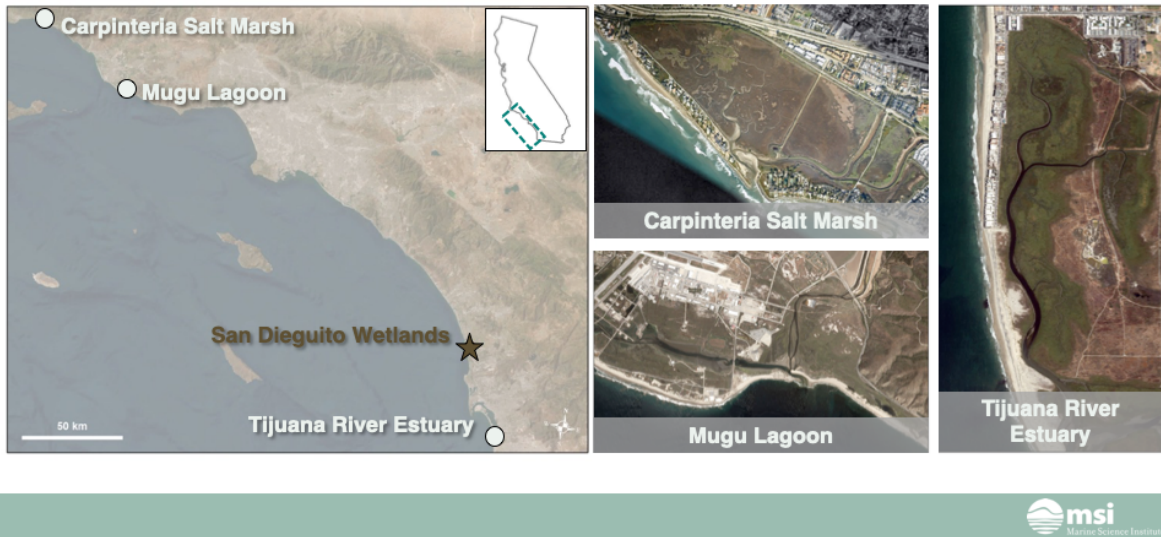
- Physical and biological standards evaluated within the restored wetland and relative to natural reference wetlands
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Standard	Sampling location	To earn mitigation credit	Evaluation method
Absolute	Restored wetland	All absolute standards must be met each year	Based on the current year
Relative	Restored and reference wetlands	Proportion of relative standards met at restored wetland must equal or exceed the lowest performing reference wetland	Based on 4-year running average



- Relative standards are assessed at both restored and reference wetlands
- To earn mitigation credit, the restored wetland must meet at least as many relative standards as the lowest performing reference wetland
- These standards are evaluated based on a four year running average. Rachel will go into more detail on the relative standards in her talk but I would like to provide a brief overview of how reference wetlands were chosen and what changes have occurred in recent years with respect to reference wetlands used for assessment

Reference wetland selection



- Reference wetland selection was based on criteria included in the SONGS permit
- Reference wetlands must be relatively undisturbed, tidal, and located in the Southern California Bight
- From a pool of 46 potential sites, the three wetlands shown here, Carpinteria Salt Marsh, Mugu Lagoon, and Tijuana River Estuary were determined to best meet these criteria

Los Peñasquitos Lagoon replaced Tijuana River Estuary as a reference site in 2024



- Unfortunately, in 2024, Tijuana River Estuary was no longer considered an appropriate reference site due to the influence anthropogenic sewer flows
- Los Penasquitos Lagoon was identified as best meeting the criteria for a replacement reference site given current conditions, as the site maintains an open inlet condition, with an added advantage of being close to San Dieguito Wetlands

Fulfilling mitigation requirement

- Physical and biological standards evaluated within the restored wetland and relative to natural reference wetlands
 - Annual mitigation credit is earned if standard requirements are met
- Restored wetland must accrue 32 years of mitigation credit (equivalent to operating life of SONGS Units 2 & 3)

Southern California Edison required to fund independent monitoring of restored wetland performance



- One year of mitigation credit is given for each year that the San Dieguito Wetlands Restoration Project meets all of the absolute performance standards and as many relative performance standards as the lowest performing reference wetland
- The SONGS permit requires SCE to fund independent monitoring of the restored wetlands performance which is led by scientists from UCSB with advice from the Science Advisory Panel
- This monitoring also tracks ecosystem development and identifies adaptive management opportunities pertaining to the physical and biological functioning of the wetland

SONGS Mitigation Monitoring Program

Scientific Staff

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Ilene Klein

Science Advisory Panel

DR. RICHARD AMBROSE, UCLA

DR. PETER RAIMONDI, UC SANTA CRUZ

DR. RUSSELL SCHMITT, UC SANTA BARBARA



- Here we list our amazing scientific staff located on and off campus as well as our Science Advisory Panel which includes Drs. Richard Ambrose, Pete Raimondi, and Russ Schmidt.

SONGS Mitigation Monitoring Program

Principal Investigators



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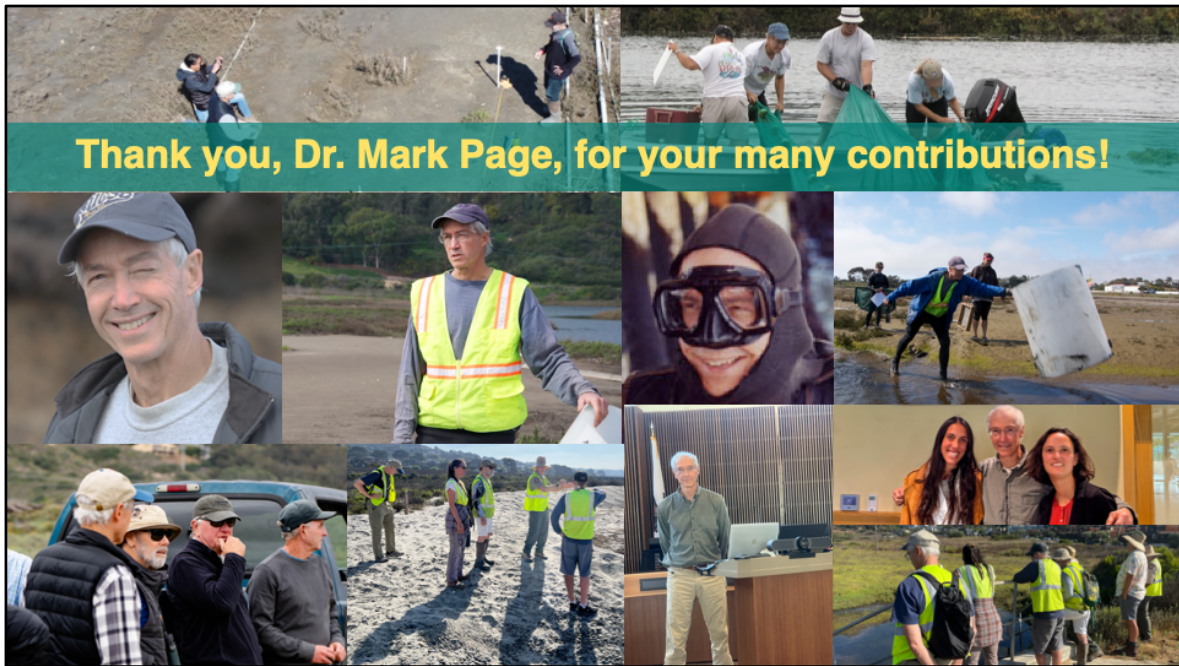
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- The monitoring program is led by four PIs who are all here today to answer any questions you may have at the end of today's workshop talks



- Last but certainly not least, we want to take this opportunity to thank Dr. Mark Page who has made tremendous contributions to this project over the past few decades. Mark will be retiring from the project this June and will be missed dearly. Mark, thank you for all of your contributions to the project and for your mentorship over the past four years.

Annual Public Wetland Workshop Agenda

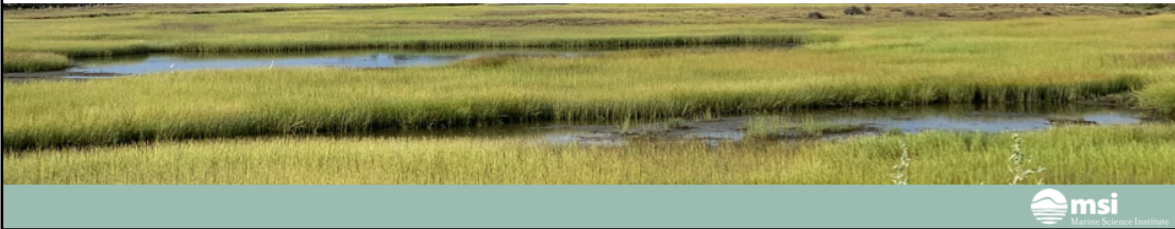
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Performance Evaluation of the San Dieguito Wetlands Restoration Project: Absolute Standards

Annual Review Workshop for SONGS Wetland Mitigation



May 21, 2026
SONGS Mitigation Monitoring Project
Marine Science Institute, University of California Santa Barbara



- Moving now to the performance evaluation of the absolute standards

Two types of standards used to assess wetland performance

Standard	Sampling location	To earn mitigation credit	Evaluation method
Absolute	Restored wetland	All absolute standards must be met each year	Based on the current year
Relative	Restored and reference wetlands	Proportion of relative standards met at restored wetland must equal or exceed the lowest performing reference wetland	Based on 4-year running average

- Like I laid out in the prior presentation, absolute standards are assessed at San Dieguito Wetlands and to receive mitigation credit, all absolute standards must be met

Absolute standards



Topography



**Plant
reproductive
success**



Exotic species



Tidal prism



Habitat areas

- There are five absolute standards, listed here
- We are going to walk through each of them one by one

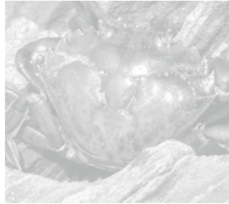
Absolute standards



Topography



**Plant
reproductive
success**



Exotic species



Tidal prism



Habitat areas

- Starting first with the topography standard

No major topographic degradation

Topography	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
 PASS														
 FAIL														



- The topography standard requires that the wetland not undergo major topographic degradation, such as excessive erosion or sedimentation
- This standard has also met since monitoring began

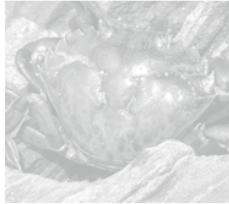
Absolute standards



Topography



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Exotic species



Tidal prism



Habitat areas

- Next, we have plant reproductive success

Plant reproduction at least once every 3 years

Plant reproduction	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
■ PASS														
✗ FAIL														



- The plant reproduction standard requires that seven common salt marsh plant species demonstrate reproduction at least once in three years
- This standard has also been met every year since monitoring began

Absolute standards



Topography



**Plant
reproductive
success**



Exotic species



Tidal prism



Habitat areas

- Next, we have the exotic species standard

Exotic species do not impair function

Exotic species	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
PASS														
FAIL														



Carcinus maenas (Green crab)



Limonium perezii (Perez's sea lavender)

- The exotic species standard requires that the important functions of the wetland shall not be impaired by exotic species that can have negative impacts on wetland functioning, for example by altering food webs or physical habitat structure
- This standard has also been met since monitoring began

Absolute standards



Topography



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Exotic species



Tidal prism

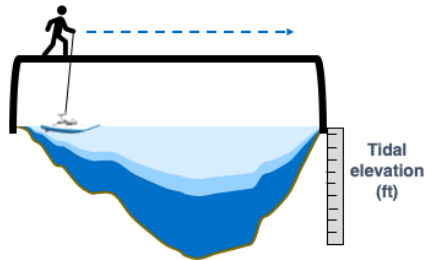


Habitat areas



- Moving now to the tidal prism standard
- The tidal prism standard specifies that the tidal prism of San Dieguito Wetland shall be maintained
- The tidal prism is the volume of water exchanged in an estuary between the low and high tide levels, and it is a metric of tidal flushing, inundation of marsh habitat, and inlet stability
- We have adopted a new analytical approach used to assess this standard so we will walk through this standard in more detail

How we survey tidal prism



- We survey the tidal prism from Jimmy Durante Bridge (0.9 km from the inlet) using a portable acoustic Doppler profiler/discharge measurement system (SonTek RiverSurveyor) towed back and forth across the width of the channel every 15 minutes during an incoming tide; each pass under the bridge is referred to as a transect
- It's important to note that Jimmy Durante Bridge extends over the San Dieguito River channel that fills and empties San Dieguito Lagoon and it's many restoration projects

Large-scale restoration at San Dieguito Lagoon

In 2024, over 70 acres of tidal habitat restored outside SONGS Project area

PRE - Restorations



POST – SONGS Restoration



POST – CalTRANS/SANDAG Restoration (2024)



San Dieguito Lagoon
SONGS
CalTrans/SANDAG

Tidal prism at the lagoon expected to increase



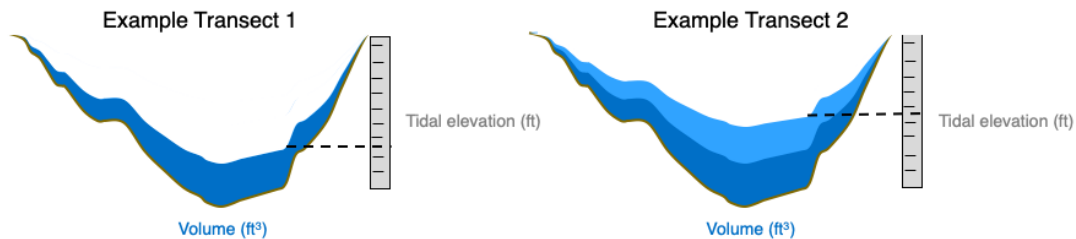
- Here we show a map of San Dieguito Lagoon prior to large scale restoration efforts
- From 2006-2011, the SONGS restoration was constructed
- And more recently, in June of 2024, over 70 new acres of tidal wetland habitat were restored outside of the SONGS project area as part of the CalTrans/SANDAG Transnet mitigation project
- All of these restorations together were part of a broader vision for restoring the San Dieguito Lagoon from it's degraded, filled state, to a restored tidal system that supports many of its known historical habitat types and functions
- One consequence of increasing the amount of tidal habitat within the system is that we expect the tidal prism at the lagoon to increase

In 2025, we surveyed Jimmy Durante Bridge and CalTrans/SANDAG restoration inlets



- As you can see from this map, the river channel under Jimmy Durante Bridge, indicated by the white circle, drains and fills both the SONGS and CalTrans projects
- We needed to account for the tidal prism of the two CalTrans projects, W6 and W19 so that our assessment of the tidal prism standard was restricted to the SONGS project area and comparable to assessments from 2012-2024
- Our initial analysis used from 2012 through 2024 was deemed insufficient for detecting the changes in prism from these additional projects
- We developed a new analytical approach using the same survey source data that was sensitive enough to detect such changes and could distinguish between the contributions to tidal prism of SONGS and other projects

New analysis assesses tidal prism as the amount of wetland submerged as a function of tidal elevation



We divide the change in volume (ft³) by the change in tidal elevation (ft) between all consecutive transects to calculate the new metric, “wetland acres filled” (ft²)



- The new analysis assesses tidal prism as the amount of wetland submerged as a function of tidal elevation
- This is done by decomposing the volume of water flow in a transect into area and elevational change
- Given that volume, area and elevation change are all measured in the same units (i.e., ft³, ft², ft, respectively), dividing the volume (ft³) by the elevational change (ft) yields an estimate of the area of submerged wetland (for that particular tidal elevation)

Tidal prism standard passed in 2025



- When we subtract the contributions from the CalTrans/SANDAG projects to tidal prism, we isolate the tidal prism associated with the SONGS project area and see that the standard passes in 2025 as it is above the as-built threshold, indicated on the figure on the left by the dashed black line
- As proof of concept, we applied our new analysis to the historical tidal prism dataset from 2012-2024 and the pass/fail outcomes were comparable to the initial analysis used up until this year

Tidal prism shall be maintained

Tidal prism	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
PASS														
FAIL														



Scan QR code for recently updated Wetland Monitoring Plan

New analysis used



- To reiterate, 2025 was the first year the new analysis was applied and, similar to years past, the standard was met
- If you'd like to read more about this new analysis I encourage you all to scan the QR code on this slide which will take you to revised Wetland Monitoring Plan

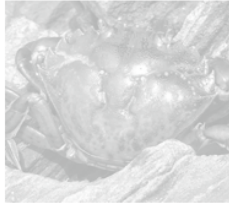
Absolute standards



Topography



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Exotic species



Tidal prism



Habitat areas



- Now, we will review the last absolute standard—habitat areas

Habitat areas shall not vary by more than 10% from acreages outlined in restoration plan

Habitat areas	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
PASS	X	X	X	X	X	X	X	X	X	X	X	X	X	X
FAIL														



Planned acres

Salt marsh: 92.6 acres

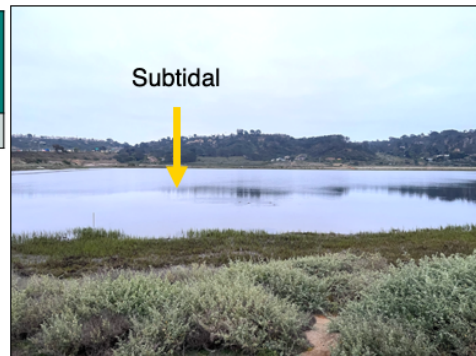
Mudflat: 24.9 acres

Subtidal: 32.0 acres

- The habitat areas standard specifies that wetland habitat areas shall not vary by more than 10% from the planned habitat acreages outlined in the Final Restoration Plan, as shown here by the acreages of salt marsh, mudflat, and subtidal habitat on right
- This standard is designed to preserve the mix of habitats provided in the Final Restoration Plan and guard against large scale conversions of one habitat type to another, for example of vegetated marsh to mudflat or vice versa
- This standard has yet to be met, so we will examine this standard in more detail

Subtidal habitat classification at San Dieguito Wetlands (SDW)

Habitat	Elevation (ft, NGVD)	Necessary characteristics
Subtidal	< -0.9	Continuously submerged



- I'll begin by providing an overview of the criteria used to classify each habitat type, beginning with subtidal habitat
- Habitat is classified as subtidal if it is continuously submerged and at elevations less than -0.9 ft NGVD

Mudflat habitat classification at San Dieguito Wetlands (SDW)

Habitat	Elevation (ft, NGVD)	Necessary characteristics
Subtidal	< -0.9	Continuously submerged
Mudflat	-0.9 to 3.5	Intertidal, < 5% vegetation cover



- Habitat is classified as Mudflat if it is intertidal and $\leq 3.5'$ NGVD with <5% cover of vegetation. In the photo on the right, this unvegetated intertidal area on the left would be classified as mudflat, but this unvegetated area on the right would not because the elevation is too high to be considered mudflat

Salt marsh habitat classification at San Dieguito Wetlands (SDW)

Habitat	Elevation (ft, NGVD)	Necessary characteristics
Subtidal	< -0.9	Continuously submerged
Mudflat	-0.9 to 3.5	Intertidal, < 5% vegetation cover
Salt marsh	-0.9 to 4.5	Intertidal, ≥ 30% vegetation cover



- Habitat is classified as Salt Marsh if the area is intertidal and $\leq 4.5'$ NGVD and also has at least 30% cover of vegetation, which is evaluated with aerial imagery

“Other” habitat classification at San Dieguito Wetlands (SDW)

Habitat	Elevation (ft, NGVD)	Necessary characteristics
Subtidal	< -0.9	Continuously submerged
Mudflat	-0.9 to 3.5	Intertidal, < 5% vegetation cover
Salt marsh	-0.9 to 4.5	Intertidal, ≥ 30% vegetation cover
<i>Other*</i>	-0.9 to 3.5	<i>Intertidal, 5 - 30% vegetation cover</i>
	3.5 to 4.5	<i>Intertidal, < 30% vegetation cover</i>



*not a planned habitat



- Lastly, there is “Other” habitat, which is not a planned habitat type and is not included in the Final Restoration Plan. This category was defined after monitoring began, and includes areas that are intertidal and $\leq 3.5'$ NGVD with greater than 5 and less than 30% cover of vegetation or $> 3.5'$ NGVD with less than 5% cover of vegetation
- For example in this photo on the right, this area is too sparsely vegetated to be assessed as salt marsh, but has too much vegetation and is too high in elevation to be considered mudflat

Habitat areas standard not met in 2025

Habitat	Elevation (ft, NGVD)	Necessary characteristics	Planned acres	± 10% planned acres	2025 acres
Subtidal	< -0.9	Continuously submerged	32	28.8 – 35.2	31.1
Mudflat	-0.9 to 3.5	Intertidal, < 5% vegetation cover	24.9	22.4 – 27.4	13.4
Salt marsh	-0.9 to 4.5	Intertidal, ≥ 30% vegetation cover	92.6	83.3 – 101.9	93.1
Other*	-0.9 to 3.5	Intertidal, 5 - 30% vegetation cover	0	NA	11.6
	3.5 to 4.5	Intertidal, < 30% vegetation cover			
Total			149.3		

*not a planned habitat



- We now show the results for 2025 that indicate why the habitat areas standard was not met in 2025. This table shows the planned acres, the range of acres that are within 10% of those planned values and the acres measured in 2025
- Subtidal and salt marsh habitat were within 10% of the planned acreages in 2025, but the area of mudflat was less than 10% of the minimum required acreage of 22.4 acres at 13.4 acres

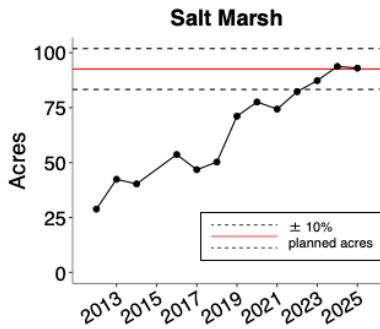
Absolute standard requirement was not met in 2025

Topography															
Plant reproduction															
Exotic species															
Tidal prism															
Habitat areas	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	



- Since the habitat areas standard failed in 2025, the absolute standard requirement was not met this year

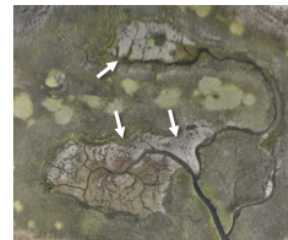
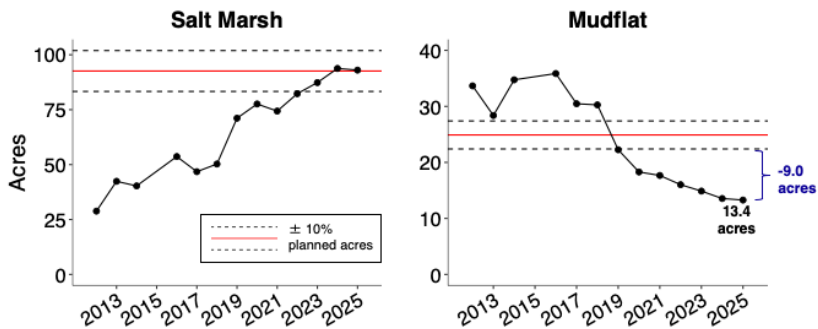
Salt marsh is within planned acreage targets



San Dieguito Wetlands – W4/16 (2025)

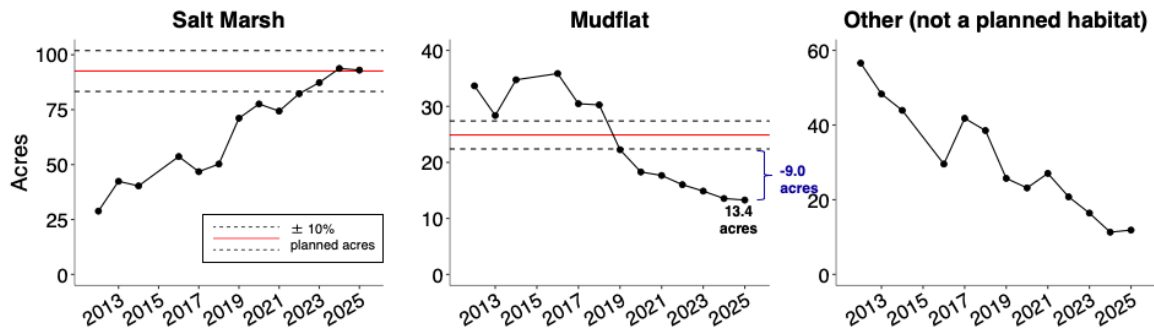
- Looking at the trend in habitat areas over time, we see that salt marsh acreage has continued to increase over time and now exceeds the planned acreage of this habitat type and may be plateauing
- Natural colonization of marsh plants, in combination with the success of SCE's planting program, and well timed years of high rainfall have contributed to this increase in salt marsh area in recent years

Mudflat area has declined over time and is 9.0 acres short of minimum required acreage in 2025



- In contrast, the area of mudflat has been decreasing over time due largely to salt marsh encroachment, particularly in the last 5 years, and is currently 9. acres lower than the minimum required area of 22.4 acres
- Though, the rate of decline seems to be decreasing

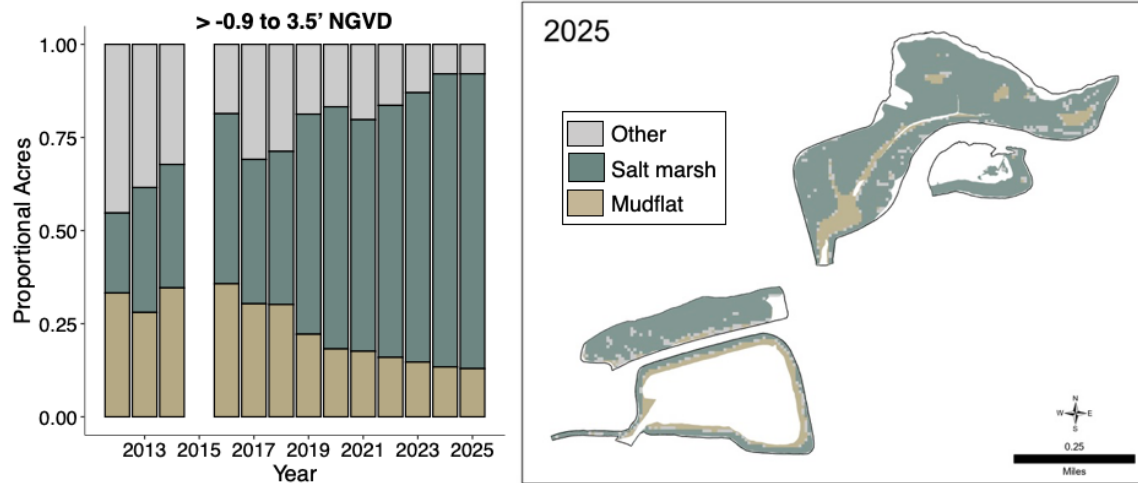
~12 acres of “other” remain



Is there mudflat habitat to gain in areas classified as “other”?

- “Other” habitat has also been declining since 2012 and was slightly higher this year than last year
- Yet, we still have around 12 acres of “other” habitat, one could ask, is there mudflat habitat to gain in areas classified as “other”?

Decreasing “other” habitat within mudflat elevation zone (> -0.9 to 3.5’ NGVD), replaced with salt marsh



- The map on the right shows the habitat types within this elevation zone for 2025
- The slight uptick in “other” habitat in 2025 is likely driven by the grids along the edge of the mudflat habitats that have vegetation cover greater than 5% and less than 30%, these grids are likely to shift towards salt marsh in the coming years
- As a reminder, the planned elevation zone for mudflat is >-0.9 to 3.5’ NGVD
- If we isolate this area and look at how the proportional acres of each of the three habitats (salt marsh, mudflat, and other) have shifted over time, we see from the figure on the left that both “other” and mudflat habitat have been replaced with salt marsh

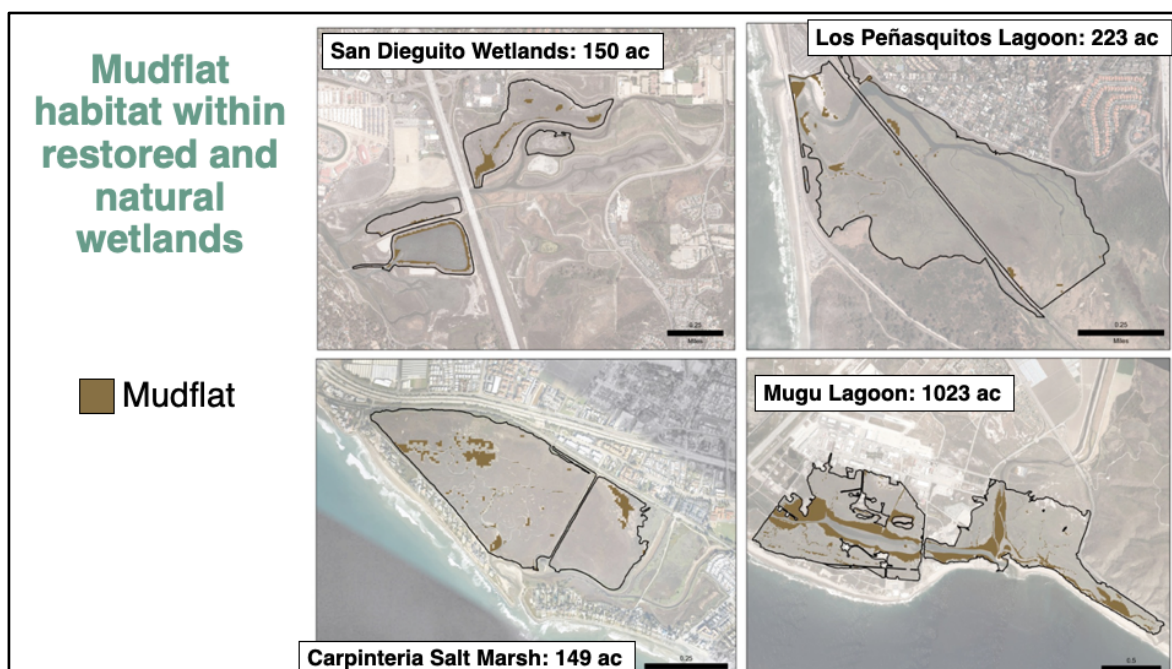
Limited opportunities to gain mudflat acreage within SONGS project area

- Salt marsh continues to encroach into areas planned to support mudflat habitat
- “Other” habitat continues to convert to salt marsh habitat

How much mudflat habitat do natural wetlands support?

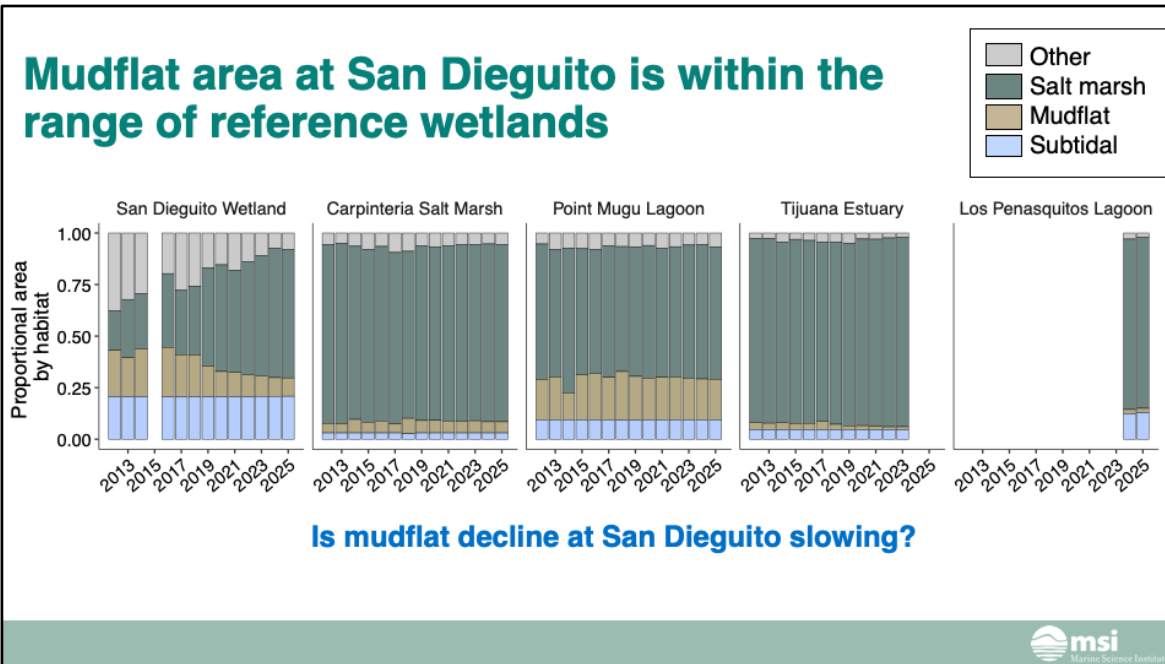


- This indicates that there is limited opportunity to gain mudflat acreage within the SONGS project area as salt marsh continues to encroach into areas planned to support mudflat habitat and “other” continues to convert to salt marsh
- A follow-up line of inquiry may be to ask how much mudflat habitat would one expect natural wetlands to support?
- We can use our time series of classified aerial imagery from the reference wetlands to answer this question



- Here we show maps of the currently monitored restored and natural wetlands
- The black indicates the perimeter of the monitored sites and the brown indicates the 10x10m grids classified as mudflat

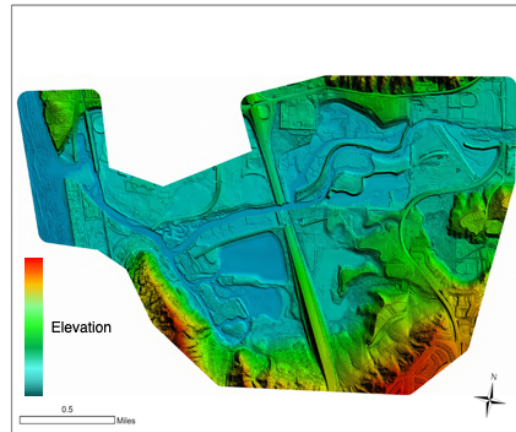
Mudflat area at San Dieguito is within the range of reference wetlands



- Plotted here is a time series from 2012-2025 of the proportional area by habitat, other is in grey, salt marsh in green, mudflat in brown, and subtidal in blue
- San Dieguito Wetland supports proportionally more mudflat than 3 of the 4 reference wetlands historically monitored by the SONGS project
- We should note that for Tijuana Estuary, only the northern arm of the wetland was used for performance monitoring and therefore classified. The southern portion of the Tijuana Estuary supports more mudflat habitat than the northern arm monitored by SONGS from 2012-2024. That said, San Dieguito is still within the range of the reference wetlands with respect to proportional mudflat habitat area
- While the reference wetlands see less year to year variation in the proportional area of each habitat, it does appear that mudflat decline at San Dieguito may be slowing and appears to be converging towards a proportional area that is more similar to what we observe at some of the reference wetlands
- This upcoming year, we are going to try and explore the fate of mudflat habitat at San Dieguito more fully

Next steps

- Use LiDAR Digital Elevation Model (DEM) funded by SCE to determine area of planned mudflat susceptible to future marsh encroachment



- Which leads me to our primary next steps related to the continual failure of the habitat areas standard
- We will be utilizing a LiDAR DEM funded by SCE to determine the area of existing habitat susceptible to future marsh encroachment
- The loss of mudflat habitat is part of a broader issue related to wetland performance and habitat conversion that Rachel will dig deeper into in the next talk

Annual Public Wetland Workshop Agenda

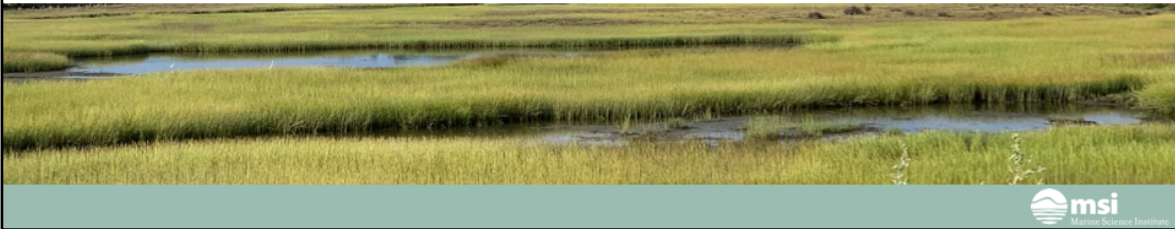
San Onofre Nuclear Generation Station Mitigation Monitoring Program
May 21, 2026

1:30 – 2:30 Introduction and Overview – Dr. Kathryn Beheshti, UCSB

**Performance Evaluation of the San Dieguito Wetlands Restoration
Project: Absolute Standards – Dr. Kathryn Beheshti, UCSB**

**Performance Evaluation of the San Dieguito Wetlands Restoration
Project: Relative Standards – Dr. Rachel Smith, UCSB**

2:30 – ? General Questions & Discussion



Performance Evaluation of the San Dieguito Wetlands Restoration Project: Relative standards

Annual Review Workshop for SONGS Wetland Mitigation



May 21, 2026

SONGS Mitigation Monitoring Project
Marine Science Institute, University of California Santa Barbara



- Good afternoon, I'm excited to talk to you about the performance of the San Dieguito Wetlands Restoration Project for the relative standards, which, in addition to the absolute standards just discussed, are used to assess wetland compliance.

Two types of standards used to assess wetland performance

Standard	Sampling location	To earn mitigation credit	Evaluation method
Absolute	Restored wetland	All absolute standards must be met each year	Based on the current year
Relative	Restored and reference wetlands	Proportion of relative standards met at restored wetland must equal or exceed the lowest performing reference wetland	Based on 4-year running average

- This talk focuses on the relative standards, which compare the restored wetlands to natural reference sites.
- To earn mitigation credit for a given year, the proportion of relative standards met at the restored wetland must equal or exceed the lowest performing reference wetland.
- Evaluation of each relative standard is based on a four-year running average to account for natural fluctuations over time.

Reference sites used for 2024-2025



Carpinteria Salt Marsh



Los Peñasquitos Lagoon



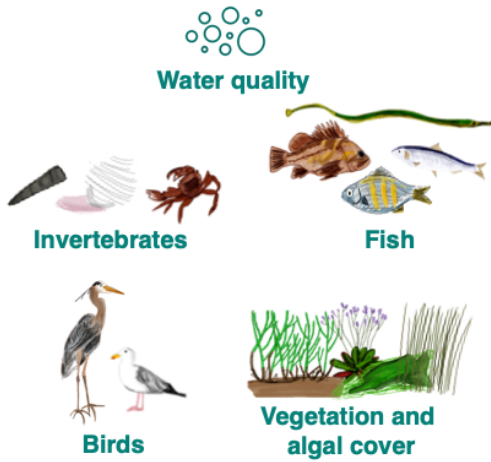
Mugu Lagoon

With replacement of Tijuana Estuary in 2024, standards have different years of data available (1, 2, or 4 years)



- As Kat mentioned in the introduction talk, in 2024, Los Peñasquitos Lagoon replaced Tijuana Estuary as the third reference wetland used to measure the relative standards. We started monitoring this lagoon in 2024, and 2025 was the first year we were able to measure all of the relative standards at Los Peñasquitos Lagoon. Thus, the relative standards vary in the number of years of data that are available, and we have 1, 2, or 4 years of data available depending on the standard. We will continue to build out these averages into 4-year running averages over time.

15 relative standards measured at restored and reference wetlands

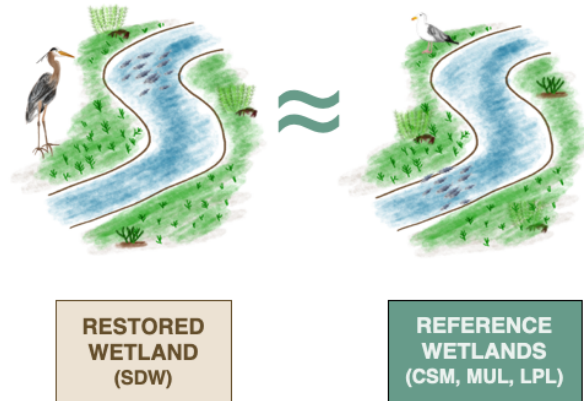


- To assess whether the restored wetland provides similar resources to nearby reference wetlands, we measure 15 relative standards at restored and reference wetlands.
- These include standards related to water quality, vegetation and algal cover, and bird, fish and invertebrates density and species richness.
- We also measure fish and invertebrate density and richness in tidal creek and main channel habitats of all wetlands.

Restored wetlands should be “similar” to reference wetlands

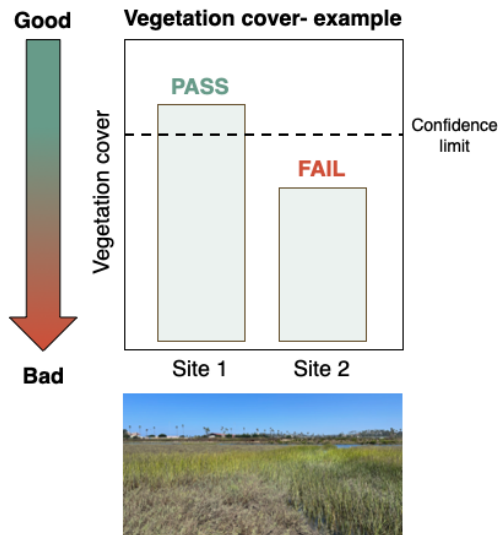
What is “similar”?

- **At the standard level:** “similar” means the 4-year running average for a relative standard at SDW equals or exceeds the lowest performing reference wetland
- **At the wetland level:** “similar” means the proportion of relative standards met at SDW equals or exceeds the lowest performing reference wetland



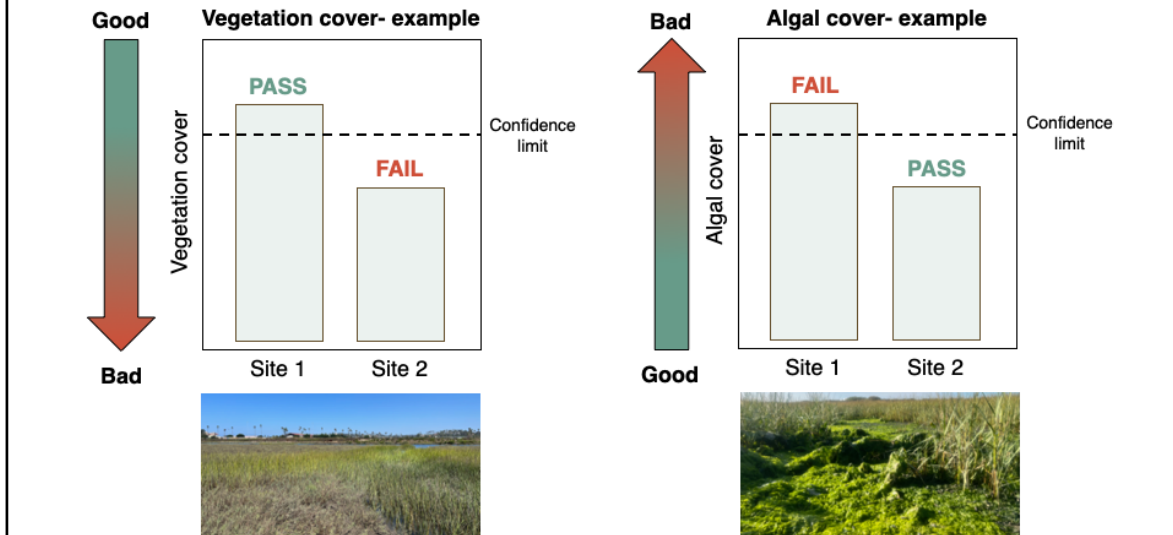
- We measure the restored wetland relative to reference wetlands because the goal is for the restored wetland to be similar to reference wetlands
- We determine similarity using a 2-step process.
- First we assess similarity at the standard level, where “similar” means that the 4-year running average for a relative standard at SDW is equal to or exceeds the lowest performing reference wetland.
- We assess this statistically using a series of t-tests and determine pass-fail outcomes for each standard relative to a confidence limit, which I will describe in more detail on the next slide.
- Next, we combine these standard-level pass/fail outcomes to assess similarity at the wetland level.
- San Dieguito Wetlands is considered similar to reference wetlands if the proportion of relative standards met at SDW equals or exceeds the lowest performing reference wetland.

Assessing pass/fail outcomes for each standard relative to confidence limit

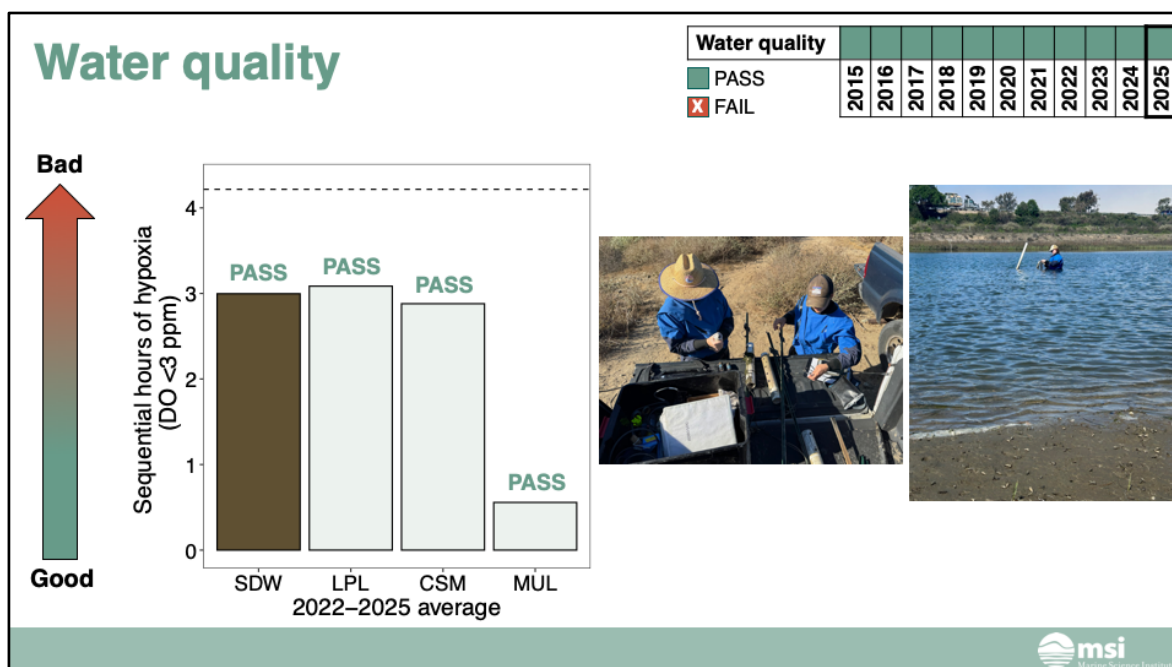


- For most of the relative standards, we determine pass/fail outcomes with a one sample, one-tailed t-test that compares the mean value at San Dieguito Wetlands to the lowest performing reference wetland.
- The same approach is then applied to each of the reference wetlands to determine pass/fail outcomes for each wetland.
- For each t-test used to assess similarity, we calculated a confidence limit, shown here with a dashed line that represents the boundary between passing and failing.
- To orient you to how we will display the results on the following slides, for standards like vegetation cover, where higher values indicate better performance (the case for the majority of the standards), values above the confidence limit indicate that a site passed and values below the limit indicate that a site has failed.

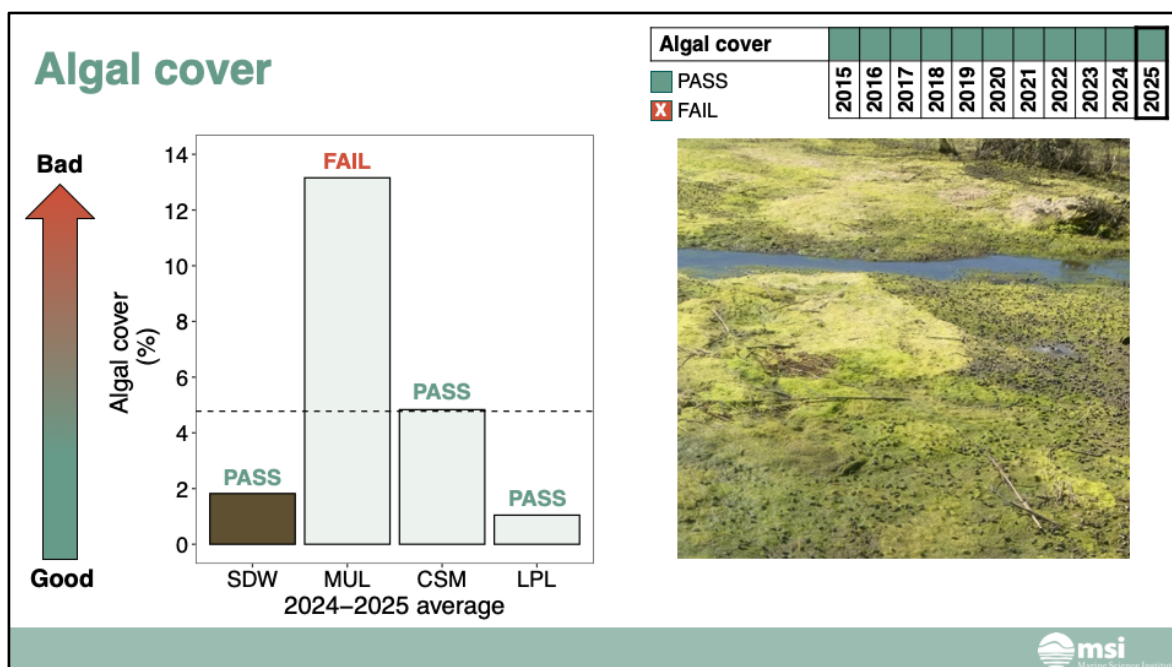
Assessing pass/fail outcomes for each standard relative to confidence limit



- Conversely, for standards like algal cover, where higher values indicate poorer performance, values above the confidence limit indicate that a site failed and values below the limit indicate that a site has passed.
- Now that you can see how the standards will be visualized, we can dive into the results, beginning with water quality.

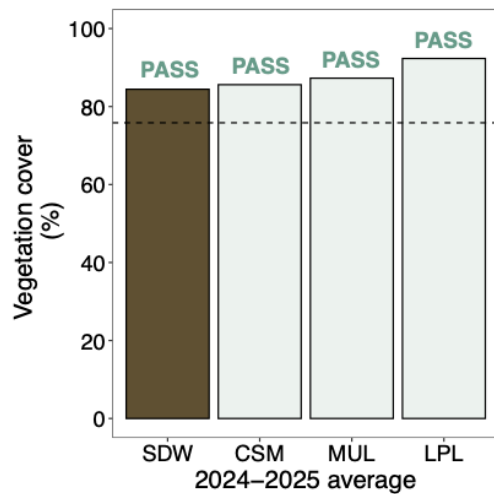


- We measure water quality with continuous water loggers, as shown on the right, and we compare the mean sequential hours of hypoxia, where dissolved oxygen levels are below 3 ppm.
- Thus, for this standard, lower values are more desirable, as shown by the arrow on the left and values below the dashed confidence limit line will pass.
- In this and the following figures, SDW stands for San Dieguito Wetlands, LPL is Los Penasquitos Lagoon, CSM is Carpinteria Salt Marsh, and MUL is Mugu Lagoon. The results for San Dieguito are shown in brown, and the results for the reference sites will be shown in light green. In this and in future figures, we always place the lowest performing reference wetland that San Dieguito is compared to statistically just right of San Dieguito. In this case, LPL is the lowest performer.
- The table in the upper right hand corner shows the history of pass/fail outcomes at SDW and indicates that San Dieguito has consistently met this standard for the last 10 years. This pattern continued in 2025, and all wetlands, including SDW, passed the water quality standard in 2025.



- We now examine the results for algal cover. The algal cover standard uses aerial imagery to assess the percent cover of algae. Excessive algal growth can affect wetland function through effects on vegetation, bird feeding, and water quality. Thus, this is another standard where higher values of algal cover are less desirable, as shown by the arrow on the left.
- San Dieguito has consistently met this standard for the last 10 years. This pattern continued in 2025, and SDW passed this standard in 2025, as algal cover was lower at SDW than at the lowest performing reference wetland, Mugu Lagoon, which had high algal cover.

Vegetation cover



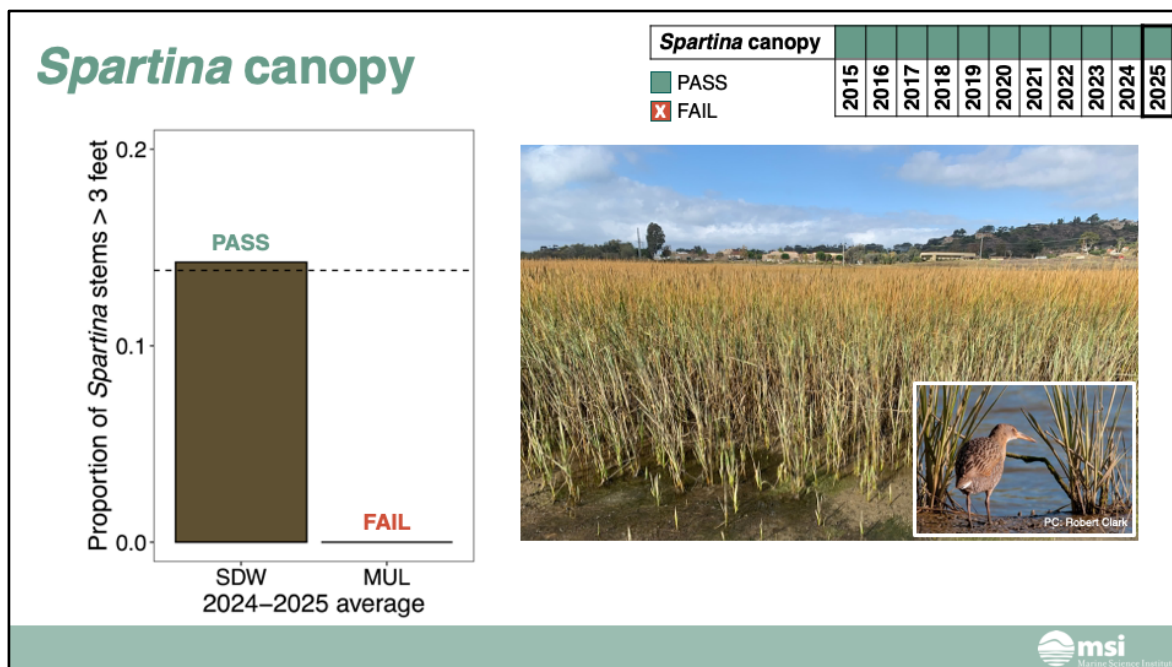
Vegetation cover

PASS
FAIL

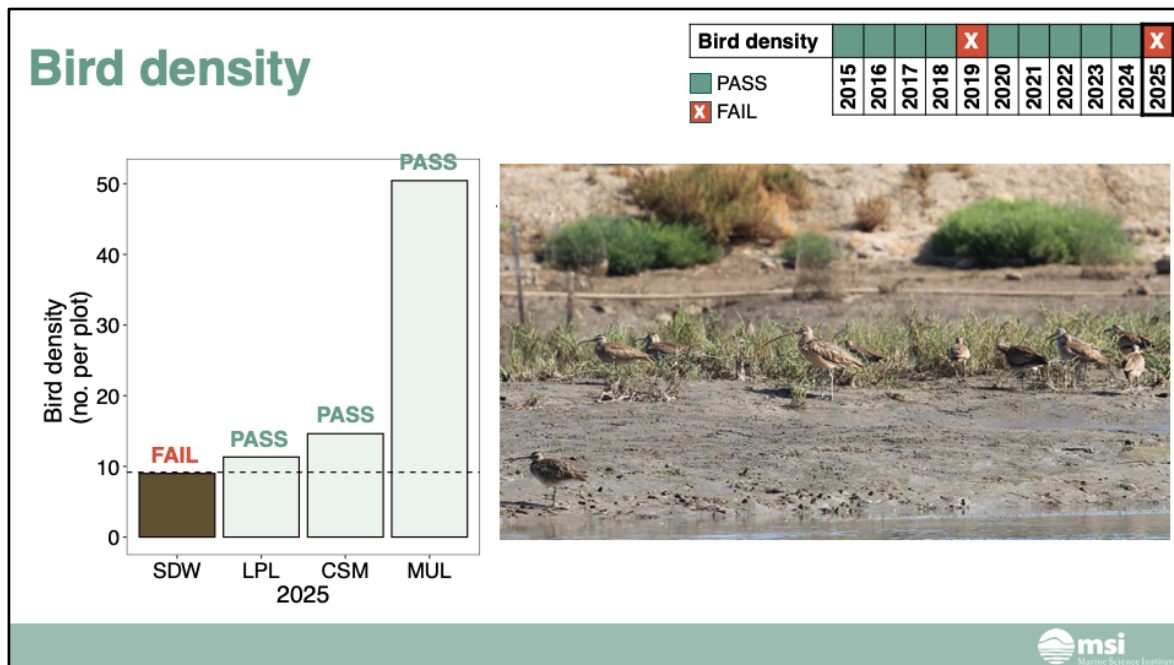
2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
×	×	×	×	×	×	×	×	×	×	✓



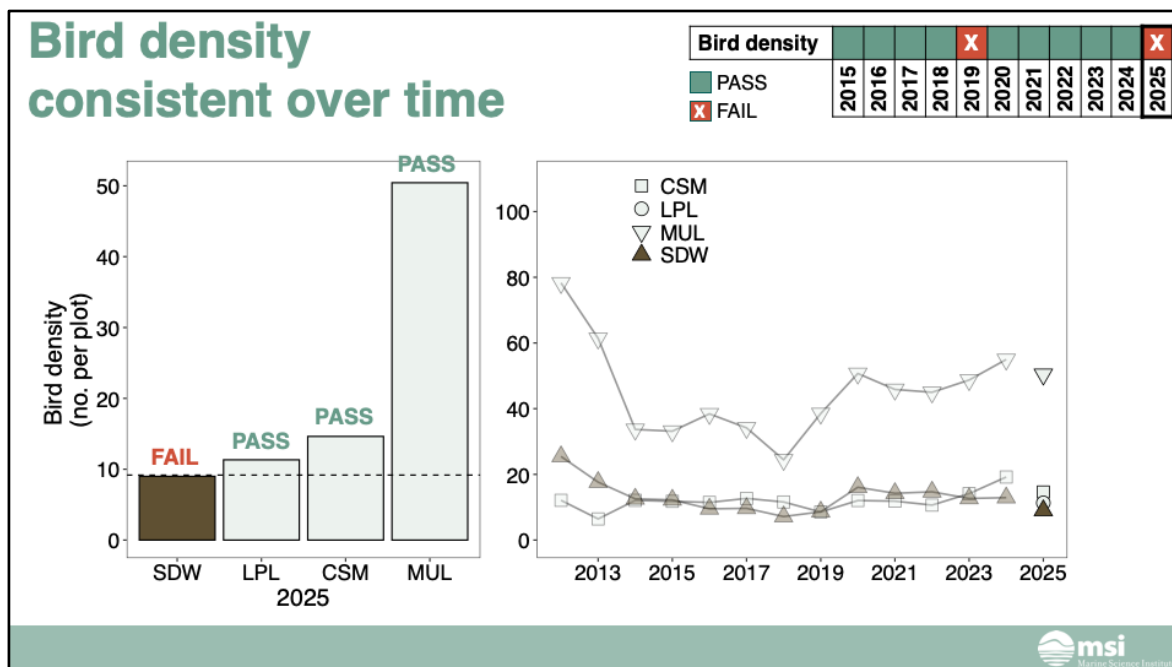
- We now move on to vegetation cover. The vegetation cover standard uses aerial imagery (as shown on the right) to assess the percent cover of salt marsh that is greater than 30%.
- This standard has been on a positive trajectory over the past few years and the vegetation cover standard was met for the first time this year. This outcome is due in part to the success of SCE's planting program coincident with well-timed rainfall over the last few years.



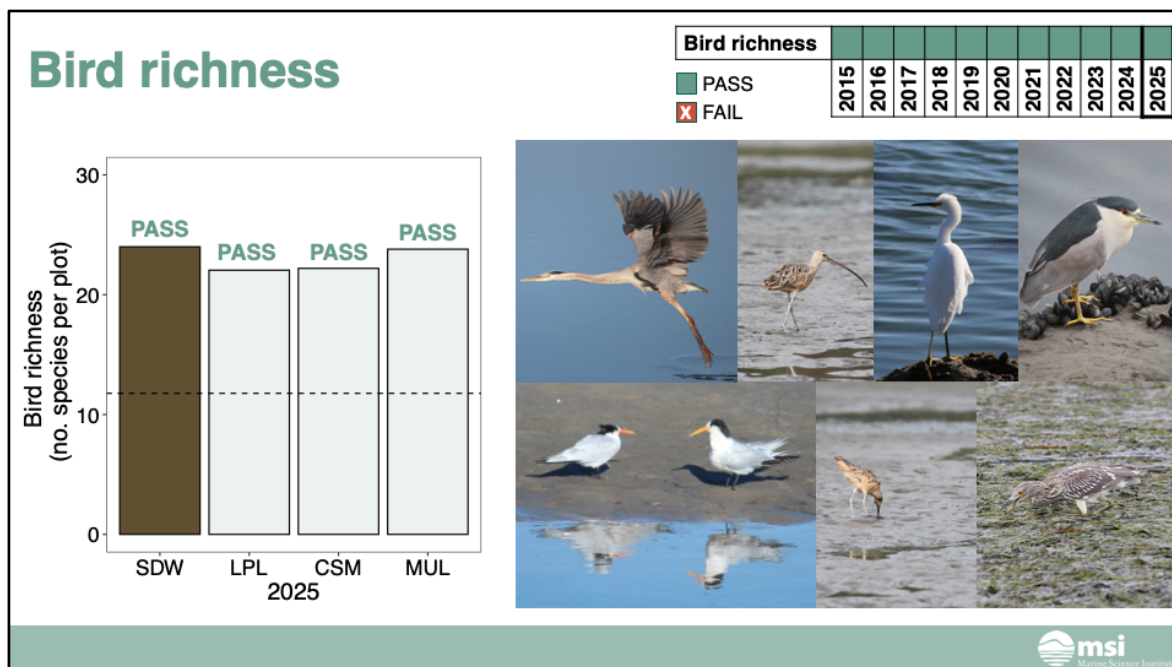
- We now move onto *Spartina* canopy architecture. This standard is meant to assess the capacity for marsh cordgrass, or *Spartina foliosa*, shown here, to provide habitat for Ridgway's Rail and other bird species by measuring the proportion of *Spartina* stems greater than 3 feet tall.
- San Dieguito has consistently met this standard for the last 10 years. This pattern continued this year, and SDW passed this standard in 2025.



- We now move onto the bird standards, beginning with bird density.
- From the schematic in the upper right hand corner, you can see that bird density has been consistently met at San Dieguito, except for in 2019.
- San Dieguito failed the bird density standard in 2025, but you can see that the mean for San Dieguito is extremely close to the confidence limit.
- To better understand this underperformance at San Dieguito, we will examine the full annual time series for bird density.

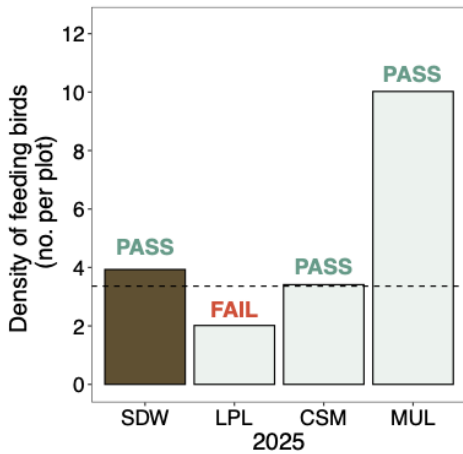


- To orient you to the figure on the right, this plot shows the annual time series of bird density for each of the wetlands from 2012 to the present, with San Dieguito shown as the upward brown triangles and the three references as the other light green shapes. In this and in future time series, the separate, highlighted values on the far right of the figure indicate the years that are included in the average used to assess compliance for 2025. In this case, we only have one year of bird density data for all of the wetlands, so only 2025 is highlighted.
- Looking over the entire time series, you can see that bird density has been generally consistent at San Dieguito, with a comparable density to Carpinteria Salt Marsh over time.
- Because of the replacement of Tijuana Estuary with Los Penasquitos Lagoon in 2024, we only have one year of bird data.
- Thus, pass/fail outcomes for this standard only capture the variability associated with this year, which highlights the value of using a 4-year running average when the data is available.
- The bird density measured this year was comparable to prior years. Given that bird density has been met consistently over time and that the value measured in 2025 was just short of the confidence limit, it is likely that as we build out the 4-year running average, this standard will again be met in future years.



- Moving on to bird richness, this standard has been consistently met at San Dieguito over time. As in prior years, San Dieguito passed this standard in 2025 with the highest value for bird richness relative to the other wetlands.

Food chain support to birds



Food chain support to birds

PASS

FAIL

2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
		X	X	X	X	X	X	X	X	



- Next, we move on to food chain support to birds. This standard has chronically underperformed at San Dieguito relative to the reference wetlands since 2017.
- However, with the replacement of Tijuana Estuary with Los Penasquitos Lagoon in 2024, Los Penasquitos Lagoon was the lowest performing wetland in 2025, and San Dieguito passed this standard in 2025.
- As for bird density and bird richness, we only have one year of data for this standard, so it will be interesting to see if this pattern is maintained over time.

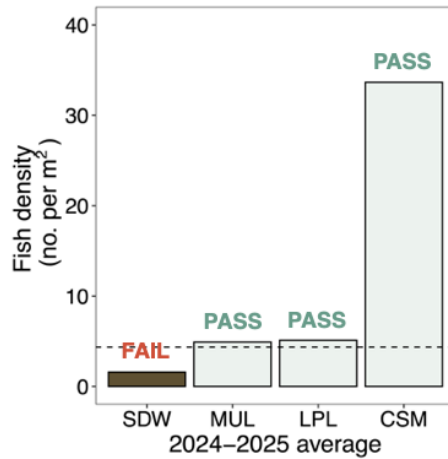
Main channel-fish density

Fish density

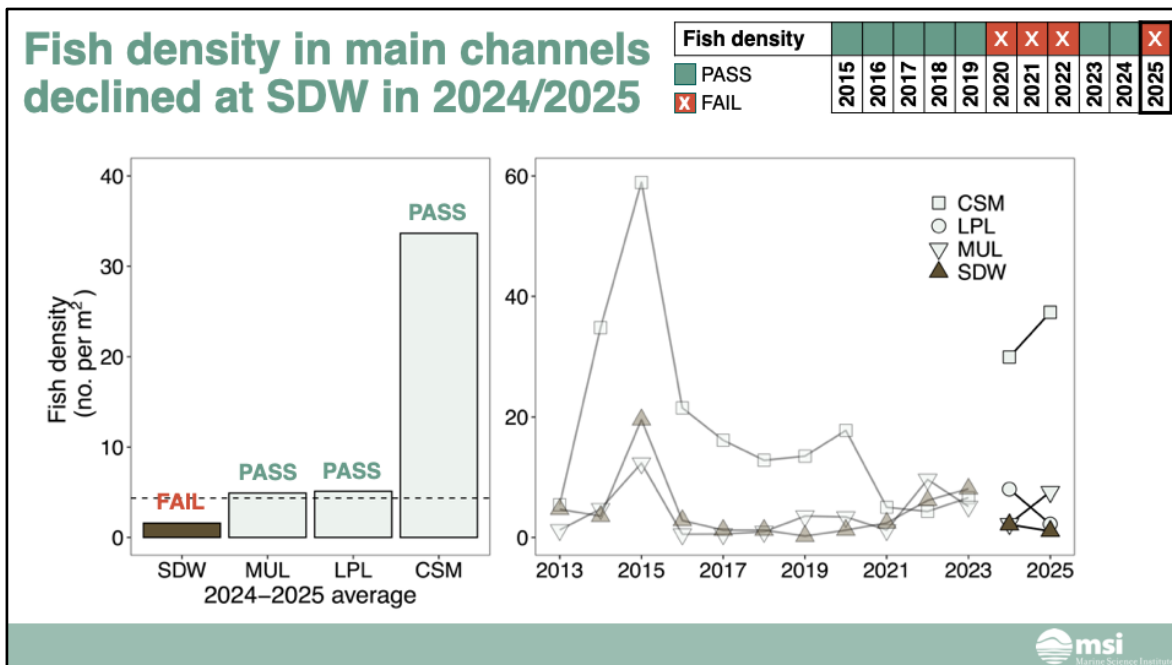
PASS

FAIL

2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
					X	X	X			X

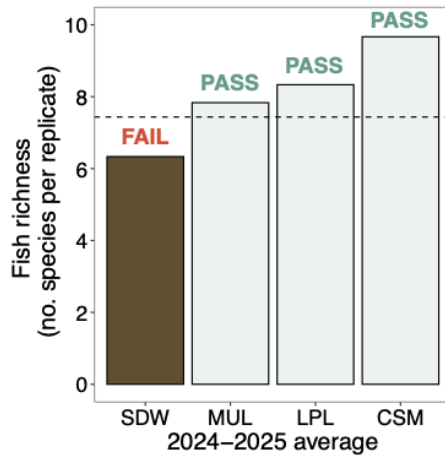


- We now move onto standards measured in main channel habitats, beginning with fish density. This standard has been intermittently met over time, and San Dieguito has passed this standard for the past few years.
- However, in 2025, San Dieguito failed this standard.
- To better understand this underperformance at San Dieguito, we will examine the full annual time series.

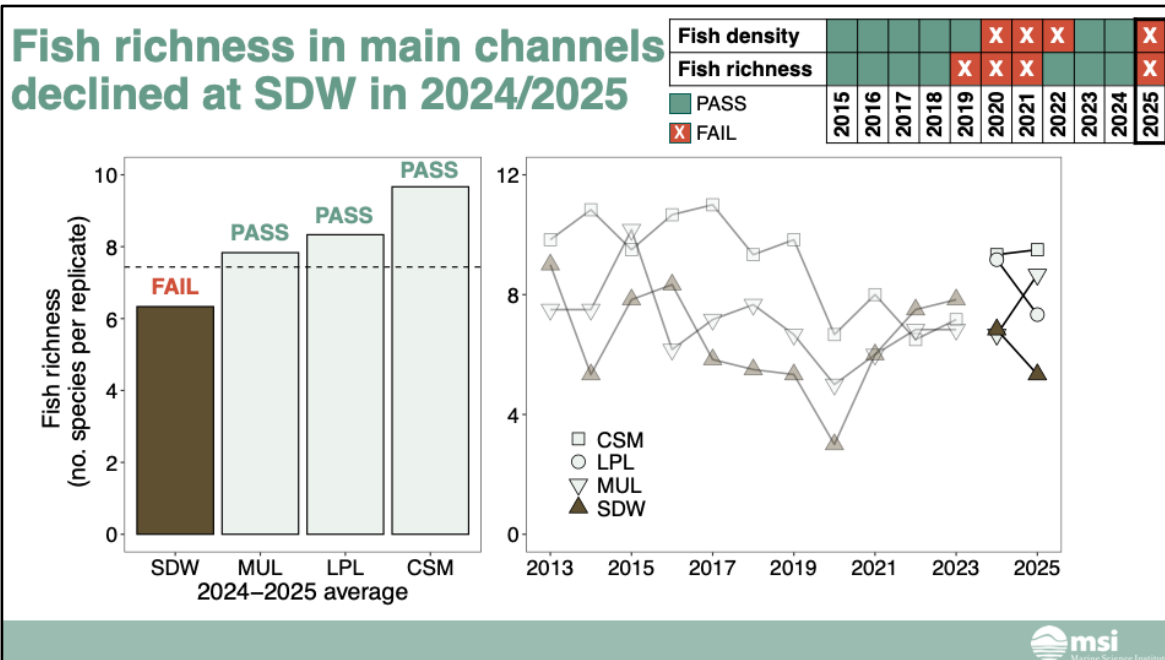


- This plot shows that fish density in main channels has varied at San Dieguito over time, and fish density has generally been comparable to Mugu Lagoon.
- However, there has been a decline in fish density at San Dieguito Wetland over the last two years.
- Because of the replacement of Tijuana Estuary with Los Penasquitos Lagoon, only two years of data are available for all wetlands to assess this standard. It is possible that as we build out the 4-year running average, these fluctuations in fish density will average out, and it is possible that San Dieguito will meet this standard in future years.

Main channel-fish richness

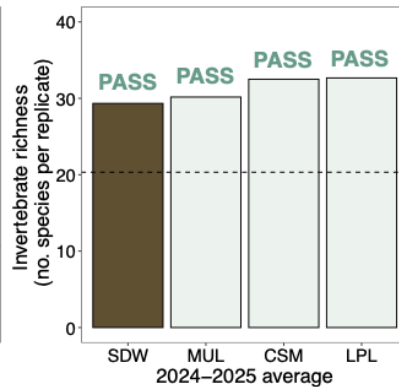
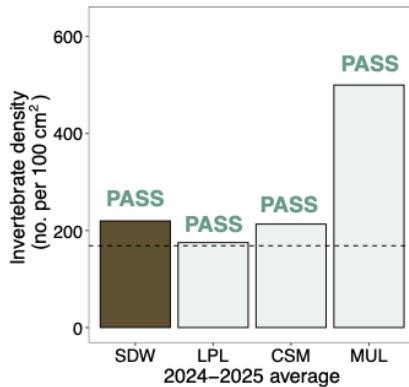
[illegible]

- Similarly to fish density in main channel habitats, San Dieguito has intermittently met the standard for fish richness in main channel habitats, and in 2025, San Dieguito failed this standard.
- To better understand this underperformance at San Dieguito, we will examine the full annual time series for fish richness in main channel habitats.



- Similarly to fish density, there has been substantial variation in fish richness in main channel habitats over time. Fish richness has historically been similar to or slightly below Mugu Lagoon, and there has also been a decline in fish richness at San Dieguito Wetland over the last two years.
- As for fish density, it is possible that these fluctuations in fish richness may average out as we continue to build out the 4-year running average, and we will continue to collect data to assess whether this pattern is consistent over time.

Main channel-invertebrates



Invertebrate density

Invertebrate richness

PASS

FAIL

2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	PASS	PASS

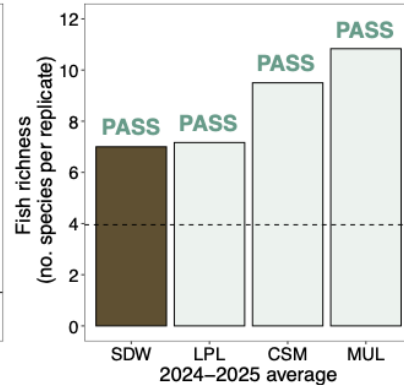
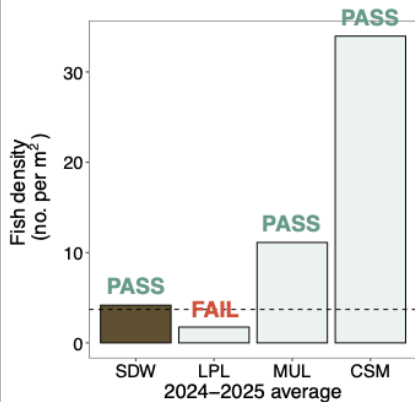


- We now examine invertebrate density and richness in main channel habitats.
- Invertebrate density in main channel habitats has been on a positive trajectory over the past few years, and San Dieguito Wetlands met this standard in both 2024 and 2025.
- Invertebrate richness in main channel habitats has been consistently met at San Dieguito for the past 10 years, including in 2025.

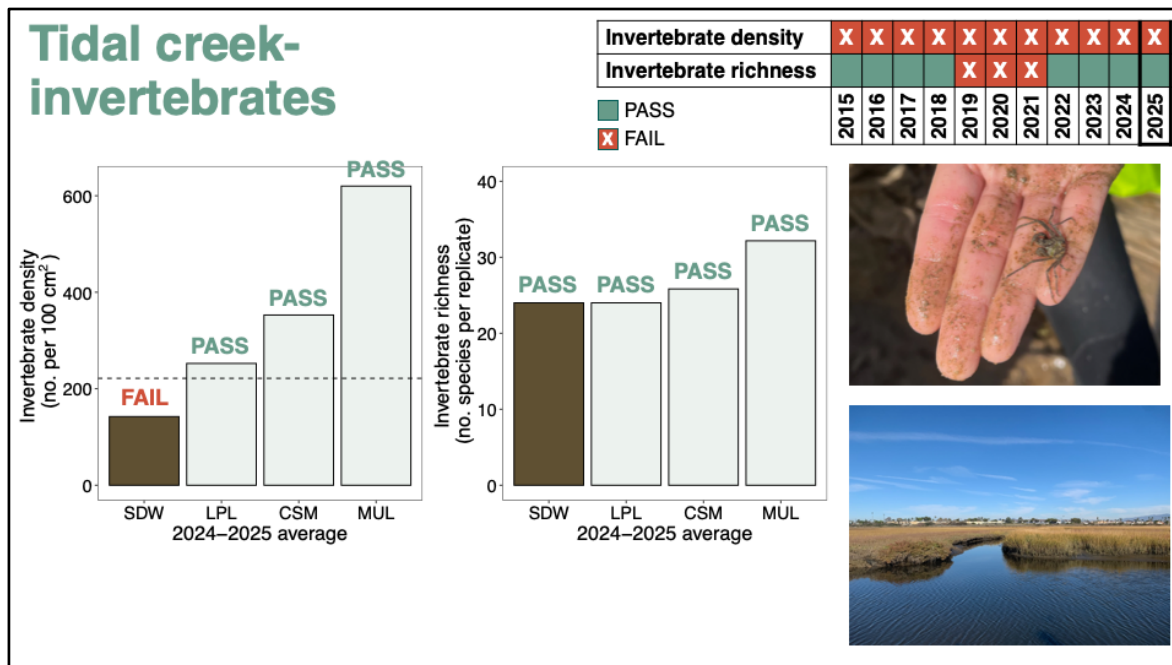
Tidal creek- fish

Fish density	X			X		X	X	X						
Fish richness				X	X		X							
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025			

■ PASS
X FAIL

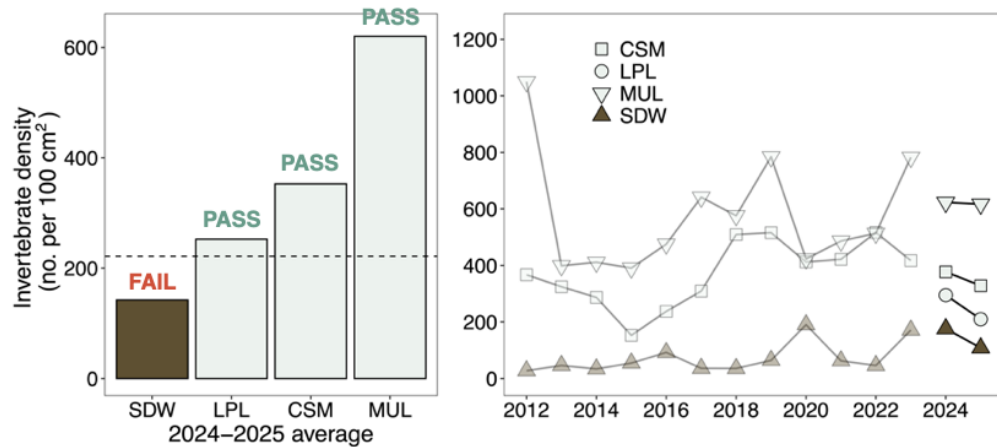


- We now move onto standards measured in tidal creek habitats, beginning with fish density and fish richness. These standards have been intermittently met over time, and San Dieguito has passed these standards over the past few years.
- In 2025, San Dieguito passed both fish standards in tidal creek habitats. All wetlands passed these standards for fish richness in 2025, but Los Penasquitos Lagoon failed the standard for fish density this year.



- We now examine invertebrate density and richness in tidal creek habitats.
- Invertebrate density in tidal creek habitats has never been met at San Dieguito wetland and SDW failed this standard in 2025.
- In contrast, invertebrate richness in tidal creek habitats has recently been met at San Dieguito over the past few years, and this standard continued to be met in 2025. For this standard, both SDW and LPL have the same running average value, so there was no confidence limit and all wetlands pass.
- To better understand the underperformance of invertebrate density in tidal creeks at San Dieguito, we can examine the annual time series for this standard.

Invertebrate density in tidal creeks at SDW consistently below references



- The annual time series on the right indicates that invertebrate density at San Dieguito has remained well below the reference sites since the beginning of monitoring. In 2025, San Dieguito was still below the lowest performing reference site, Los Penasquitos Lagoon.

In 2025, SDW met fewer relative standards than lowest performing reference wetland

		SDW	LPL	MUL	CSM
	PASS				
X	FAIL			X	
	NOT /			X	
Main channel	Water quality				
	Algal cover			X	
	Vegetation cover				
	Spartina canopy			X	
	Bird density	X			
	Bird richness				
	Food chain support to birds		X		
	Fish density	X			
	Fish richness	X			
	Invertebrate density				
	Invertebrate richness				
	Tidal creek	Fish density		X	
Tidal creek	Fish richness				
Tidal creek	Invertebrate density	X			
Tidal creek	Invertebrate richness				
Proportion of standards met in 2025		0.73	0.86	0.87	1.00

- This table summarizes the outcomes for each relative performance standard for each wetland for 2025.
- Carpinteria Salt Marsh did not fail any assessed standards in 2025. Mugu Lagoon failed two standards – algal cover and *Spartina* canopy. Los Penasquitos Lagoon also failed two standards- fish density in tidal creeks and food chain support to birds.
- San Dieguito Wetlands failed 4 standards, including bird density, fish density and richness in main channel habitat, and invertebrate density in tidal creeks, meaning that it is the lowest performing wetland. Therefore, San Dieguito did not meet the relative standards requirement for 2025.

SDW has yet to receive mitigation credit

Absolute standards	Tidal prism																
	Topography																
	Plant reproduction																
	Exotic species																
	Habitat areas	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Relative standards requirement	X			X	X	X	X	X	X	X	X			X	X	

Mitigation credit	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
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PASS

X

 FAIL

Number of years of credit needed = 32
 Number of years of credit earned = 0

We are evaluating why the wetland is not meeting certain performance standards to inform potential remediation options if required

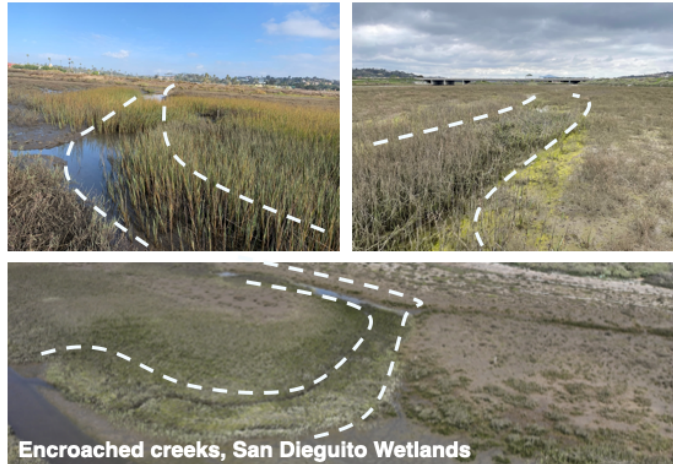
- To sum up all of the results across both talks, to receive mitigation credit for a given year, the wetland restoration project must meet all of the Absolute Standards and as many of the Relative Standards as the lowest performing reference wetland.
- In terms of absolute standards, as Kat described, the San Dieguito Wetlands has yet to meet the Habitat Areas Absolute Standard due to the loss of mudflat.
- In 2025, San Dieguito Wetlands also failed to meet the relative standards requirement.
- Thus, San Dieguito Wetlands has yet to receive mitigation credit.
- We are evaluating why the wetland is not meeting certain performance standards to inform potential remediation options, if required.

Understanding mechanisms of underperformance



- We are working to understand the mechanisms of underperformance that are associated with both the habitat areas standard and the relative standards requirement. As Kat described in the absolute standards talk, she showed that habitat conversion of mudflat to salt marsh has prevented San Dieguito from meeting the habitat areas standard.

Salt marsh encroachment into tidal creeks has reduced sampling area, requiring shifts in sampling locations



- We see similar salt marsh encroachment into tidal creek habitats that has reduced the sampling area, requiring shifts in sampling locations that have changed how we assess the four fish and invertebrate relative standards that we measure in tidal creeks.

In 2024 and 2025, only two constructed creeks were possible to sample

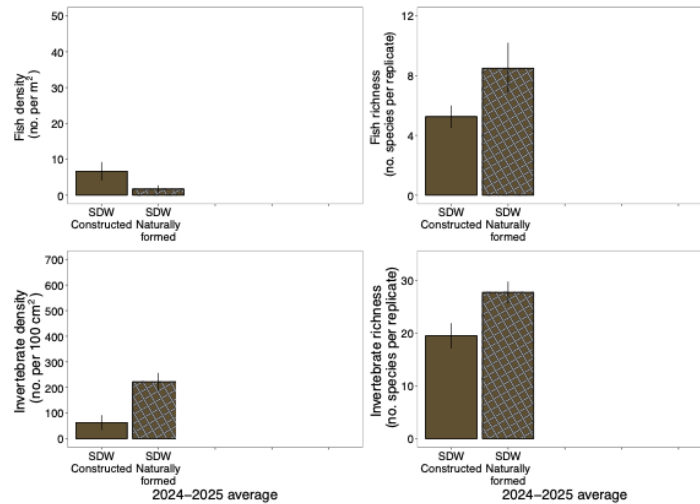


Two “naturally-formed” creeks were also sampled and used to assess compliance



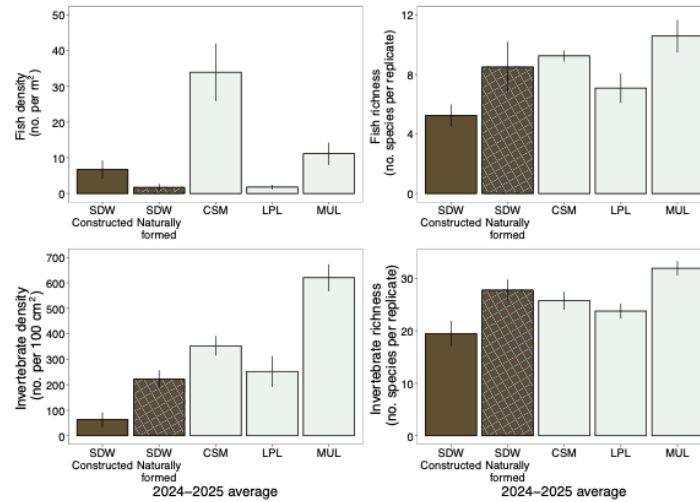
- To match the sample size of the reference sites, we aim to sample six constructed tidal creeks at San Dieguito Wetlands each year.
- However, due to *Spartina* encroachment, in 2024 and 2025, it was only possible to sample two constructed tidal creeks, shown by the white circles on the west side of the restoration project.
- Over time, two “naturally formed” creeks have evolved from frequently exposed mudflat, as shown by the unfilled circles on the east side of the restoration project.
- In both 2024 and 2025, we also sampled these two naturally formed creeks and used them to assess compliance to have a more comparable sample size to the reference wetlands.
- You can see from the photos on the right that the geomorphology of the naturally formed creeks is distinct from the constructed creeks that are experiencing salt marsh encroachment. The constructed creeks are much wider, shallower, and at a higher elevation relative to the naturally formed creeks, which are deeper, narrower, and at a lower elevation. These naturally-formed creeks have a much more similar geomorphology to the tidal creeks present at the reference wetlands.

On average, most fish and invertebrate standards lower in constructed creeks than naturally formed creeks



- If we compare the outcomes for mean fish and invertebrate density and richness for the constructed creeks at San Dieguito (shown in brown on the left) relative to those collected from the naturally formed creeks (shown with the hatched pattern on the right), we see that all fish and invertebrate standards except for fish density were lower in the constructed creeks relative to the naturally formed creeks.

On average, most fish and invertebrate standards in naturally formed creeks more similar to references



- If we compare the values collected from constructed and naturally formed tidal creeks at San Dieguito to the reference wetlands, it is clear that the values collected in the naturally formed creeks are more similar to those collected at the references.
- Thus, grouping constructed and naturally formed creeks together in assessing compliance may mask the contributions of constructed creeks, which were generally lower than the naturally formed creeks.

Next steps

- SCE is funding a modeling study to assess the optimal density, location, and geomorphology of tidal channels that can be supported within the SONGS project footprint, considering the hydrology of the entire San Dieguito Lagoon
- UCSB will review the modeling study and provide recommendations to CCC about next steps for potential remediation or adaptive management at SDW, if needed



- Given the superior performance of naturally formed creeks relative to the constructed creeks, we want to better understand the fate of the constructed creeks. Tidal creeks are an important feature of natural wetlands, and were historically part of the San Dieguito Lagoon. Tidal creeks align with the SONGS permit objectives in providing fish habitat and are used as a sampling location for assessing numerous standards.
- Given these values, SCE is currently funding a modeling study to assess the optimal density, location, and geomorphology of tidal creeks that can be supported within the SONGS project area, considering the broader hydrology of the San Dieguito Lagoon.
- This work includes a Green LiDAR flight to support digital elevation model development, as well as a hydrodynamic model that will characterize tidal dynamics in creek channels and on the marsh plain. Existing tidal creek geomorphology will then be related to the hydrodynamic model, with the goal of determining what tidal creeks can be supported within the San Dieguito Wetlands Restoration project.
- In 2026, we plan to review this modeling study and provide recommendations to the Coastal Commission about next steps for potential remediation or adaptive management, if needed, with the goal of improving wetland performance over time.

Annual Public Wetland Workshop Agenda

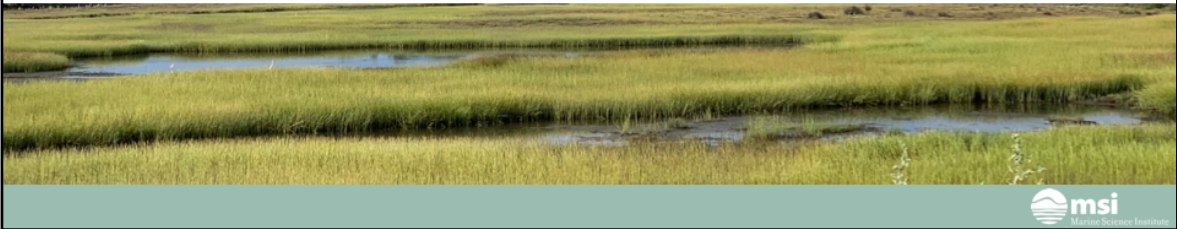
**San Onofre Nuclear Generation Station Mitigation Monitoring Program
May 21, 2026**

1:30 – 2:30 Introduction and Overview – Dr. Kathryn Beheshti, UCSB

**Performance Evaluation of the San Dieguito Wetlands Restoration
Project: Absolute Standards – Dr. Kathryn Beheshti, UCSB**

**Performance Evaluation of the San Dieguito Wetlands Restoration
Project: Relative Standards – Dr. Rachel Smith, UCSB**

2:30 – ? General Questions & Discussion



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