

San Dieguito Wetlands Restoration Project: Third Year Progress Report 2014 Monitoring Results



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

This presentation focuses on:

- The results of the third 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 against a fixed value and 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 Dieguito 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.

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Absolute Performance Standards for San Dieguito Wetlands Restoration Project



Tidal Prism



Habitat Areas



Topography



Plant Reproduction



Exotic Species

- Absolute performance standards for the San Dieguito Wetlands Restoration Project pertain to tidal prism, habitat areas, topography, plant reproduction, and exotic species.
- I will now go through the evaluation of each of the absolute standards for 2014.

Performance Standard: Tidal Prism

The designed tidal prism shall be maintained, and tidal flushing shall not be interrupted

Tidal prism: The volume of water exchanged in an estuary between the low and high tide levels.

Why measure it? Metric of tidal flushing, inundation of marsh habitat, and inlet stability.

W4/16 – low tide

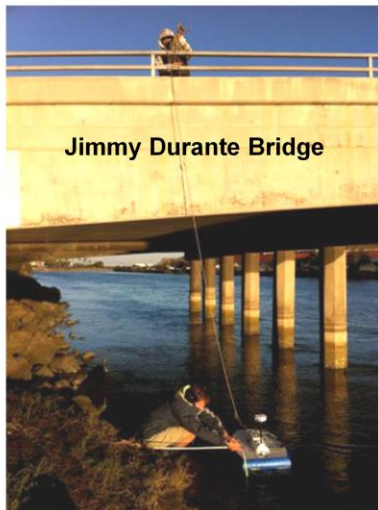


W4/16 – high tide



- Tidal prism as an absolute standard, is evaluated only within the San Dieguito Wetlands Restoration.
- This standard specifies that the designed tidal prism shall be maintained, and tidal flushing shall not be interrupted.
- 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.

Method of Assessing Tidal Prism

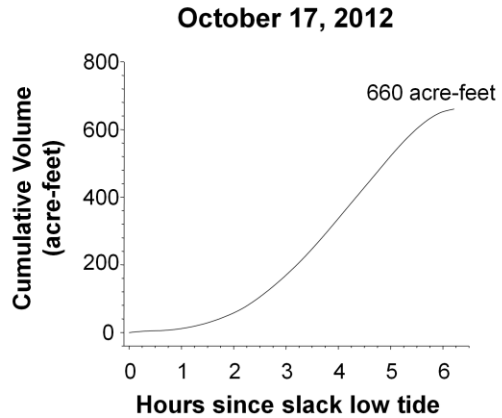


River Surveyor--Acoustic Doppler Current Profiler (ADCP)

- Tidal prism is assessed using a River Surveyor—a small acoustic doppler current profiler or ADCP that measures channel profile and volume of water flow.

Method of Assessing Tidal Prism

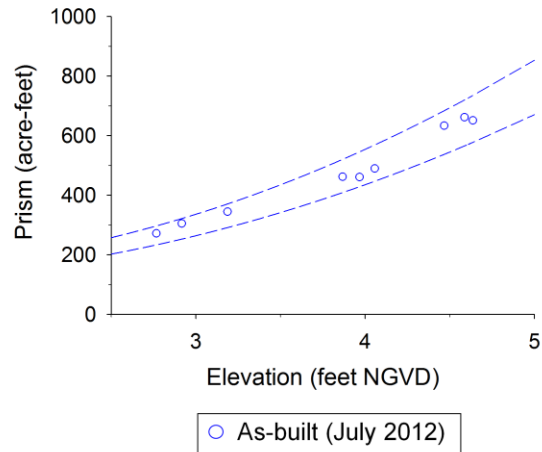
- Measurements of flow volume are taken every 15 minutes during an incoming tide using the River Surveyor.
- Flow volume values are cumulated over the entire incoming tide to estimate prism.



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- Flow volume values are cumulated over the entire incoming tide to estimate prism.

Performance Standard: Tidal Prism

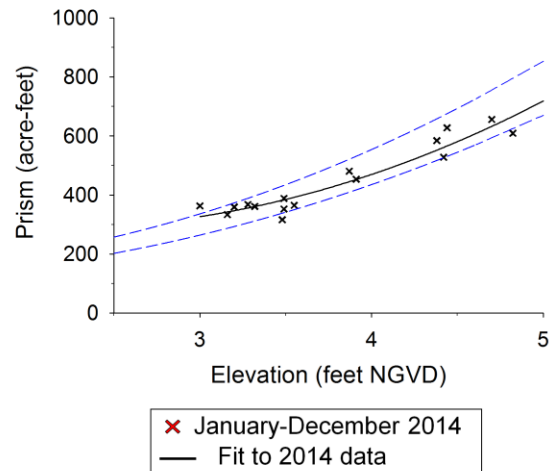
- Tidal prism is plotted against the maximum high tide and evaluated against an “as-built” prism, which was assessed in July 2012 over a range of high tides.
- Measured prism must fall within the blue dotted lines to ensure no more than a 10% shift in planned salt marsh habitat.



- Tidal prism is plotted against the maximum high tide and evaluated against an “as-built” prism, indicated by the blue circles, which was assessed in July 2012 over a range of tides.
- The measured prism must fall within the dashed blue lines to ensure no more than a 10% shift in planned salt marsh habitat.

Performance Standard: Tidal Prism

- Measured tidal prism in 2014 falls within the blue dotted lines.



The fitted line to the tidal prism data from January through December 2014 falls within the dashed blue lines, indicating that the tidal prism at the San Dieguito Wetlands was maintained in 2014.

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


- Habitat Areas 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 thus guard against large scale conversions of one habitat type to another, for example of vegetated marsh to mudflat.
- 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 as well as the planned acres for the different habitats.

- **Aerial imagery and field surveys were used to determine acreages of the three wetland habitat types (salt marsh, mudflat, and subtidal) in 2014.**
- **These acreages were compared to the those in the Final Plan to determine whether they were within 10% of the Final Plan values.**
- **Habitat types were evaluated within 10 x 10 m plots.**

San Dieguito Wetlands



Mudflat



- Aerial imagery and field surveys were conducted to determine acreages of the three wetland habitat types (salt marsh, mudflat, and subtidal) in 2014.
- These measures were compared to the planned acreages to determine whether they were within 10% of these values.

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

- Areas were assessed as salt marsh if they were:
- Intertidal and at or below an elevation of 4.5' NGVD, which is the upper limit of tidally influenced habitat for this project.
- Additionally, areas assessed as salt marsh habitat must have at least $\geq 30\%$ cover of vegetation, measured within the 10 x 10 m plot area to provide perches and bare foraging habitat for Belding's Savannah Sparrow and other species.
- These photos show examples of areas that were assessed as salt marsh habitat and areas where the cover of vegetation was insufficient to be assessed as salt marsh
- It is important to note that there is a separate relative performance standard that pertains the cover of vegetation within the salt marsh habitat that I'll be talking about shortly.

Assessed as Mudflat Habitat if:

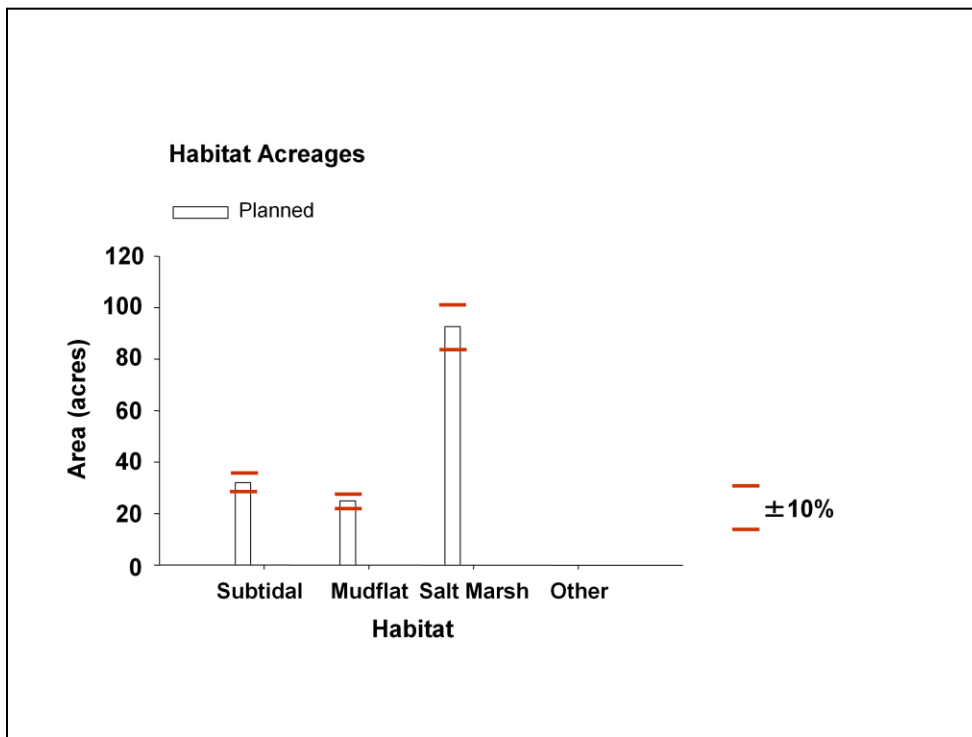
- Intertidal and $\leq 3.5'$ NGVD
- <5% cover of vegetation (mudflats are defined as intertidal and unvegetated)

Assessed as Subtidal Habitat if:

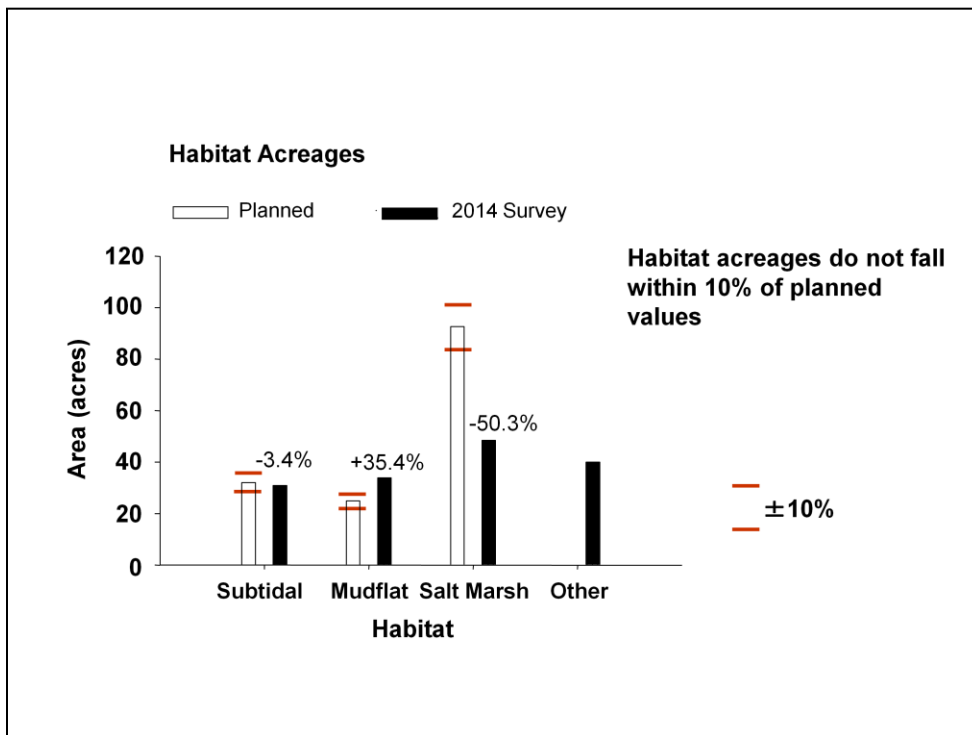
- Continuously submerged



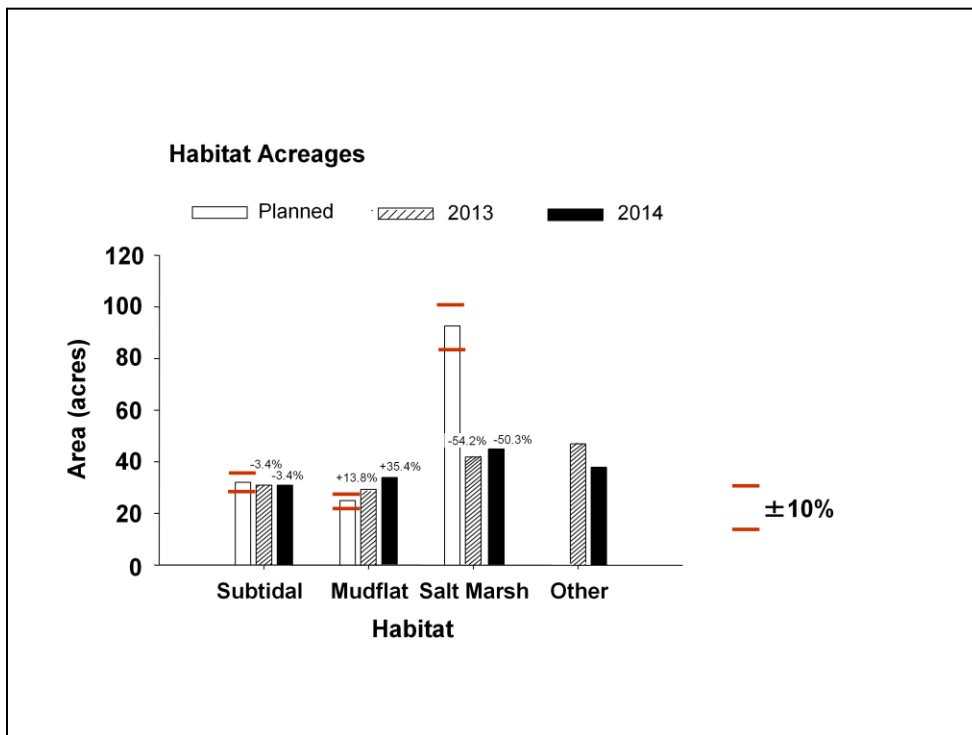
- Habitat was assessed as mudflat also based on tidal elevation and cover of vegetation.
- Restored areas are assessed as mudflat if they are intertidal and fall at or below 3.5' NGVD and thus are subject to regular tidal flooding.
- Additionally, areas assessed as mudflat must possess less than 5% cover of vegetation, as mudflats are defined as intertidal and unvegetated
- Finally, areas are assessed as subtidal if they are continuously submerged.



- The open bars on this slide show the planned acreages of subtidal, mudflat, and salt marsh habitat.



- The hashed bars indicate the acreages determined in our 2014 survey.
- The area for subtidal habitat measured in the 2014 surveys is within $\pm 10\%$ of the planned acreages.
- However, the area of mudflat and salt marsh habitat is not within 10% of the planned acreages.
- About 40 acres were assessed as “Other” not assessed as one of the planned habitats provided in the Final Restoration Plan.
- Therefore the habitat areas do not yet meet the requirements of the Habitat Areas standard.



- Although not yet meeting the standard for habitat areas, the monitoring results for 2014 are encouraging in that the area classified as Other, not one of the planned habitats, and there was an increase of about 5 acres classified as Salt Marsh habitat and 4 acres classified as Mudflat, and a 9 acre decrease in the Other.
- The increase in mudflat was largely due to the regrading of W2/3 west of the I-5 freeway

Performance Standard: Topography

The wetland shall not undergo major topographic degradation (such as excessive erosion or sedimentation)



Erosion of upland bordering the restoration following storm events

- Topography is another absolute performance standard.
- The standard for topography requires that the wetland not undergo major topographic degradation, such as excessive erosion or sedimentation.

Methods of Assessing Topography

- The intent of the topography standard is to ensure that the expected functions of the wetland are not affected by excessive erosion or sedimentation.
- Survey data and field observations are used to determine whether the topography standard is met.
- Survey results indicate that the wetland did not undergo major topographic degradation in 2014.



Surveying elevations in the San Dieguito Wetland

- The intent of the topography standard is to ensure that the expected functions of the wetland are not affected by excessive erosion or sedimentation.
- Survey data and field observations are used to determine whether the topography standard is met.
- The monitoring results for 2014 indicate that the wetland did not undergo major topographic degradation.

Performance Standard: Reproductive Success

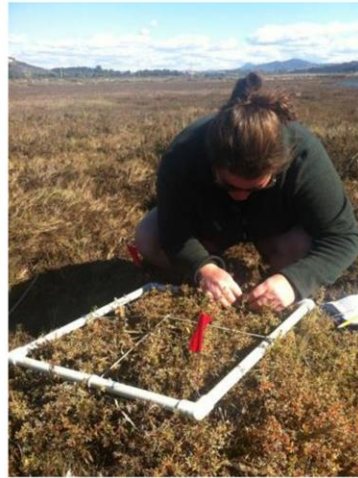
Certain plant species, as specified in the work program, shall have demonstrated reproduction (i.e. seed set) at least once in three years



- Plant reproductive success, another absolute standard, requires that certain plant species, as specified in the work program, have demonstrated reproduction (i.e. seed set) at least once in three years.
- This slide shows pictures of 6 of the 7 plant species used to evaluate this standard: Alkali Heath, Salt Grass, Pickleweed, Salty Susan, Spiny Rush, and Sea Lavender.
- These are the most common plant species in San Dieguito Wetlands and occupy a range of tidal elevations.

Methods of Assessing Plant Reproductive Success

- Inspection of the 7 species for the setting of seed in summer-fall when seed set is greatest.
- 10 stations sampled per plant species distributed throughout the wetland.
- Seed set identified using a sub-sample of mature flowers of each species.



Collection of mature flowers

- To assess plant reproductive success, we inspect the 7 common species at sites throughout San Dieguito Wetlands for the setting of seed in summer-fall when seed set is greatest.
- There are 10 sampling stations for each plant species distributed throughout the wetland.
- Seed set is identified from a subsample of mature flowers of each species.

Performance Standard: Reproductive Success

2012

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

- All 7 species produced seed in 2012.
- Since the standard requires that the selected species have demonstrated reproduction (i.e. seed set) at least once in three years, the standard is met for 2014.

Performance Standard : Exotics

The important functions of the wetland shall not be impaired by exotic species

Exotic species can cause compositional and functional changes in estuarine ecosystems (e.g., alteration of food webs or physical structure of habitats).



- 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.
- To illustrate, the Asian mussel can occur in very dense mats that exclude native benthic organisms.
- This boring isopod burrows into channel banks and at high densities can enhance bank erosion and adversely affect topography

Methods used to Assess Exotics

- Use monitoring data to assess the prevalence of exotic species.
- Conduct a special survey that covers as much of the wetland as possible that looks for exotic species once per year.
- If exotic species are prevalent
 - Conduct targeted studies to assess how the invader is affecting the functioning of the restored wetland.
 - Consult appropriate resource agencies regarding a plan of action to manage these species.



- To evaluate this standard, the monitoring data are used to assess the prevalence of exotic species.
- A special survey is also conducted covering as much of the wetland as possible that looks for exotic species.
- If exotic species are prevalent, targeted studies may be done to assess how the invader is affecting the functioning of the restored wetland.
- Appropriate resource agencies will be contacted regarding a plan of action to manage these species.

Performance Standard : Exotics

The important functions of the wetland shall not be impaired by exotic species

Conclusion: No evidence that exotic species have impaired the important functions of San Dieguito Wetlands.

- Although some relative performance standards for macroinvertebrates were not met, to be discussed when we get to the relative standards, there was no evidence from our sampling or the special survey that exotic species were responsible.
- We note that the Yellow Fin Goby, an exotic species that was the fifth most abundant fish as determined from our fish sampling in 2013, was not abundant in 2014.

Types of Performance Standards

2. Relative Standards: Measured against 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.)

- The second type of performance standards are relative standards, evaluated against natural wetlands in the region that are used as a reference sites.

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

Definition: The mean value for a relative performance standard at San Dieguito Wetlands must be *equal to or better than* the mean 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.

- The SONGS Coastal Development Permit envisioned a quantitative definition of “similar” for evaluating the performance of both the wetland and reef mitigation projects relative to reference sites, and it specified that the measure of similarity would be defined in the monitoring plans for these projects.
- After considerable discussion the definition for the measure of similarity that was chosen is that the mean value for a relative performance standard at the San Dieguito Wetlands must be *equal to or better than* the mean value for the lowest performing reference wetland for that standard.
- The rationale behind this definition is that the San Dieguito Wetlands should perform at least as well as the lowest performing natural wetland used as a reference site.

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

Requirement

- The San Dieguito Wetlands Restoration must meet as many relative standards as the lowest performing reference wetland in a given year for that year to count towards mitigation credit.
- To meet a given standard the value at the restoration must be *similar* to values at the reference wetlands.

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.

Rationale

- Requiring San Dieguito Wetlands Restoration to meet at least as many 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 requirement for the relative performance standards is that the San Dieguito Wetlands Restoration must meet as many of the relative standards as the lowest performing reference wetland in a given year for that year to count towards mitigation credit.
- To meet a given standard the value at the San Dieguito restoration must be *similar* to values at the reference wetlands.
- The evaluation of each relative standard in any given year is based on a four-year running average calculated from data collected at San Dieguito Wetlands and the reference wetlands for that year and the previous three years similar to the to the method used for reef mitigation project.
- Requiring San Dieguito Wetlands to meet at least as many 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.

Relative Performance Standards for the San Dieguito Wetlands Restoration Project

1. Water Quality
2. Bird density
3. Bird species richness
4. Fish density (channel / creek)
5. Fish species richness (channel / creek)
6. Macro-invertebrate density (channel / creek)
7. Macro-invertebrate species richness (channel / creek)
8. Vegetation
9. Algae
10. *Spartina* canopy architecture*
11. Food chain support



* Evaluated relative to Tijuana Estuary only

- Shown here are the relative performance standards used to evaluate the success of the San Dieguito Wetlands Restoration Project.
- One of the relative standards, *Spartina* canopy architecture, is evaluated only in comparison to Tijuana Estuary because *Spartina* is not present in Carpinteria Salt Marsh and present, but rare in Mugu Lagoon.
- What follows is a summary of the monitoring results as they pertain to each of these standards for 2014.

Performance Standard: Water Quality

Water quality variables [to be specified] shall be similar to reference wetlands

Dissolved oxygen concentration critically important to the health of estuarine biota



Closed and opened inlet at San Dieguito in 2002

- Water quality as a relative standard requires that water quality variables in the San Dieguito Wetlands shall be similar to the reference wetlands.
- Dissolved oxygen concentration is critically important to the health of estuarine organisms, whereas many estuarine species are tolerant of wide ranges of salinity and temperature.
- Dissolved oxygen concentration is very sensitive to inlet closure.
- As a result of its importance to estuarine health, dissolved oxygen concentration is the water quality variable used to evaluate this standard.

Method of Assessing Dissolved Oxygen (DO) Concentration

- DO measured every 15 minutes using dataloggers continuously deployed in SDL and reference wetlands.
- DO below 3 mg/l considered “hypoxic” and sustained values below this value are detrimental to estuarine biota.
- The mean number of consecutive hours spent below this value is calculated for each wetland.
- If mean number of consecutive hours DO < 3 mg/l is significantly higher in San Dieguito than the reference wetland with the highest value, San Dieguito fails to meet the standard.

Checking dataloggers



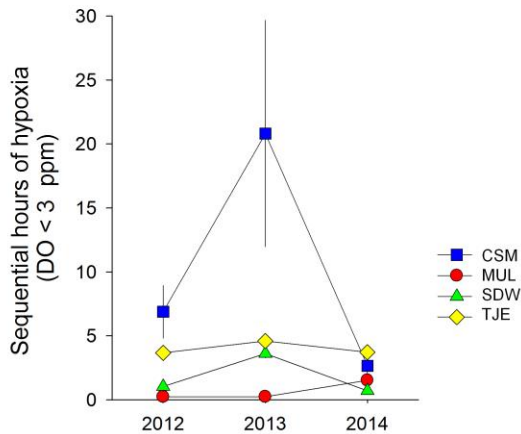
San Dieguito Wetland



Carpinteria Salt Marsh

- Dissolved oxygen concentration (DO) is measured in San Dieguito Wetlands and the reference wetlands using YSI dataloggers.
- A DO value less than 3 mg/l is considered hypoxic and sustained values below 3 are potentially detrimental to estuarine biota.
- Therefore, one approach to assessing DO is to compare the mean number of hours of continuous hypoxia between San Dieguito Wetlands and the reference wetlands.
- If mean number of consecutive hours DO <3 mg/ 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.

Performance Standard: Water Quality (DO) (Mean length of hypoxic events)



- This slide shows the mean number of hours of continuous hypoxia at the San Dieguito Wetlands compared with the 3 reference wetlands.
- Again, this standard is evaluated by comparing values in San Dieguito to the reference wetland with the highest value of sequential hours of hypoxia.
- In 2014, similar to the previous two years, the value for sequential hours of hypoxia at San Dieguito was lower than the reference wetland with the highest values and therefore San Dieguito Wetlands is found to be similar to the reference wetlands for the Water Quality standard.

Performance Standard: 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



- 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 birds requires that 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.

Method of Assessing the Density and Number of Species of Birds

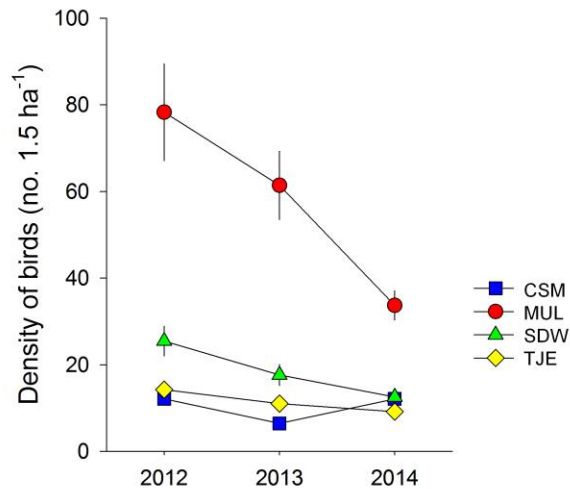
- Birds counted and identified within 20-100 x 150 m plots spread throughout each wetland.
- 5 minutes per plot to standardize sample effort across wetlands.
- Sampling observations made during 3 periods: January-February, April-May, and October-November.
- 6 sampling surveys made in each wetland during each seasonal period.
- Comparison among wetlands based on average of the 18 survey dates using plots as replicates for each wetland.



Bird sampling plots in restored habitat in San Dieguito Wetlands

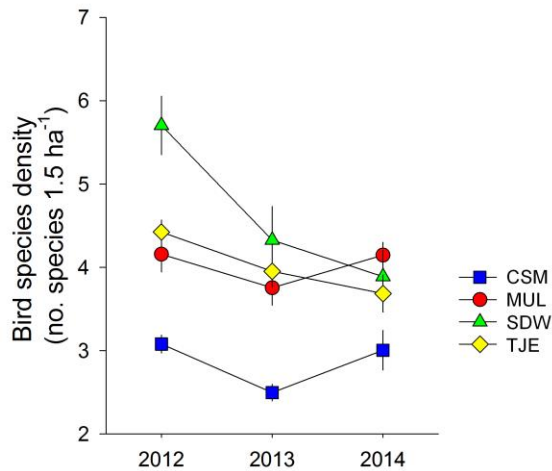
- This slide summarizes the methods used to assess the density and number of species of birds in San Dieguito Wetlands and the reference wetlands.
- Birds are sampled within 20-100 x 150 m plots spread throughout the wetlands.
- Five minutes is spent per plot to standardize sampling effort across wetlands.
- Sampling observations are made during 3 periods: January-February, April-May, and October-November.
- Six sampling surveys are made in each wetland during each seasonal period.
- The comparison among wetlands is based on the average of the 18 survey dates using plots as replicates for each wetland.

Performance Standard: Bird Total Density



- This slide compares bird total density, as mean number per sample plot of 1.5 hectare, in San Dieguito Wetlands to Carpinteria Salt Marsh, Mugu Lagoon and Tijuana Estuary for 2012, 2013, and 2014.
- Mugu Lagoon had the highest bird density the past three years, but bird density in San Dieguito Wetlands was higher than the wetland with the lowest value during this period
- Therefore, bird density in San Dieguito Wetlands was similar to the reference wetlands for the past three years.

Performance Standard: Bird Species Richness



- This slide compares bird species richness, as mean number of species per hectare, in San Dieguito Wetlands to the three reference wetlands.
- San Dieguito Wetlands had higher bird species richness than the lowest performing of the three reference wetlands in 2012, 2013, and 2014.
- Therefore, bird species richness in San Dieguito Wetlands was similar to the reference wetlands for these years.

Performance Standard: 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



- The relative performance standard for fish requires that 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.

Sampling Design for Fish

- San Dieguito Wetlands and the 3 reference wetlands are sampled in the late summer-early fall.
- 6 tidal creeks & 6 sections of main channel/basin are sampled in each wetland.
- The sampled creeks or sections of main channel/basin are treated as replicates.
- Tidal creeks and main channels are assessed separately.



- This slide summarizes the general sampling design fish.
- This general design is also used for macro-invertebrates.
- San Dieguito Wetlands and the 3 reference wetlands are sampled in late summer-fall.
- Six tidal creeks and 6 sections of main channel/basin are sampled in each wetland.
- The creeks or sections of main channel/basin that are sampled are treated as replicates.
- Because tidal creeks and main channels differ in width, water depth, hydrology, and thus the likelihood that they will support different assemblages of fish and macroinvertebrates, tidal creeks and main channels are assessed separately.

Methods of Assessing the Density and Species Richness of Wetland Fish

- Two methods are used: enclosure traps (for gobies) and blocked beach seines (all other species).
- Densities and species richness of fish are calculated for each creek or section of main channel/basin.
- Density and species richness values averaged across the 6 creeks or 6 sections of main channel/basin are used to compare wetlands.

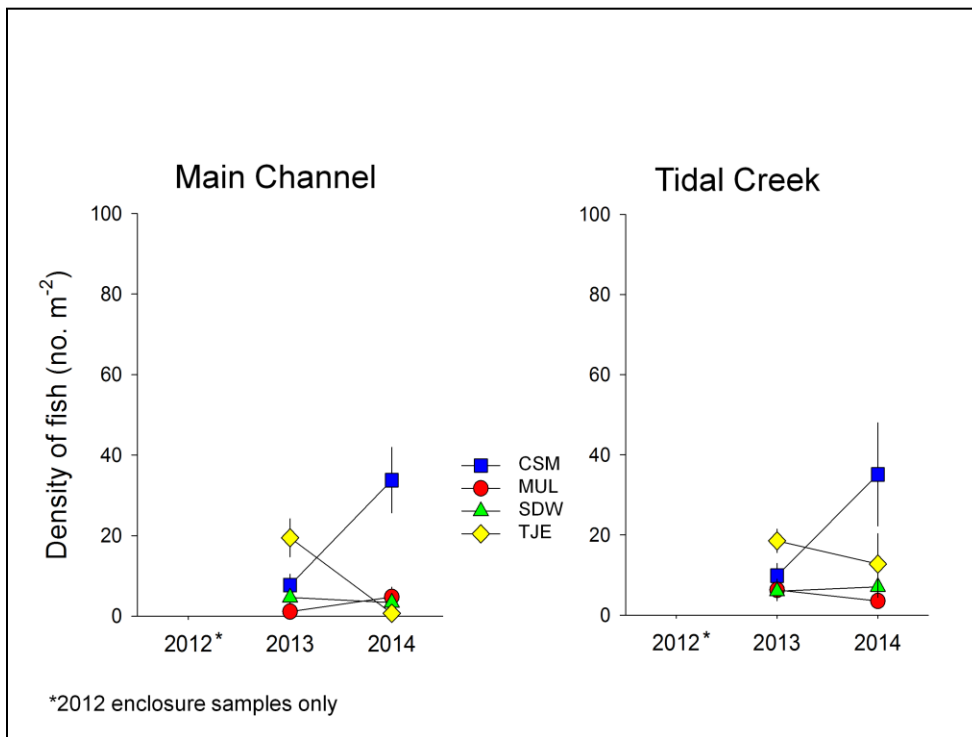
Enclosure traps



Beach seine

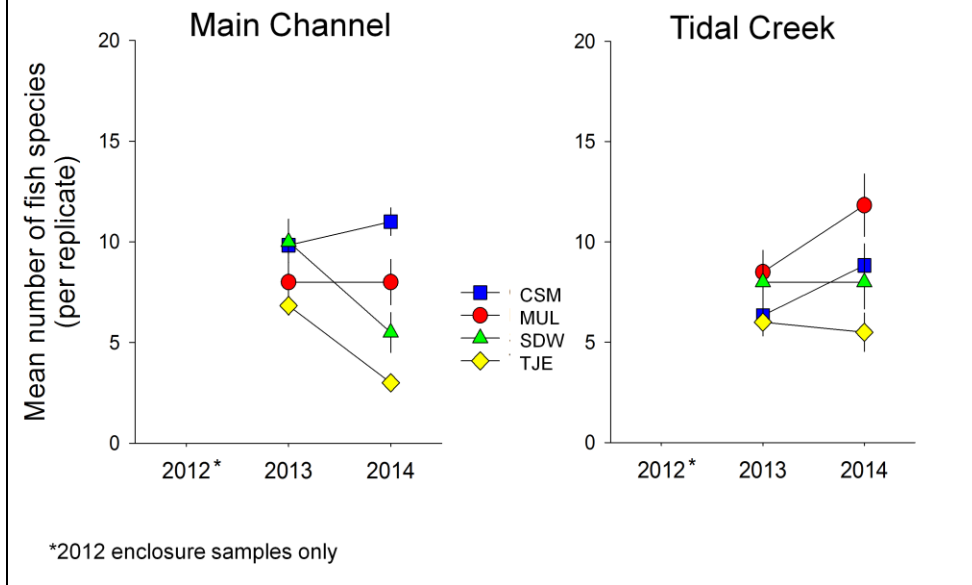


- This slide provides the methods of assessing the density and species richness of wetland fish.
- Two methods are used: enclosure traps (for gobies and other comparably sized fish) and blocked beach seines (larger fish).
- The densities and species richness of fish are computed for each sampled creek or section of main channel/basin.
- These density and species richness values are averaged across the 6 creeks or 6 sections of main channel/basin and used to compare wetlands.



- This slide shows the monitoring results for fish total density as mean number per m².
- Clapper Rail nesting in Tijuana Estuary prevented sampling using seines in 2012 so only data collected using enclosure traps from San Dieguito Wetlands and the reference sites were used to assess the density and species richness of wetland fish in that year.
- These data are not shown here, but the value for San Dieguito Wetlands in main channel and tidal creeks evaluated just using enclosure traps was higher than the lowest performing reference wetland for that year.
- We were able to sample using enclosure traps and seines in Tijuana Estuary in 2013 and 2014.
- For these years, for both main channel and tidal creeks, fish density values in San Dieguito Wetlands were not significantly lower than the lowest reference wetland.
- Therefore, the restored wetland was similar to the reference wetlands for fish total density in both the main channels and tidal creeks.

Performance Standard: Fish Species Richness



- This slide shows the monitoring results for fish species richness, as mean number of species per main channel or tidal creek replicate.
- It is important to note again that we were only able to sample using enclosure traps in 2012 because of Clapper Rail nesting in Tijuana.
- For that reason, the 2012 data are not shown here, but the fish species richness value for San Dieguito Wetlands in main channel and tidal creeks evaluated just using enclosure traps was not significantly lower than the lowest performing reference wetland for that year.
- In 2013 and 2014 for both main channel and tidal creeks, values were also not significantly lower in San Dieguito Wetlands than lowest performing reference wetlands.
- Therefore, the restored wetland was similar to the reference wetlands for fish species richness in both the main channels and tidal creeks in these years.

Performance Standard: Macroinvertebrates

Within 4 years of construction, the total densities and number of species of macroinvertebrates shall be similar to the densities and number of species in similar habitats in the reference wetlands



- The relative performance standard for macroinvertebrates requires that within 4 years of construction, the total densities and number of species of macroinvertebrates shall be similar to the densities and number of species in similar habitats in the reference wetlands.

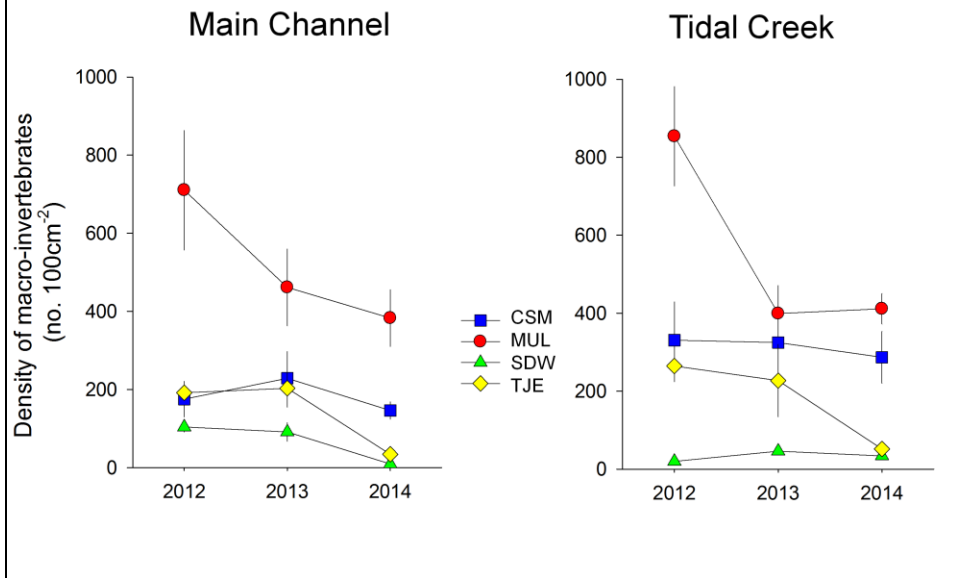
Methods of Assessing the Density and Species Richness of Wetland Macroinvertebrates

- Three sampling methods: small (3.5 cm diameter) and large (10 cm) cores. Epifauna counted in 25 cm x 25 cm quadrats.
- Small core samples screened through 0.5mm mesh; large core samples are screened on a 3 mm mesh.
- Densities and species richness of macro-invertebrates are calculated for each tidal creek or section of main channel/basin.
- Density and species richness values averaged across the 6 creeks or 6 sections of main channel/basin used to compare wetlands.



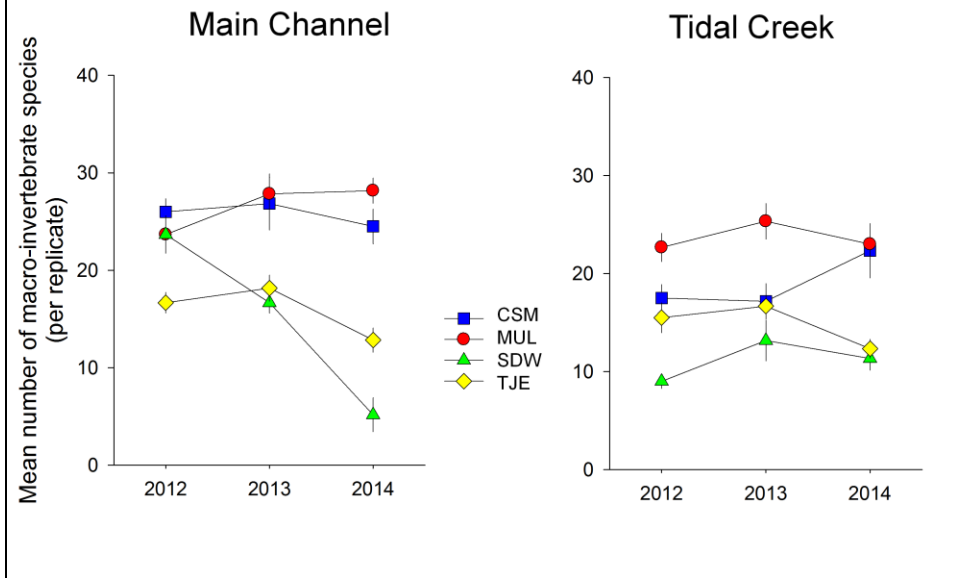
- Three sampling methods are used to sample macroinvertebrates: small (3.5 cm diameter) and large (10 cm diameter) cores are used to sample small and large infauna, respectively. Epifauna also counted in 25 cm x 25 cm quadrats.
- Small core samples screened through 0.5mm mesh; large core samples are screened on a 3mm mesh.
- The densities and species richness of macro-invertebrates are calculated for each creek or section of main channel/basin.
- Density and species richness values are averaged across the 6 creeks or 6 sections of main channel/basin and used to compare wetlands.

Performance Standard: Macro-invertebrate Total Density



- This slide shows the monitoring results for macroinvertebrate total density, as mean number per 100 cm², in main channel and tidal creek.
- The density of invertebrates was lower at San Dieguito than in the lowest performing reference wetland for both main channels and tidal creeks in 2012, 2013, and 2014 thus is not similar to the reference wetlands in these years.

Performance Standard: Macroinvertebrate Species Richness



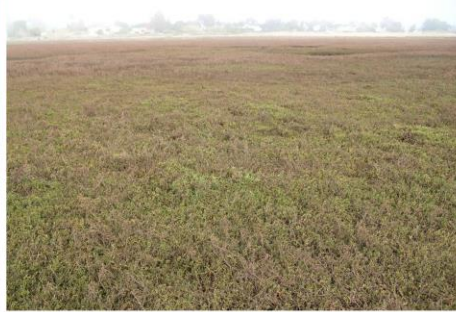
- This slide shows the monitoring results for macroinvertebrate species richness as mean number of species per main channel or tidal creek replicate.
- For main channels, invertebrate species richness in San Dieguito Wetlands was not significantly different than the lowest performing reference wetland in 2012 and 2013, but was lower than the lowest performing reference wetland in 2014.
- For tidal creeks, invertebrate species richness was lower in San Dieguito Wetlands than the lowest performing reference wetland in 2012, 2013, however it was similar to the lowest performing reference wetland in 2014, and therefore met the standard in 2014.

Performance Standard: Vegetation

The proportion of total vegetation cover and open space in the marsh shall be similar to those proportions found in the reference sites. The percent cover of algae shall be similar to the percent cover found in the reference wetlands



San Dieguito Wetlands (W4/16)
March 2014

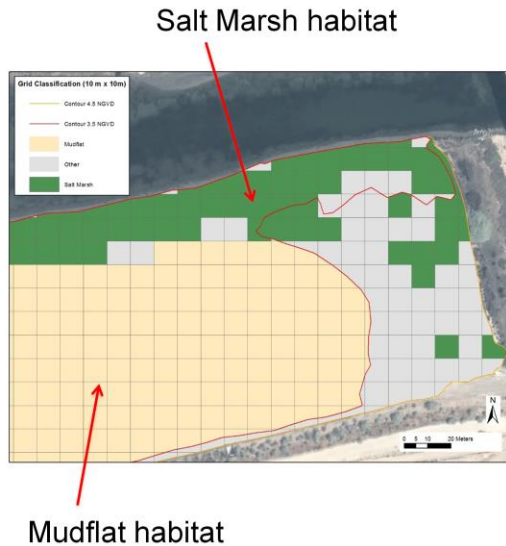


Mugu Lagoon

- The performance standard for vegetation also a relative standard, requires that the proportion of total vegetation cover and open space in the marsh shall be similar to those proportions found in the reference sites. The percent cover of algae shall be similar to the percent cover found in the reference wetlands.

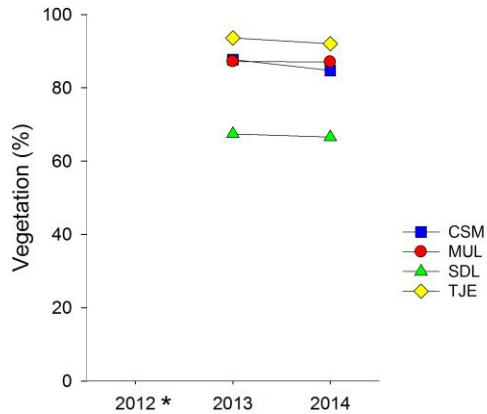
Methods of Assessing the Cover of Vegetation and Algae

- Estimates of percent cover of vegetation and algae made using aerial images taken in late May-early June.
- Wetland wide cover estimates of vegetation and algae are compared among wetlands.



- Estimates of percent cover of vegetation and algae in San Dieguito Wetlands and the reference wetlands were made using aerial imagery taken in the late spring or summer.
- Wetland wide estimates of cover classes are compared between San Dieguito Wetlands and the reference wetlands.
- Cover estimates of vegetation are compared among wetlands in salt marsh habitat, as defined earlier, whereas cover estimates of algae are compared among wetlands across all habitats.

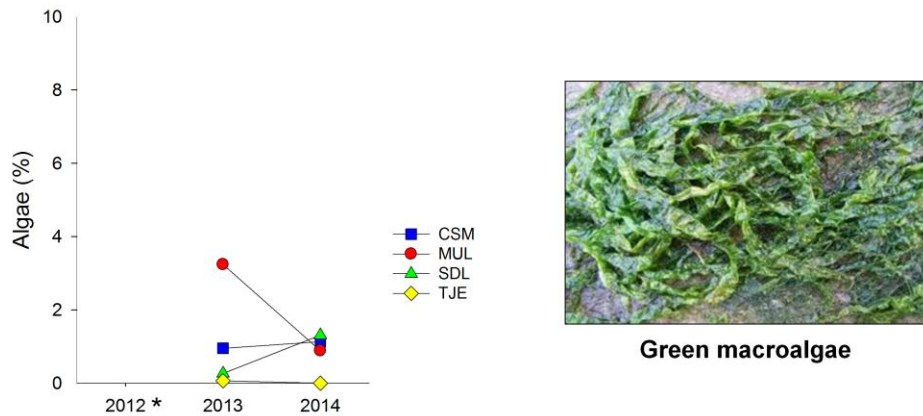
Performance Standard: Vegetation



San Dieguito Wetlands (September 2014)

- This slide compares the cover of vegetation in the San Dieguito Wetlands restoration site to the reference wetlands..
- Cover of vegetation in San Dieguito Wetlands was the lowest of all four wetlands in 2012, 2013 and 2014.
- However, cover of vegetation has increased, which is encouraging.

Performance Standard: Algae



- This slide compares the cover of macroalgae in San Dieguito Wetlands to macroalgal cover in the reference wetlands.
- A high cover of macroalgae can indicate eutrophic conditions or poor tidal circulation and can be detrimental to estuarine health.
- In this case, we evaluate algal cover relative to the reference wetlands with the highest of cover of macroalgae, since excessive cover may be detrimental.
- Macroalgal cover in San Dieguito Wetlands was lower than the value in the reference wetland with the highest cover in 2012, 2013, and 2014 and therefore the restoration project met the requirements of this standard in these years.

Performance Standard: *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



- Spartina was planted throughout the restoration site to provide habitat for the light foot clapper rail and other species.
- The performance standard for Spartina specifies that 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.
- This standard is only evaluated relative to Tijuana Estuary because as mentioned earlier Spartina is absent in Carpinteria Salt Marsh and rare in Mugu Lagoon.

Method of Assessing *Spartina* Canopy Architecture

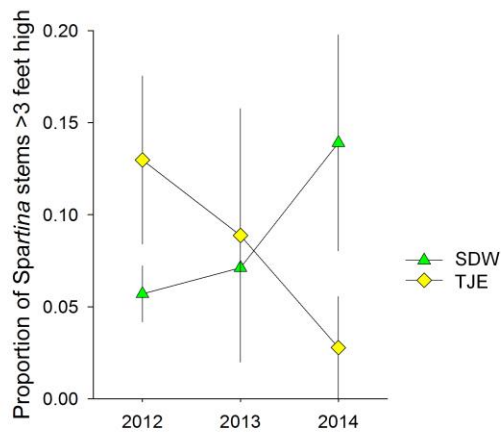
- Four patches of *Spartina* sampled in San Dieguito Wetlands & Tijuana Estuary.
- Maximum heights (excluding flowering stalks) of all stems in 10 0.1 m² quadrats placed in each patch were recorded.
- Mean proportion of stems >3 feet tall, calculated using patches as replicates, is compared between wetlands.



Assessing *Spartina* canopy

- This slide summarizes the method of assessing *Spartina* canopy architecture which is identical to the methods developed by Zedler, 1993 that are currently in use in the Tijuana Estuary.
- Four patches of *Spartina* at least 20 m in extent are sampled in San Dieguito Wetlands and Tijuana Estuary.
- *Spartina* sampled in 0.1 m² quadrats placed every 2 m along a 20 m long transect in each patch.
- Maximum heights (excluding flowering stalks) of all stems present in the quadrat were recorded.
- The mean proportion of stems >3 feet (91 cm) tall, calculated using patches as replicates, is compared between wetlands.

Standard: *Spartina* Canopy Architecture



Patch of *Spartina* in San Dieguito Wetlands

- The mean proportion of stems >3 feet (or 91 cm) tall was significantly lower in San Dieguito Wetlands than in Tijuana Estuary in 2012.
- However, this measure was similar, that is not lower in San Dieguito Wetlands than Tijuana Estuary in 2013 and 2014.

Performance Standard: 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



- Food chain support is one of the more important functions of coastal wetlands.
- This standard specifies that 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.

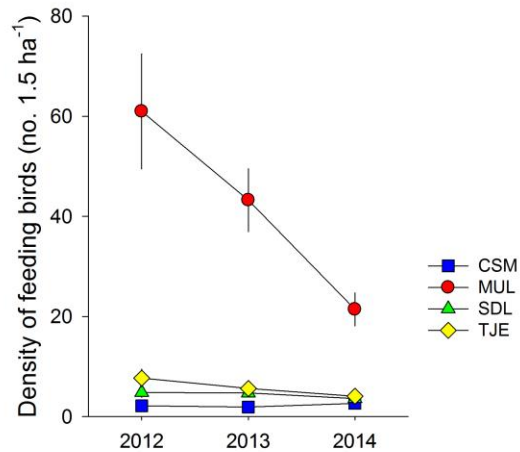
Methods Used to Assess Food Chain Support

- Evaluated at the same that birds are sampled to determine density and species richness.
- Birds recorded as feeding if one feeding attempt is made over five minute time interval.
- Density of feeding birds in each of selected plots consists of average across the 18 survey dates.
- Mean densities of feeding birds in San Dieguito Wetlands are compared to densities at the reference wetlands.



- This standard is evaluated during the period that birds are sampled to determine density and species richness.
- A bird is recorded as feeding if one feeding attempt is made over a five minute time interval.
- The density of feeding birds in each of the selected plots consists of the average across the 18 survey dates.
- Mean densities of feeding birds computed across plots in the restored wetland is compared to that of the reference wetlands.

Performance Standard: Food Chain Support



- This slide shows the feeding activity of birds as mean number of feeding birds per hectare.
- The highest density of feeding birds occurred in Mugu Lagoon in 2012, 2013, and 2014.
- However the density of feeding birds was higher in San Dieguito Wetlands than in Carpinteria Salt Marsh, the lowest performing reference site, and therefore similar to the reference wetlands in all three years.

Summary of Assessment for Absolute Standards

ABSOLUTE STANDARDS	2014
1. Habitat Areas	NO
2. Tidal Prism	YES
3. Topography	YES
4. Plant Reproductive Success	YES
5. Exotic Species	YES
NUMBER OF ABSOLUTE STANDARDS MET	4

The San Dieguito Wetlands Restoration met 4 of the 5 absolute standards in 2014

- To review, this slide shows a summary evaluation of the absolute performance standards.
- The San Dieguito Wetlands Restoration was consistent with 4 of the 5 absolute standards in 2014. The restoration did not meet the requirement of the Habitat Areas standard.

Summary Assessment for Relative Standards 2014

RELATIVE STANDARDS	SDL	TJE	MUL	CSM
1 Water Quality	YES	NO	YES	YES
2 Bird Density	YES	NO	YES	YES
3 Bird Species Richness	YES	YES	YES	NO
4 Fish Density - Main Channels	YES	NO	YES	YES
5 Fish Species Richness - Main Channels	YES	NO	YES	YES
6 Fish Density - Tidal Creeks	YES	YES	NO	YES
7 Fish Species Richness - Tidal Creeks	YES	NO	YES	YES
8 Macro-invertebrate Density - Main Channels	NO	YES	YES	YES
9 Macro-invertebrate Species Richness - Main Channels	NO	YES	YES	YES
10 Macro-invertebrate Density - Tidal Creeks	NO	YES	YES	YES
11 Macro-invertebrate Species Richness - Tidal Creeks	YES	YES	YES	YES
12 Vegetation Cover	NO	YES	YES	YES
13 Algae Cover	NO	YES	YES	YES
14 Food Chain Support - Bird Feeding	YES	YES	YES	NO
15 Spartina Canopy Architecture *	YES	NO		
PROPORTION OF RELATIVE STANDARDS MET	0.67 (10/15)	0.60 (9/15)	0.93 (13/14)	0.86 (12/14)

**The San Dieguito Wetlands Restoration received a higher a proportion of “YES”
than the lowest performing reference wetland (TJE) in 2014**

- This table provides a summary assessment of the relative performance standards for 2014.
- “Yes” indicates that values at a particular wetland are similar to the other wetlands
- Mugu Lagoon and Carpinteria Salt Marsh were the best performing wetlands with a higher proportion of standards met than in the other two wetlands.
- San Dieguito Wetlands received a higher proportion of “YES” than Tijuana Estuary, the reference site with the lowest proportion of “YES”, which is very encouraging given that this is the third year of monitoring.
- Relative standards in San Dieguito that we will continue to watch closely include macro-invertebrate density and species richness, and development of vegetation cover.