Performance Evaluation of the San Dieguito Wetlands Restoration Project

Annual Review Workshop for SONGS Wetland Mitigation

May 6, 2019

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

This presentation focuses on:

- The results of the seventh year of performance monitoring of the San Dieguito Wetlands Restoration Project, and
- Our evaluation of the progress of the restoration project towards meeting the performance standards required for successful mitigation.

Types of Performance Standards

1. **Absolute Standards: Measured only in the San Dieguito Wetlands.**

   (e.g., area of wetland habitats shall not vary by more than 10%)

2. **Relative Standards: Measured against natural wetlands that serve as reference sites.**

   (e.g., the densities and number of species of birds shall be similar to that of natural wetlands in the region)

- Two types of standards are used to assess the performance of the restoration project.
- The first type, absolute standards, are measured against a fixed value and evaluated only in San Dieguito Wetlands.
- For example, the area of wetland habitats shall not vary by more than 10%.
- The second type are relative standards.
- These standards are evaluated against natural wetlands in the region that serve as reference sites.
- For example, the densities and number of species of birds in San Dieguto Wetlands shall be similar to that of natural wetlands in the region.

Absolute Performance Standards

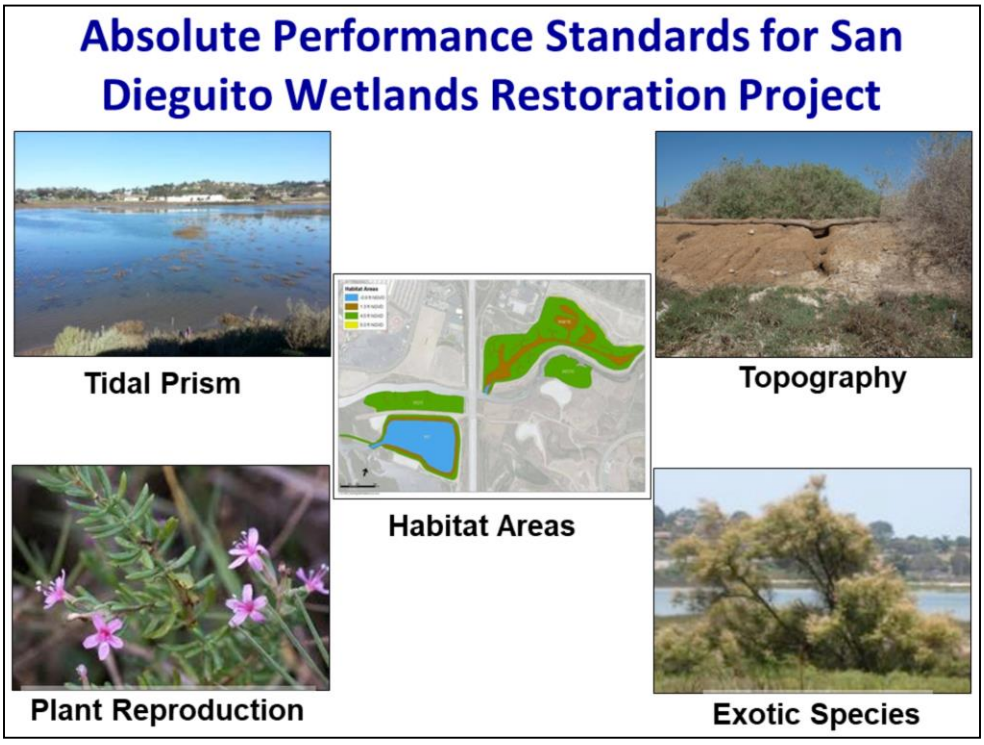
Requirement

The San Dieguito Wetlands Restoration must meet each absolute performance standard for that year to count towards mitigation credit.

Method of Evaluation

The evaluation of each absolute performance standard is based on the value for the current year.

- The San Dieguito Wetlands Restoration must meet each absolute performance standard for that year to count towards mitigation credit.
- The evaluation of each absolute performance standard is based on the value for the current year.



- Absolute performance standards for the San Dieguito Wetlands Restoration Project pertain to tidal prism, habitat areas, topography, plant reproduction, and exotic species.
- The tidal prism is the volume of water exchanged in an estuary between the low and high tide levels.
- It is an important metric of tidal flushing, inundation of marsh habitat, and inlet stability and the standard specifies that the tidal prism shall be maintained.
- Habitat areas standard specifies that area of wetland habitats shall not vary by more than 10% from the planned areas in the Final Restoration Plan.
- The standard for topography requires that the wetland not undergo major topographic degradation, such as excessive erosion or sedimentation.
- Plant reproductive success requires that certain plant species have demonstrated reproduction (i.e. seed set) at least once in three years.
- The last absolute performance standard pertains to exotic species.
- It requires that the important functions of the wetland shall not be impaired by exotic species.
- Exotic species can have negative impacts on wetland functioning, for example by altering food webs or the physical structure of habitats.

Performance Standard: Habitat Areas

The area of different habitats shall not vary by more than 10% from the areas indicated in the final restoration plan

Planned acres :

Salt marsh:	**green**	**92.6 acres**
Mudflat:	**brown**	**24.9 acres**
Subtidal:	**blue**	**32.0 acres**

Vegetated salt marsh inundated at high tide at San Dieguito Wetlands

- Taking a look at the Habitat Areas standard in more detail, this standard specifies that the areas (as acres) of the different habitats shall not vary by more than 10% from the areas indicated in the final restoration plan.
- This performance 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.
- Panel on the left shows the planned locations of salt marsh (green), mudflat (brown), and subtidal (blue) habitats as provided in the Final Plan for the restoration project as well as the planned acres for the different habitats.

Assessment of Salt Marsh Habitat

Habitat assessed as Salt Marsh if:

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

Vegetation cover evaluated under the Relative Standards

Salt Marsh Habitat in San Dieguito Wetlands

Insufficient cover of vegetation for Salt Marsh

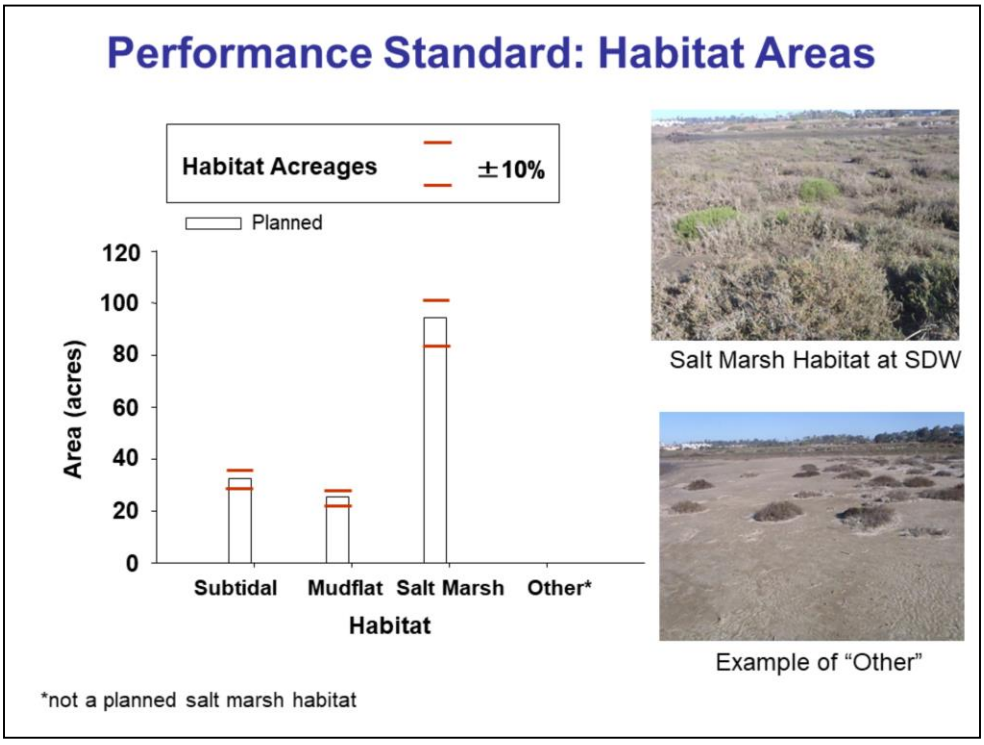
Assessment of Mudflat & Subtidal Habitat

Assessed as Mudflat Habitat if:

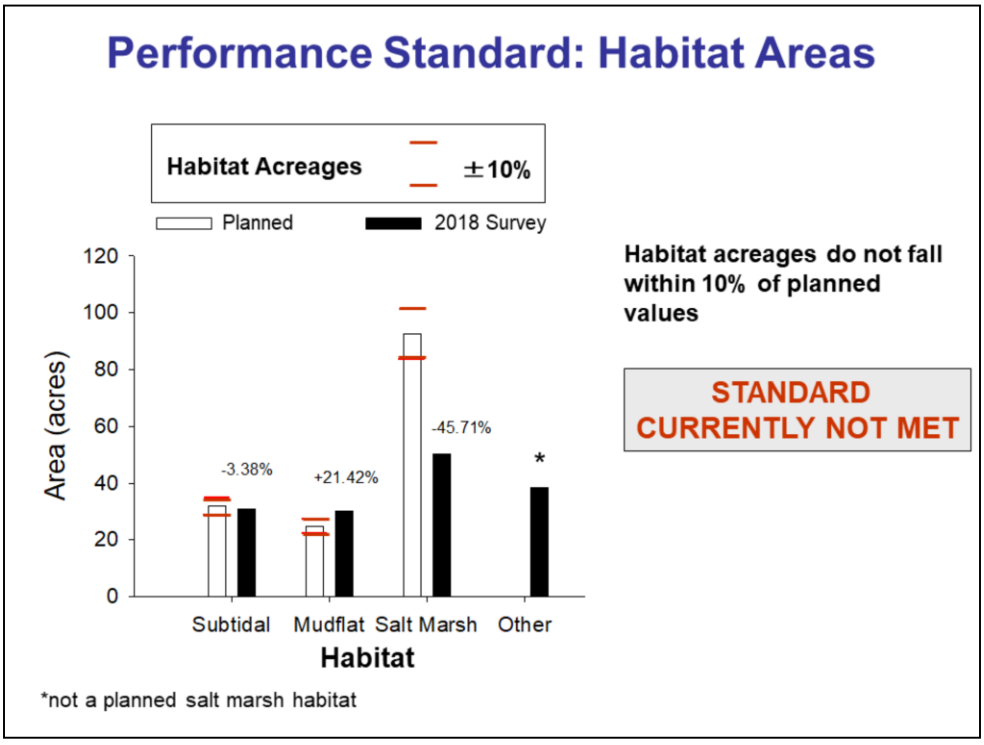
- **Intertidal and ≤3.5' NGVD**
- **<5% cover of vegetation (mudflats are defined as intertidal and unvegetated)**

Assessed as Subtidal Habitat if:

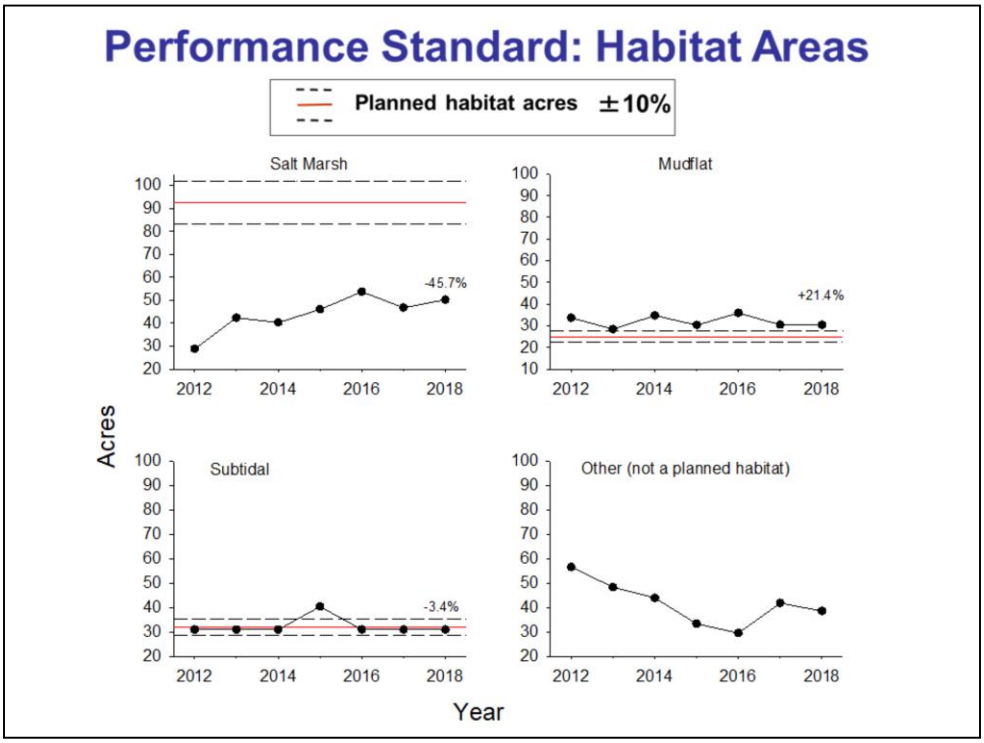
- **Continuously submerged**



- The open bars on this slide show the planned acreages of subtidal, mudflat, and salt marsh habitat, plus or minus 10% of these values, as well as an example of salt marsh habitat in the restored wetland with a high cover of vegetation.
- Also shown is a category that we term “other”, which is not a planned habitat.
- These are areas with insufficient cover of vegetation to be assessed salt marsh and too much vegetation and/or too high intertidally to be assessed as “mudflat”.



- The solid bars indicate the acreages determined in our 2018 survey.
- While the area of subtidal habitat was within 10% of the planned acreage in 2018, the area of mudflat was greater than 10%, and there was a deficit of salt marsh habitat (of ~33 acres), which was also not within ± 10% of the planned acreages. Salt marsh acreage in 2018 was about 50 acres, about 33 acres below the lower 10% limit of the designed acreage.
- As a result, the performance standard for habitat areas is currently not met.



- This slide shows the trend over time in acres of habitat categories and the Other category.
- The red line shows the planned acreage in the Restoration Plan and dashed lines indicate values plus or minus 10 % that value.
- Although there has been a general increase since 2012, the acres of salt marsh has remained relatively unchanged over the past 3 years.
- The small increase in Other in 2017 and 2018 can largely be accounted for by colonization of mudflat created by re-grading in W2/3 by vegetation.

Types of Performance Standards

2. *Relative Standards*: Must be similar to natural wetlands that serve as reference sites.

(e.g., the density and number of species of birds must be similar to that of natural wetlands in the region.)

Method of Evaluation

The evaluation of each relative standard in any given year is based on an average calculated from data collected at San Dieguito Wetlands and the reference wetlands for that year and for the previous three years.

- The second type of performance standards are relative standards, evaluated against natural wetlands in the region that are used as a reference sites.
- The evaluation of each relative standard in any given year is based on an average calculated from data collected at San Dieguito Wetlands and the reference wetlands for that year and for the previous three years.

What counts as similar in the context of assessing the performance of the San Dieguito Wetlands Restoration Project?

Definition: **The 4-year running average for a relative performance standard at San Dieguito Wetlands must be *equal to* or *better than* that value for the lowest performing reference wetland for that standard.**

Rationale:

- **To be successful, the San Dieguito Wetlands Restoration must provide resource values *similar* to those of natural wetlands in the region.**
- **A running average rather than the value for the current year better accounts for natural fluctuations over time.**

- *Definition:* The 4-year running average for a relative performance standard at San Dieguito Wetlands must be *equal to* or *better than* that value for the lowest performing reference wetland for that standard.

Rationale:

- To be successful, the San Dieguito Wetlands Restoration must provide resource values *similar* to those of natural wetlands in the region.
- A running average rather than the value for the current year better accounts for natural fluctuations over time.

Reference Wetlands

46 sites evaluated

Criteria for inclusion of a wetland as a reference site are provided in the SONGS Permit.

Reference wetlands shall be:

- **Relatively undisturbed**
- **Tidal**
- **Located in Southern California Bight**

- The criteria for inclusion of a wetland as a reference site is provided in the SONGS permit.
- These criteria are that the reference wetland be relatively undisturbed, tidal, and located in the Southern California Bight.
- 46 wetlands in the region were evaluated as possible reference sites, and Carpinteria Salt Marsh, Mugu Lagoon, and Tijuana Estuary were selected as best meeting the criteria provided in the SONGS permit.

Relative Performance Standards

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

- Shown here are the relative performance standards used to evaluate the success of the San Dieguito Wetlands Restoration Project.

Relative Performance Standards

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

- The first standard pertains to water quality, a physical factor.

Relative Performance Standards

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

- Standards 2-11 pertain to biological communities of birds, fish, and invertebrates.

Relative Performance Standards

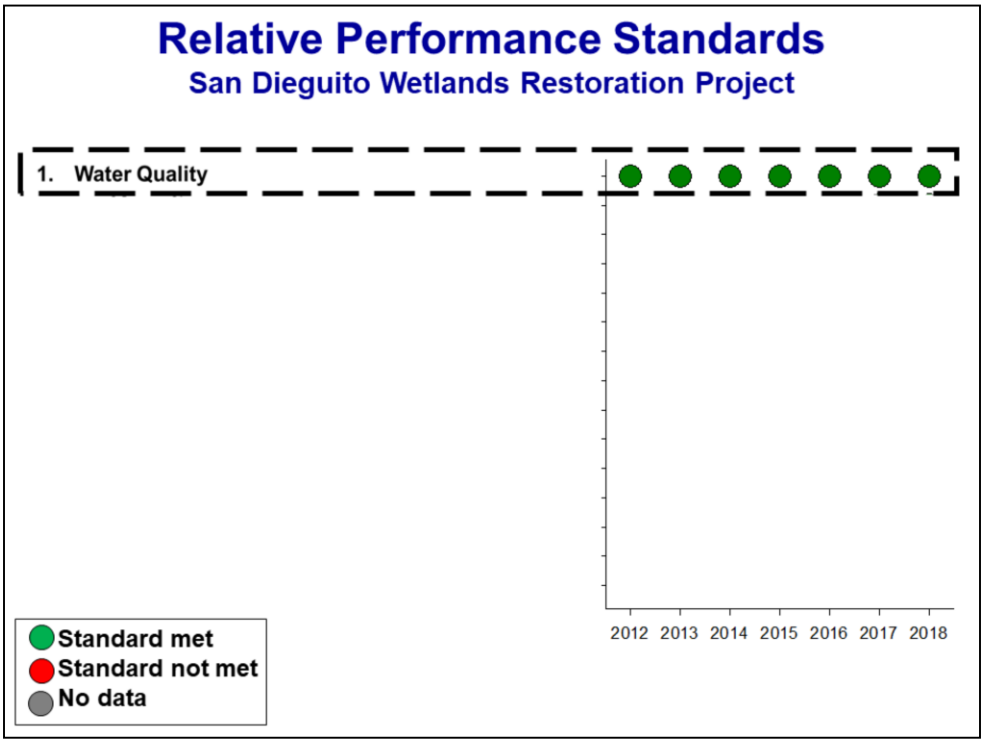
1. Water Quality
2. Bird Density
3. Bird Species Richness
4. Fish Density – Main Channel (MC)
5. Fish Species Richness – MC
6. Fish Density – Tidal Creek (TC)
7. Fish Species Richness – TC
8. Invertebrate Density – MC
9. Invertebrate Species Richness – MC
10. Invertebrate Density – TC
11. Invertebrate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

- Standards 12-14 pertain to the cover of vegetation and algae and Spartina canopy architecture.

Relative Performance Standards

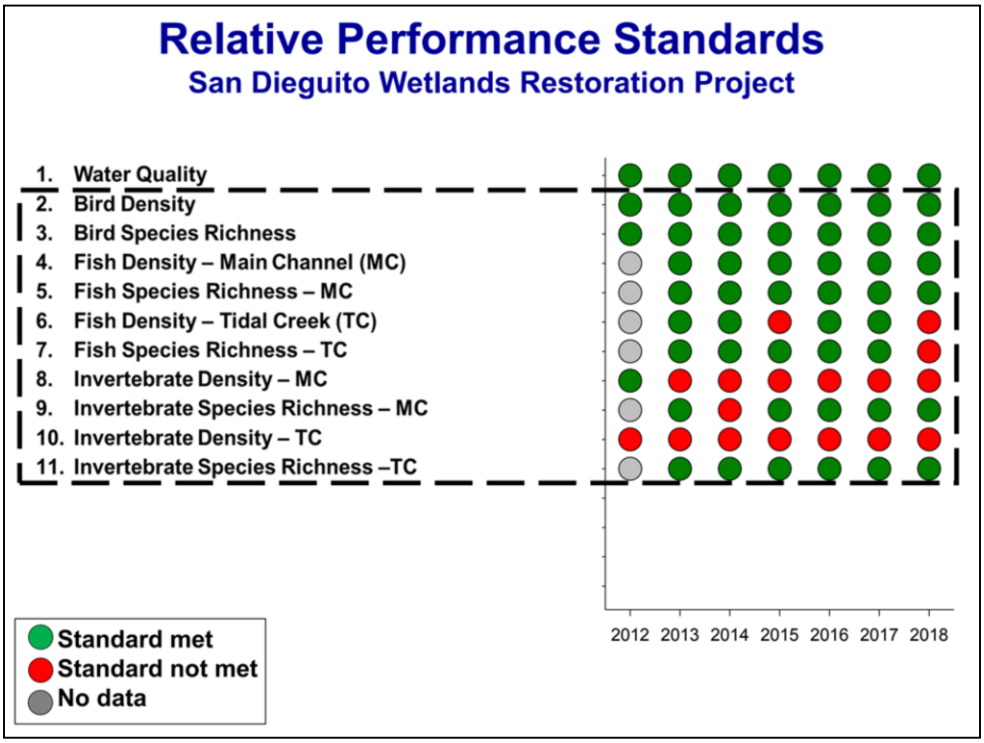
1. Water Quality
2. Bird Density
3. Bird Species Richness
4. Fish Density – Main Channel (MC)
5. Fish Species Richness – MC
6. Fish Density – Tidal Creek (TC)
7. Fish Species Richness – TC
8. Invertebrate Density – MC
9. Invertebrate Species Richness – MC
10. Invertebrate Density – TC
11. Invertebrate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

- The last standard pertains to food chain support provided by the wetland to birds.

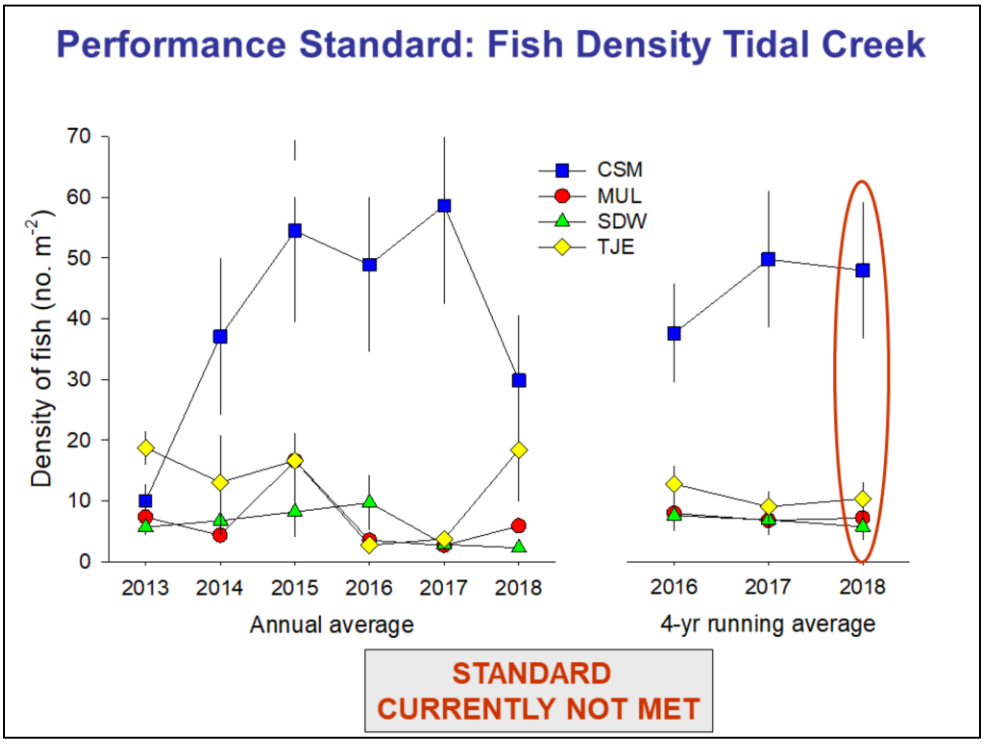


- The following slides will summarize whether a particular relative standard was met during each of the last 7 years.
- A green dot indicates that the standard was met for a particular year, and a red dot will indicate that the standard was not met.
- This slide summarizes the results for water quality.
- As a result of it's importance to estuarine health, dissolved oxygen concentration is the water quality variable used to evaluate this standard.
- We assess DO by comparing the mean number of hours of continuous hypoxia, DO values <3mg/l, between San Dieguito Wetlands and the reference wetlands.
- If mean number of consecutive hours of continuous hypoxia 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.

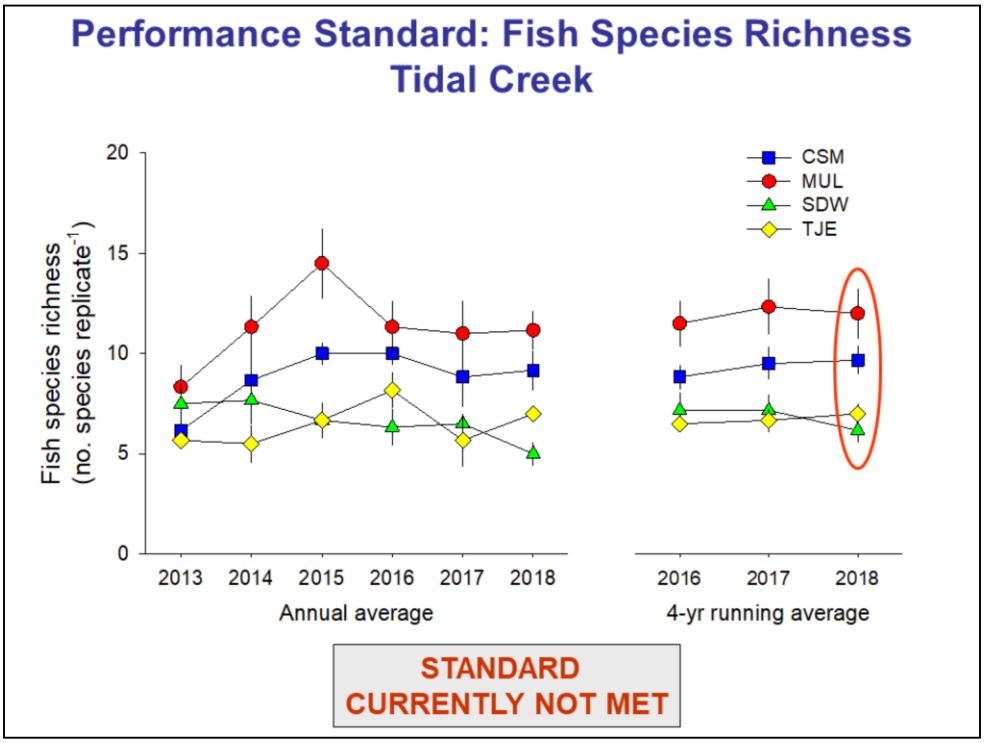
- The values for sequential hours of hypoxia at San Dieguito has been similar to the reference wetlands for the past 7 years and the standard is currently met.



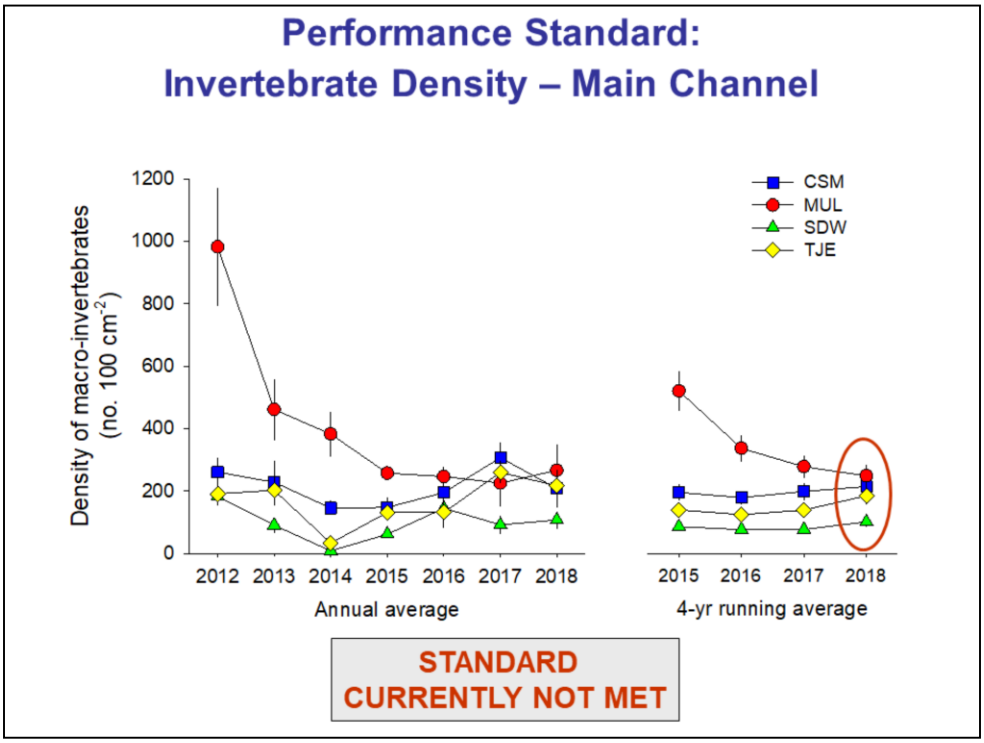
- We are now moving onto the performance standards for biological communities, which includes standards for birds, fish, and macroinvertebrates.
- These are relative standards that pertain both the densities and numbers of species of these groups.
- The performance standard for biological communities requires that within 4 years of construction, the total densities and number of species of birds, fish, and macroinvertebrates shall be similar to the densities and number of species in similar habitats in the reference wetlands.



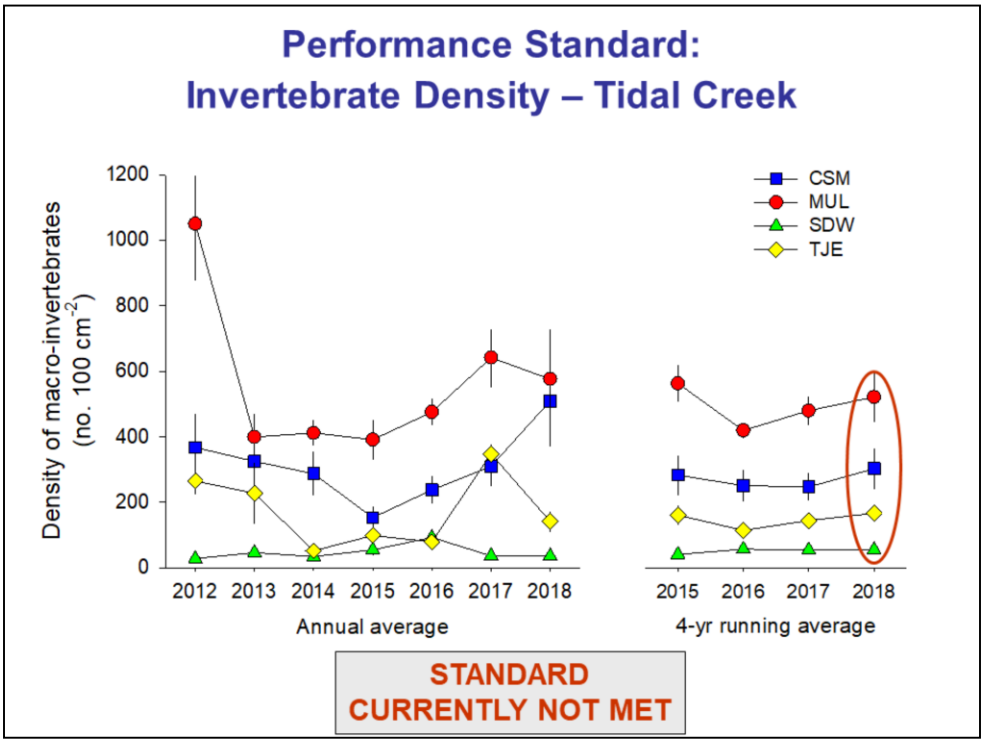
- Taking a look at the densities of fish in tidal creeks.
- Fish density in tidal creeks continued to decline from 2016 and was lowest in SDW in 2018.
- The four-year running average also declined from 2016 to 2018 and as a result this standard was not met in 2018.



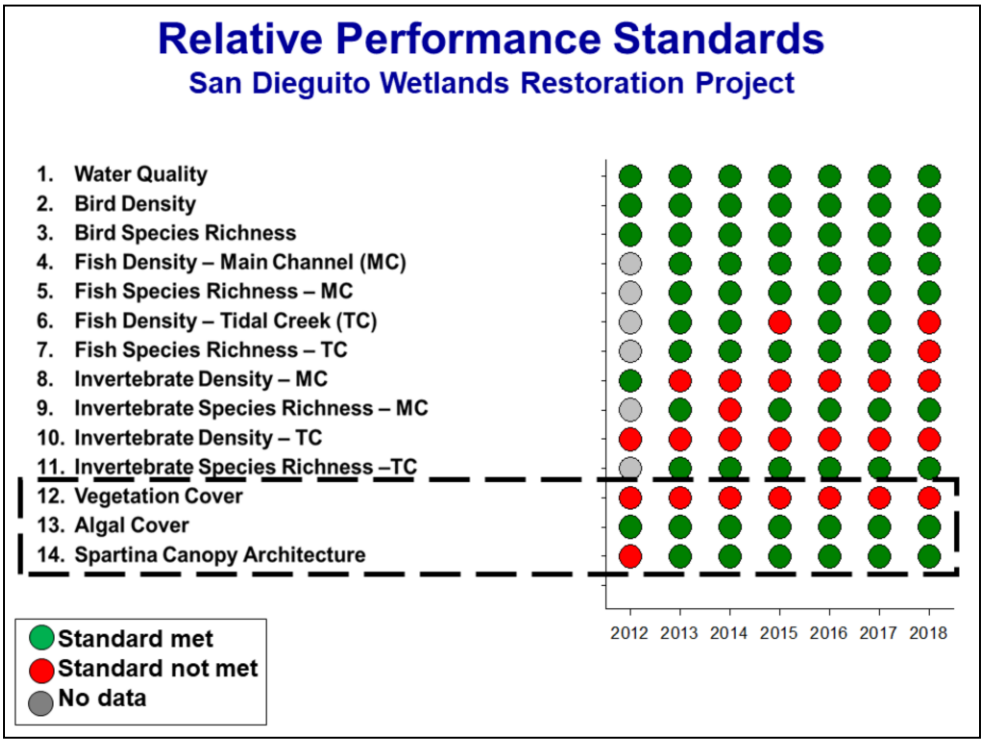
- Taking a look at the species richness of fish in tidal creeks.
- As was the case for fish density in tidal creeks, fish species richness in tidal creeks was lowest in SDW in 2018.
- The four-year running average also lowest in 2018 and as a result this standard was not met in 2018.



- Moving on to the densities of macro-invertebrates.
- The relative performance standards pertaining to macro-invertebrate density in main channel and tidal creek habitats were not met in 2018.
- Looking at invertebrate densities in main channel habitat in more detail, this slide shows both the annual averages and the running averages used to evaluate macro-invertebrate density, as mean number per 100 cm2, in the main channel habitat.
- Beginning in 2015 the running average in SDW has been lower than the reference wetland with the lowest value, which has been Tijuana Estuary.
- This year the standard has continued to be well below the lowest performing reference site.



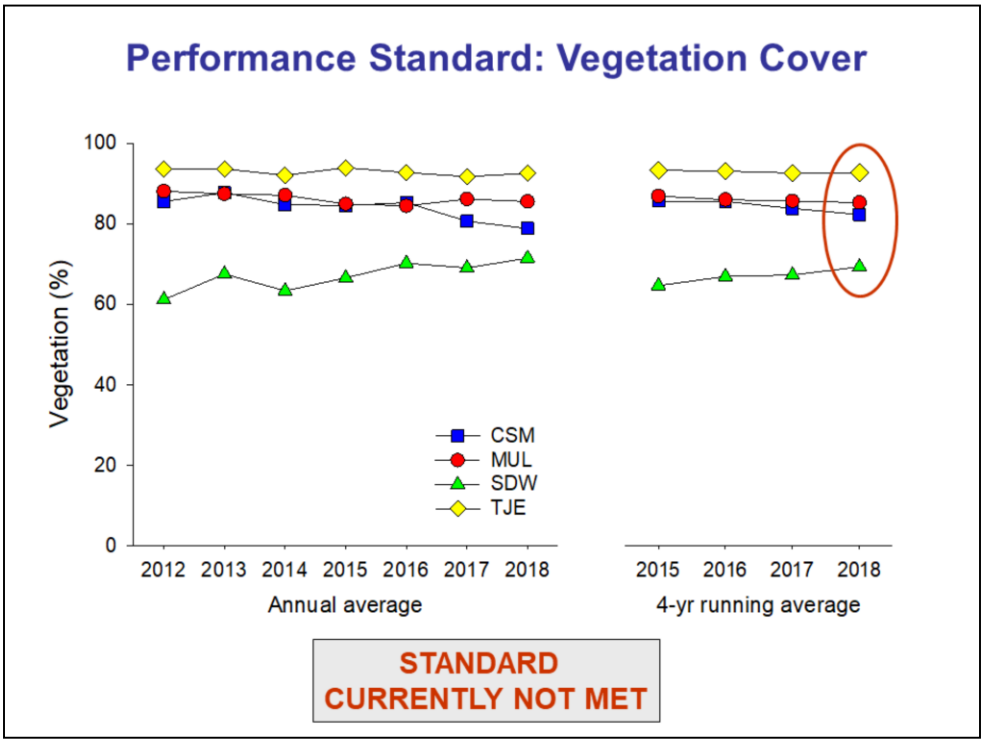
- This slide shows the annual average on the left and running averages on the right used to evaluate macro-invertebrate density in tidal creek habitat.
- Looking at the annual average on the left, we see that the value for SDW declined in 2017 and remained at the same level in 2018. Although the annual value at the Tijuana Estuary also decreased, it was still much higher than at SDW.
- The running average for invertebrate densities in tidal creek habitat remains below the lowest performing reference site in 2018.



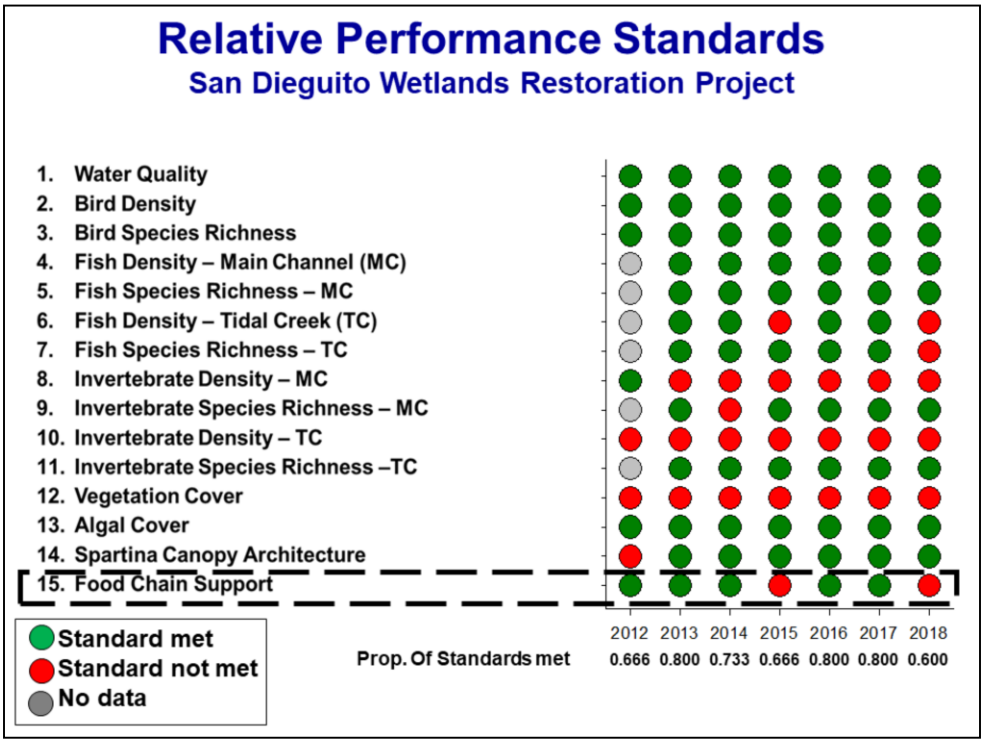
- The next 3 standards pertain to the percent cover of algae and vegetation, and Spartina canopy architecture.

- This performance standard for algae is designed to monitor the development of unusually dense mats of filamentous green macroalgae in the restoration site. Thick mats of algae have the potential to interfere with wetland structure and function by smothering benthic invertebrates and inhibiting bird feeding on mudflats. Decomposing mats of algae can also adversely affect water quality. The standard for Algal cover is met in San Dieguito if it is not significantly higher in the reference wetland with the highest coverage of algae. San Dieguito has met this standard in all 7 years of monitoring

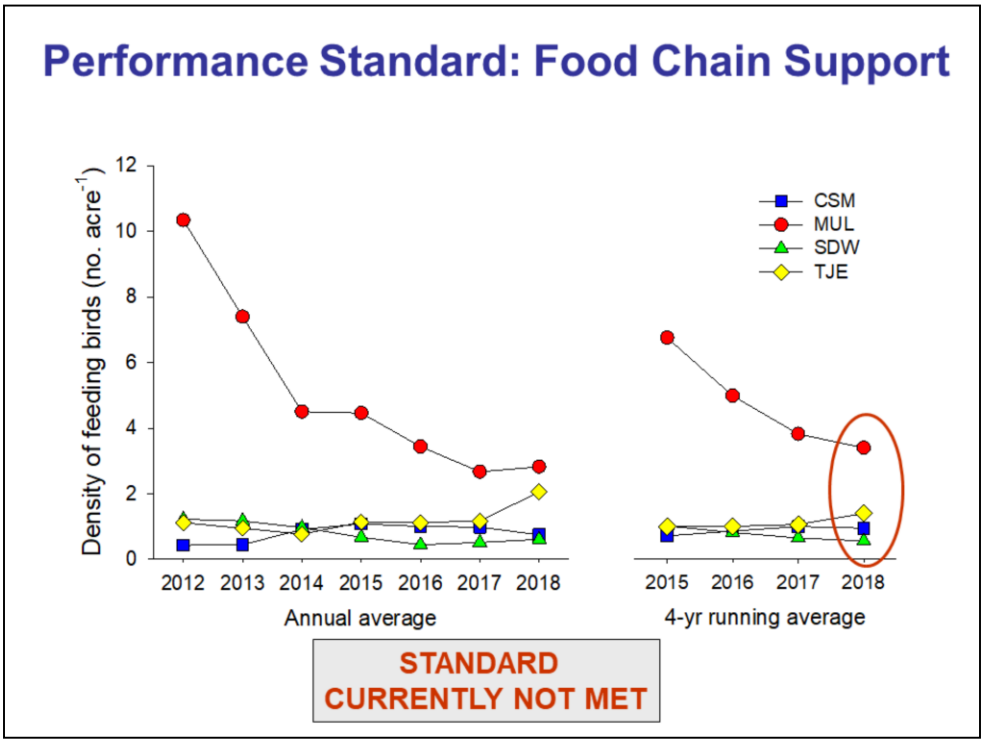
- The standard for Spartina canopy architecture requires that the proportion of stems over 3 feet tall shall not be lower in the San Dieguito wetland than in the reference wetland with the lowest proportion. The rationale for this standard is that areas with Spartina stems 3 feet or longer are required nesting habitat for the endangered Ridgeway Rail. In practice this comparison has only been made between San Dieguito and the Tijuana estuary the only two wetlands with sufficient Spartina stands to evaluate this standard. San Dieguito has passed this standard from 2013 to the present.



- Taking a look at the data for vegetation cover in salt marsh habitat in more detail, this slide shows the annual average on the left and the running average, used to evaluate the standard, on the right for cover of vegetation in the San Dieguito Wetlands compared to the reference wetlands.
- Although vegetation has colonized the restored wetland it has not yet filled in to the point where we see an appreciable increase in cover in the running average for 2018 and thus SDW is not yet similar to the reference wetlands.
- Mark will speak more about on-going adaptive management to increase vegetation cover in the next talk.



- The last standard pertains to food chain support as measured by the density of feeding birds.
- This standard has been met 5 of the past 7 years, but was not met in 2018.



- Food chain support has been consistently highest at Mugu lagoon
- At San Dieguito it has been similar or higher than at the reference wetlands through 2015 but since 2016 it has been lower.
- In 2018 food chain support in San Dieguito was lower than in Carpinteria Salt marsh, the lowest performing wetland and this standard was not met.

Relative Performance Standards

Requirement

The San Dieguito Wetlands Restoration must meet at least the same proportion of relative standards as the lowest performing reference wetland in a given year for that year to count towards mitigation credit.

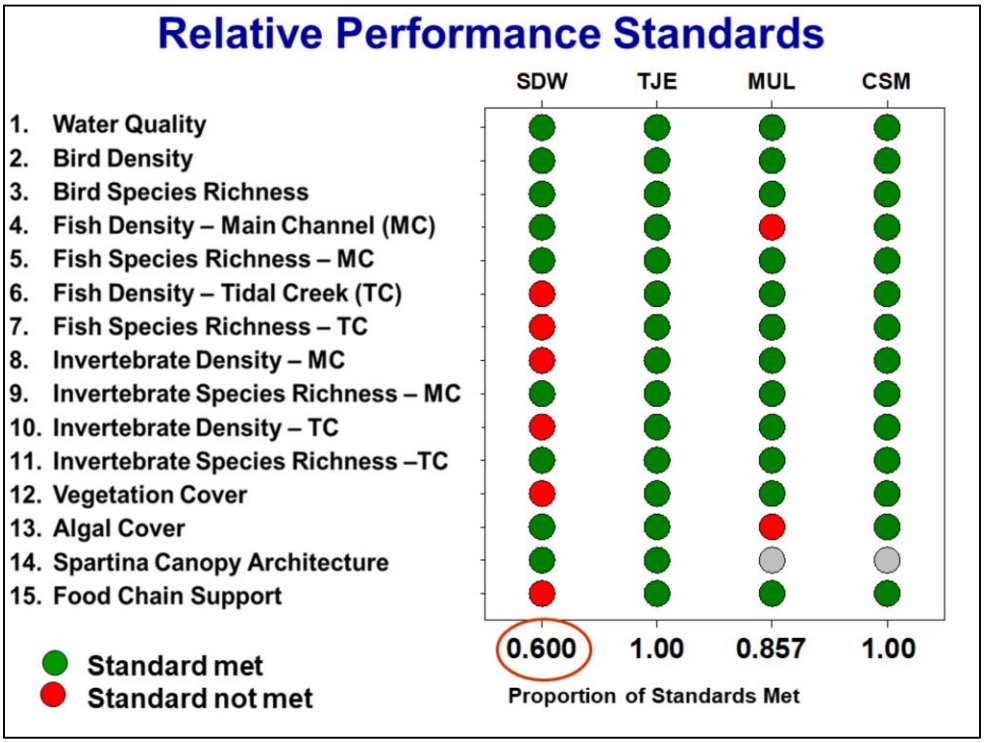
Method of Evaluation

San Dieguito Wetlands and the reference wetlands are evaluated with respect to whether or not they meet each relative standard and the proportion of relative standards met by each wetland is computed and compared.

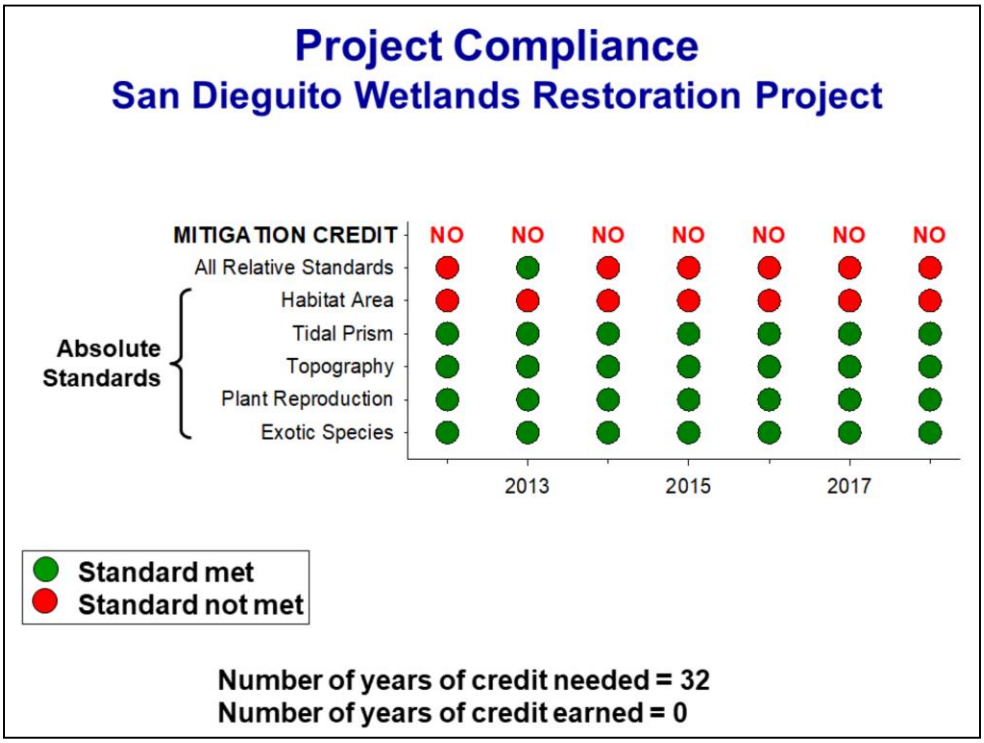
Rationale

Requiring the San Dieguito Wetlands Restoration to meet at least the same proportion of relative standards as the lowest performing reference wetland achieves the desired mitigation goal of being similar to natural wetlands without requiring the restoration to outperform the reference wetlands.

- The San Dieguito Wetlands Restoration must meet at least the same proportion of relative standards as the lowest performing reference wetland in a given year for that year to count towards mitigation credit.
- San Dieguito Wetlands and the reference wetlands are evaluated with respect to whether or not they meet each relative standard and the proportion of relative standards met by each wetland is computed and compared.
- Requiring the San Dieguito Wetlands Restoration to meet at least the same proportion of relative standards as the lowest performing reference wetland achieves the desired mitigation goal of being similar to natural wetlands without requiring the restoration to outperform the reference wetlands.



- This table provides a summary assessment of the relative performance standards for 2018 using the running averages.
- A green circle indicates that the performance variable at a particular wetland is similar to the other wetlands.
- A red circle indicates that the performance variable at a particular wetland was not similar to the other wetlands
- Gray– not measured
- Comparing the running averages, San Dieguito Wetlands met a lower proportion of the standards than Mugu Lagoon, the reference site with the lowest proportion of standards met.
- Therefore, San Dieguito Wetlands did not meet the relative standards for 2018.



- Taking a look at project compliance, in order to receive mitigation credit for a given year, the wetland restoration project must meet all of the Absolute Standards and as many of the Relative Standards as the worst performing reference wetland.
- So far, the SDW has yet to meet the Habitat Areas Absolute Standard due to slow vegetation development
- The project has also failed to meet the Relative Standard requirement due to slow rate of vegetation development, low densities of invertebrates in tidal creek and main channel, and low densities and species richness of fish in tidal creeks.
- As a result, the project has not yet satisfied the performance success criteria in the SONGS permit and has not yet received mitigation credit.

Summary and future directions:

- The absolute standard for habitat area has not yet been met.
- Additionally, the San Dieguito Wetlands has yet to meet as many of the relative performance standards as the reference wetlands since its construction.
  - These include the percent cover of salt marsh vegetation and invertebrate abundance
- Studies to address low invertebrate abundance going forward will include:
  - Examining differences in soil properties (soil texture and soil organic content) at San Dieguito vs. the reference wetlands.
  - Examining differences in channel topography and position relative to the inlet between San Dieguito and the reference wetlands.
- Studies to address the low percent cover and the insufficient acreage of tidal salt marsh habitat are the subject of the next talk.