San Dieguito Wetland Restoration Project: First Year Progress Report

2012 Monitoring Results

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

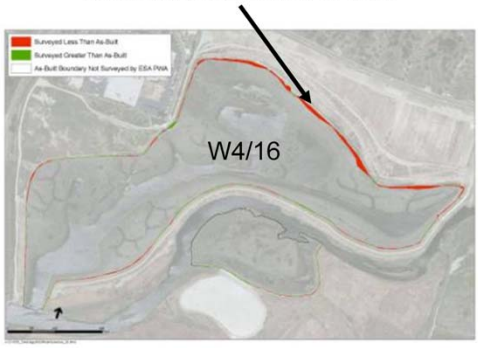
This presentation focuses on:

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

Wetland Acreage

- **Mitigation requirement is to create 115 acres of tidal wetland.**
- **As-built acreage of module W4/16 was measured in November 2008.**
- **Erosion and sediment deposition occurred in the wet year of 2011 along northern boundary of W16.**
- **Sediment deposition elevated the marsh plain above tidal influence, reducing the acreage of restored tidal wetland to 114.5 acres.**

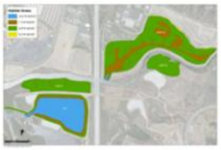
Area of deposition of eroded sediment indicated in red.



- As-built acreage of module W4/16 was determined in November 2008.
- However, significant erosion and sediment deposition occurred in the wet year of 2011 along northern boundary of W16.
- Sediment deposition elevated the marsh plain above tidal influence reducing the acreage of restored tidal habitat by 0.9 acres.
- CCC staff have determined that this loss of tidal acreage is significant and that the erosion and deposition resulting in this loss constitutes major topographic degradation.

Types of Performance Standards

Physical Performance Standards



Pertain to topography, water quality, tidal prism, and wetland habitat areas.

Biological Performance Standards

Pertain to the abundance, diversity and ecological function of the biological wetland community including birds, fish, invertebrates and plants.

- Physical and biological standards provided in the SONGS permit are used to evaluate the performance of the San Dieguito Wetland Restoration Project.
- Physical performance standards pertain to topography, water quality, tidal prism, and wetland habitat areas.
- Biological performance standards pertain to the abundance, diversity and ecological function of the wetland community, including birds, fish, invertebrates, and plants.

Types of Performance Standards

1. **Absolute Standards: Measured against a fixed value and only in the San Dieguito Wetland.**

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

Requirement

Beginning in year 4 following completion of construction, the San Dieguito Wetland Restoration must meet each absolute performance standard for that year to count towards mitigation credit.

- Two types of physical and biological standards are used to assess the performance of the restoration project.
- The first, absolute standards, are measured against a fixed value and evaluated only in San Dieguito Lagoon. For example, the area of wetland habitats shall not vary by more than 10%.
- The San Dieguito Wetland Restoration must meet each absolute performance standard in a given year from year four on for that year to count towards mitigation credit.

Types of Performance Standards

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

(e.g., the abundance and number of species of birds)

RATIONALE: To be successful, the San Dieguito Wetland Restoration must provide resource values *similar* to those of natural wetlands in the region.

- The second type are relative standards, evaluated against natural wetlands in the region that are used as a reference sites. For example, the abundance and number of species of birds must be similar to that of natural wetlands.
- The rationale behind relative standards is that, the San Dieguito Wetland restoration must provide resource values *similar* to those of natural wetlands in the region.

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.

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

Definition: **The mean value for a relative performance standard at San Dieguito Wetland must be *equal to* or *better than* the mean value for the lowest performing reference wetland for that standard.**

- The SONGS Coastal Development Permit envisioned a quantitative definition of "similar" for evaluating the performance of 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 Wetland 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 Wetland should perform at least as well as the lowest performing natural wetland used as a reference site.

Performance Standards for the San Dieguito Wetland Restoration Project

1. Water Quality
2. Tidal Prism*
3. Habitat Areas*
4. Topography*
5. Fish density (channel / creek)
6. Fish species richness (channel / creek)
7. Macroinvertebrate density (channel / creek)
8. Macroinvertebrate species richness (channel / creek)
9. Bird density
10. Bird species richness
11. Vegetation
12. Algae
13. *Spartina* canopy architecture**
14. Reproductive success*
15. Food chain support
16. Exotics*

* Absolute standard

** Evaluated relative to Tijuana Estuary only

- Shown here are the performance standards used to evaluate the success of the San Dieguito Wetland Restoration Project.
- Absolute standards are shown in green and relative standards are shown in black.
- 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 extremely rare in Mugu Lagoon.
- What follows is a summary of the monitoring results as they pertain to each of these standards for 2012.

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 is a relative standard and specifies that water quality variables in the San Dieguito Wetland 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.
- As a result of it's importance to estuarine health, dissolved oxygen concentration is water quality variable used to evaluate this standard.
- As mentioned earlier, dissolved oxygen concentration is very sensitive to inlet closure.

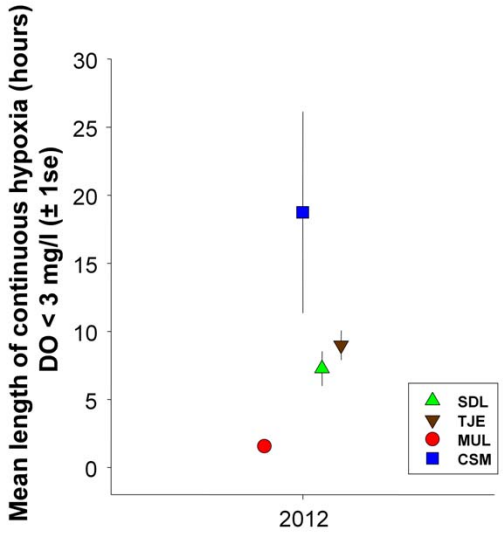
Method of Assessing Dissolved Oxygen (DO) Concentration

- **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

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

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



- This slide shows the mean length in hours of continuous hypoxia at the San Dieguito Wetland compared with the 3 reference wetlands
- The mean at San Dieguito is higher than Mugu Lagoon, but lower than Tijuana Estuary and Carpinteria Salt Marsh.
- Since water quality at the San Dieguito wetland falls within the range of values seen at the natural reference wetlands it is found to be similar to the reference sites.

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

Habitat elevational boundaries (from Restoration Plan):

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

Vegetated salt marsh inundated at high tide at SDL

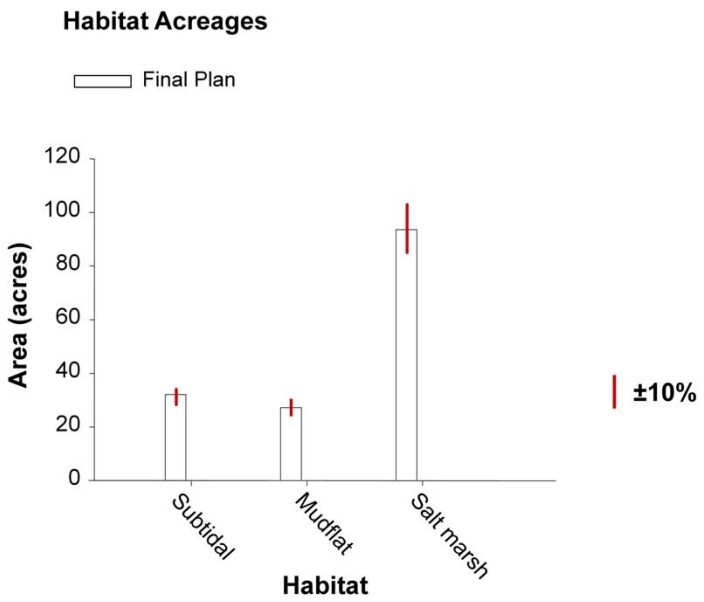
- The Habitat Areas standard is fixed and applied only to the San Dieguito Wetland restoration.
- This standard specifies that the areas (as acres) of the of the different habitats shall not vary by more than 10% from the areas indicated in the final restoration plan.
- This performance standard is designed to guard against large scale conversions of one habitat 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) and the elevational boundaries that delineate those habitats as provided in the Final Plan for the restoration project.

Methods of Assessing Habitat Areas

- **Surveys were conducted by us to determine acreages of the three constructed wetland habitats types (salt marsh, mudflat, and subtidal) in 2012.**
- **These measures were compared to the "as-built" acreages to determine whether they were within 10% of the acreages in the Final Plan.**

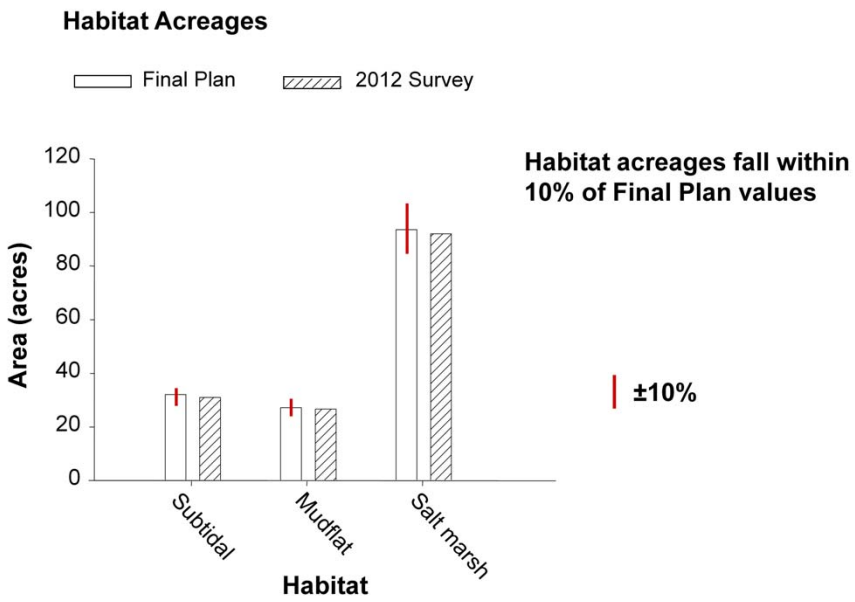
- Surveys were conducted to determine acreages of the three constructed wetland habitats types (salt marsh, mudflat, and subtidal) in 2012.
- These measures were compared to the "as-built" acreages to determine whether they were within 10% of the acreages in the Final Plan.

Performance Standard: Habitat Areas



- In this figure, the open bars indicate acreages for subtidal, mudflat and salt marsh habitats provided in the Final Plan
- The red lines indicate ±10% of the planned acreage.

Performance Standard: Habitat Areas



- The hashed bars indicate the acreages determined from the independent 2012 survey.
- The areas based on the 2012 surveys are within ± 10% of the planned acreage
- As a result, changes in habitat areas in 2012 were within the levels specified by the permit.

Performance Standard: Tidal Prism

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

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

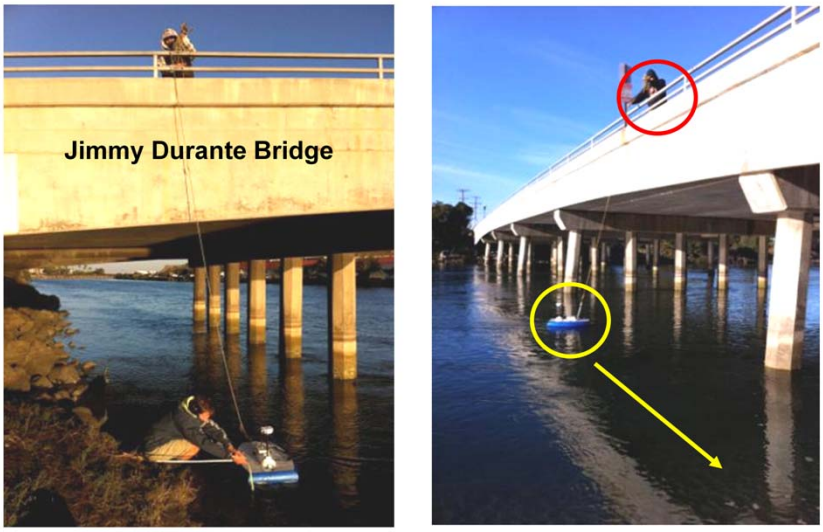
Why measure it? Metric of tidal flushing, inundation of marsh habitat, and inlet stability.

W4/16 – low tide

W4/16 – high tide

- Tidal prism is an absolute standard, evaluated only within the San Dieguito Wetland 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

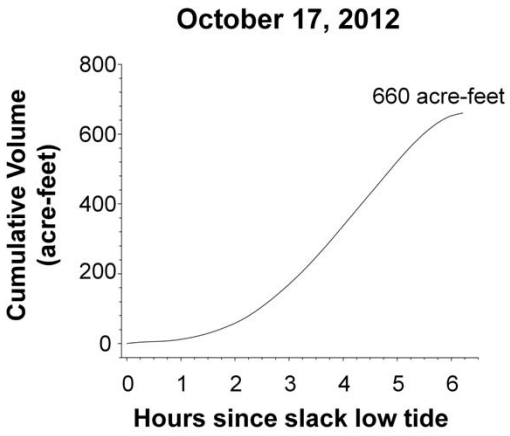


River Surveyor--Acoustic Doppler Current Profiler (ADCP)

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

Method of Assessing Tidal Prism

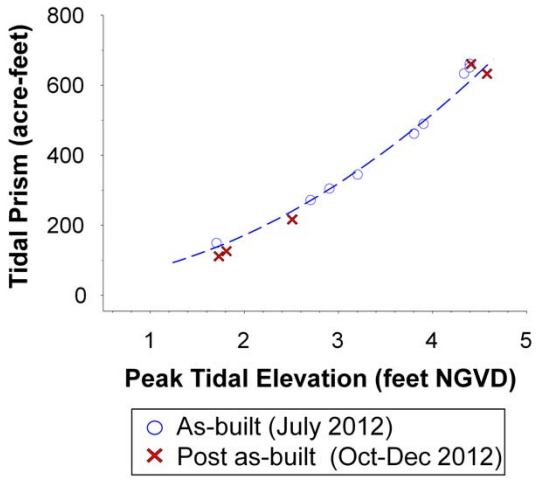
- **Measurements of flow volume are taken every 15 minutes during an incoming tide using the River Surveyor.**
- **Flow volume values are cumulated over the entire incoming tide to give to estimate prism.**



- 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 give to estimate prism.

Performance Standard: Tidal Prism

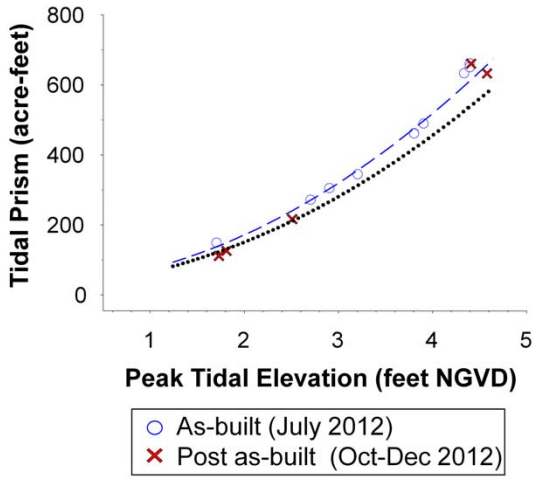
- **Tidal prism is plotted against the maximum high tide and evaluated against an "as-built" prism, which was assessed in July 2012 over a range of high tides.**



- The tidal prism, measured during monitoring, indicated by the red crosses, was plotted against the maximum high tide during the period of measurement and evaluated against the "as-built" prism, shown by the blue circles, which was assessed over a range of high tides in July 2012.

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 not be less than the dotted line to ensure no more than a 10% shift in tidally inundated salt marsh habitat.**



- The measured prism must be not fall below the dotted line to ensure that there is no more than a 10% shift in tidally inundated salt marsh habitat.
- The post as-built measurements of tidal prism are on or above the dotted line, indicating that the tidal prism at the San Dieguito Wetland was maintained in 2012.

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 a fixed performance standard.
- The standard for topography requires that the wetland not undergo major topographic degradation, such as excessive erosion or sedimentation.
- Some erosion has occurred in the upland bordering the wetland.

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.**
- **Results indicate that expected functions of the wetland were not affected by excessive erosion or sedimentation.**

Surveying elevations in the San Dieguito Wetland

- The intent of the topography standard is to ensure that the as-built acreage of restored tidal wetland is maintained.
- Survey data collected to assess Habitat Areas is used to determine whether the topography standard is met.

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.

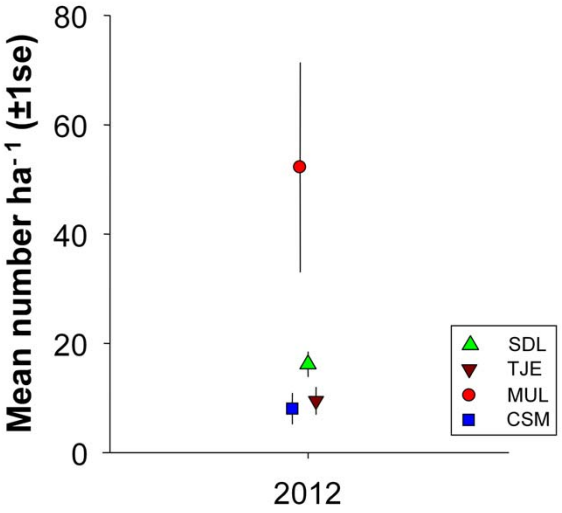
Method of Assessing the Density and Number of Species of Birds

- **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 constructed habitat in SDL

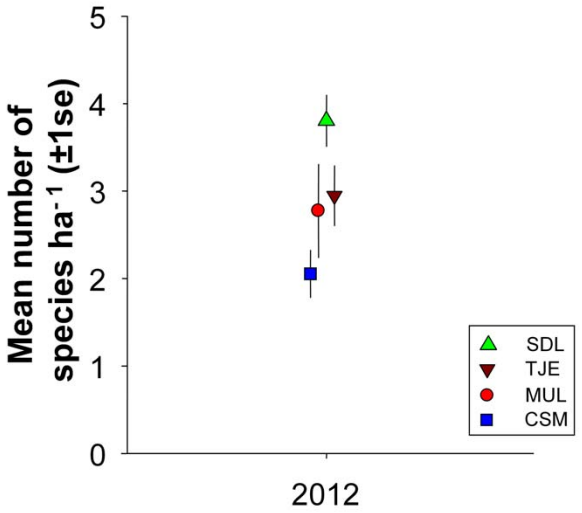
- This slide summarizes the methods used to assess the density and number of species of birds in San Dieguito Wetland and the reference wetlands:
- Birds are sampled within 20-100 x 150 m plots spread throughout the wetlands.
- Five minutes is spent per plot to standardize sampling effort across wetlands.
- 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 hectare, in San Dieguito Wetland to Tijuana Estuary, Mugu Lagoon, and Carpinteria Salt Marsh.
- Mugu Lagoon had the highest bird density, but bird density in SDL was higher than both Tijuana Estuary and Carpinteria Salt Marsh.

Performance Standard: Bird Species Richness



- This slide compares bird species richness, as mean number of species per hectare, in San Dieguito Wetland to the three reference wetlands.
- San Dieguito Lagoon had the highest bird species richness of the four wetlands.

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

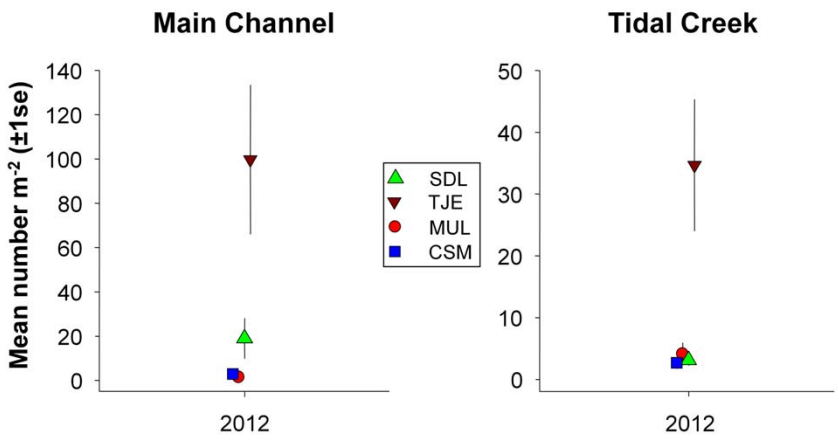
- This slide summarizes the general sampling design fish.
- This design was also used for macroinvertebrates.
- San Dieguito Wetland and the 3 reference wetlands are sampled in the summer.
- Six tidal creeks and 6 sections of main channel/basin are sampled in each wetland.
- The creeks or sections of 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 likehood 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 estimated 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 and are used to compare wetlands.**

- This slide provides the 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).
- The densities and species richness of fish for each creek or section of main channel/basin sampled is computed.
- Density and species density values averaged across the 6 creeks or 6 sections of main channel/basin are used to compare wetlands.
- Clapper Rail nesting in Tijuana Estuary prevented sampling using seines so only data collected using enclosure traps from San Dieguito Wetland and the reference sites were used to assess the density and species richness of wetland fish in 2012.

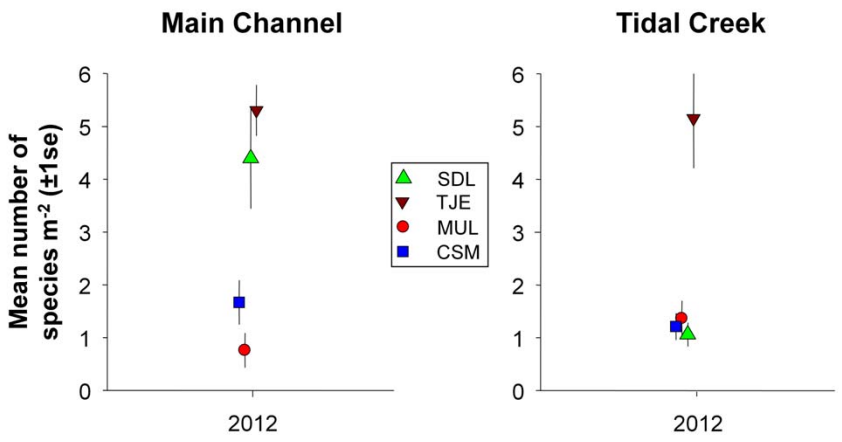
Performance Standard: Fish Total Density



- The slide shows the monitoring results for fish total density as mean number per m2, in the sections of main channel or basin and tidal creeks.
- For main channels, fish density was higher in San Dieguito Wetland than in Carpinteria Salt Marsh or Mugu Lagoon.
- For tidal creeks, fish density was higher in San Dieguito Wetland compared with Carpintera Salt Marsh.

.

Performance Standard: Fish Species Richness



- The slide shows the monitoring results for fish species richness, as mean number of species per m2, in main Channel and tidal Creek.
- For main channels, fish species richness was higher in San Dieguito compared with Carpinteria Salt Marsh and Mugu Lagoon.
- For tidal creeks, fish species richness was similar in San Dieguito Wetland compared with Carpintera Salt Marsh.
- Therefore, the restored wetland is similar to the reference wetlands for fish species richness in both the main channels and tidal creeks.

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

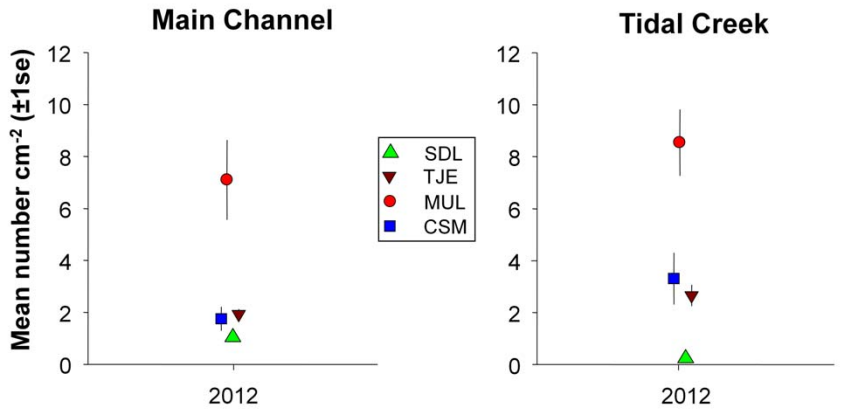
- The relative performance standard for macroinvertebrates requires that within 4 years of construction, the total densities and number of species of macroinvertebrates shall be similar to the densities and number of species in similar habitats in the reference wetlands.

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 3mm mesh.**
- **Densities and species richness of macroinvertebrates for each creek or section of main channel/basin are calculated.**
- **Density and species richness values averaged across the 6 creeks or 6 sections of main channel/basin are used to compare wetlands.**

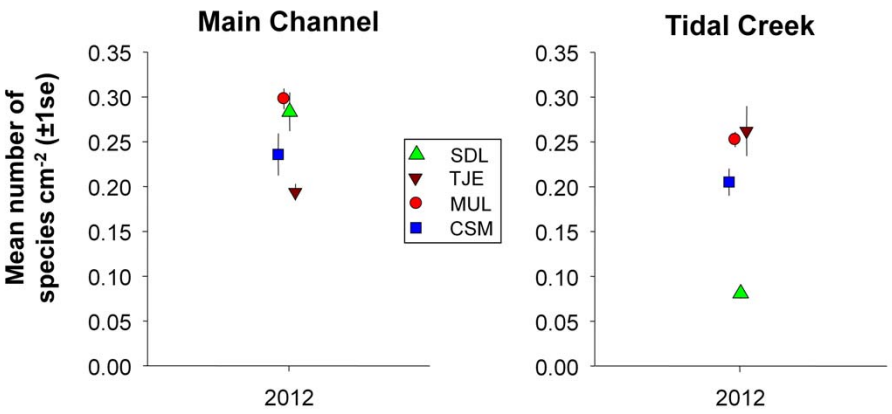
- Three sampling methods: small (3.5 cm diameter) and large (10 cm diameter) cores. Epifauna counted in 50 cm x 50 cm quadrats.
- Small core samples screened through 0.5mm mesh; large core samples are screened on a 3mm mesh.
- Densities and species richness of macroinvertebrates for each creek or section of main channel/basin are calculated.
- Density and species richness values averaged across the 6 creeks or 6 sections of main channel/basin are used to compare wetlands.

Performance Standard: Macroinvertebrate Total Density



- The slide shows the monitoring results for macroinvertebrate total density, as mean number per cm2, in main Channel and tidal Creek.
- The density of invertebrates was lower at San Dieguito than in the lowest performing reference wetlands, Carpinteria Salt Marsh and Tijuana Estuary for both main channels and tidal creeks and thus is not similar to the reference wetlands in 2012.

Performance Standard: Macroinvertebrate Species Richness



- The slide shows the monitoring results for macroinvertebrate species richness , as mean number of species per cm2, in Main Channel and Tidal Creek.
- For main channels, invertebrate species richness in San Dieguito Wetland was higher than in Tijuana Estuary and Carpinteria Salt Marsh.
- For tidal creeks, invertebrate species richness was lower in San Dieguito Wetland than in Carpintera Salt Marsh.
- As a result, invertebrate species richness in the San Dieguito Wetland was similar to the reference wetlands in 2012 but invertebrate species richness in the tidal creeks was not.

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

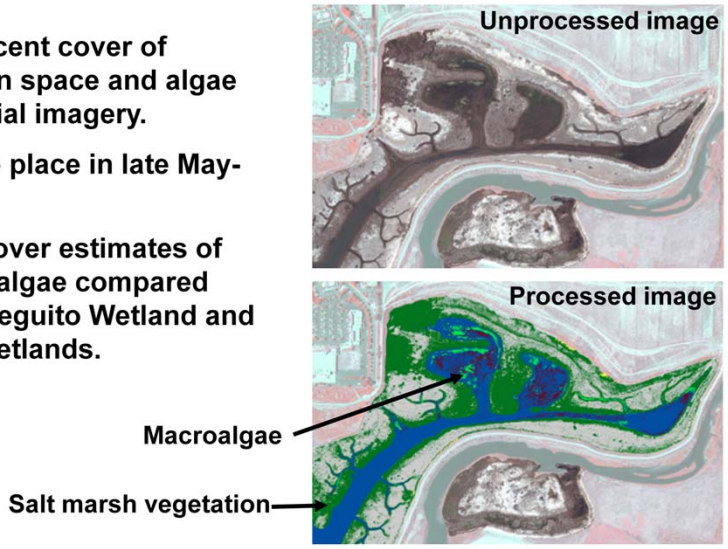
San Dieguito Wetland (W2/3)

Mugu Lagoon

- The performance standard for vegetation is a relative standard, and 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.

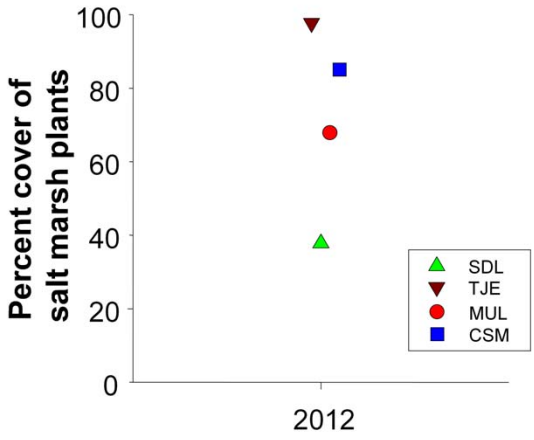
Methods of Assessing the Cover of Vegetation, Open Space and Algae

- **Estimate of percent cover of vegetation, open space and algae made using aerial imagery.**
- **Overflights take place in late May-early June.**
- **Wetland wide cover estimates of vegetation and algae compared between San Dieguito Wetland and the reference wetlands.**



- Estimates of percent cover of vegetation and algae in San Dieguito Wetland and the reference wetlands were made using aerial imagery.
- Overflights take place in late May-early June.
- Wetland wide estimates of cover classes are compared between San Dieguito Wetland and the reference wetlands.

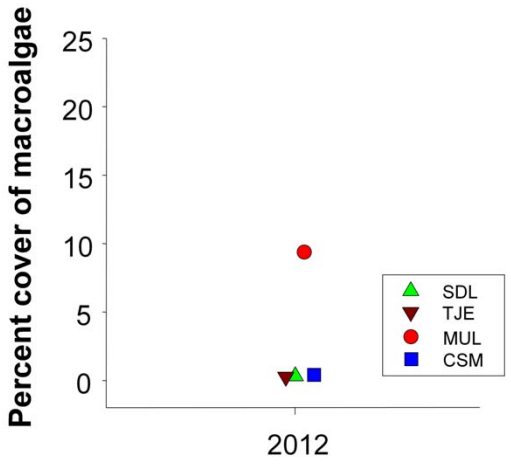
Performance Standard: Vegetation



San Dieguito Wetland (W2/3)

- This slide compares the cover of vegetation in the San Dieguito Wetland restoration site to the references wetlands.
- Cover of vegetation in San Dieguito Wetland was the lowest of all four wetlands, and about 30% lower than at Mugu Lagoon, the reference site with the lowest cover.
- As indicated in the overview talk, this was due in large part to the poor establishment of vegetation at higher marsh elevations.

Performance Standard: Algae



Green macroalgae

- This slide compares the cover of macroalgae in San Dieguito Wetland, as estimated using aerial imagery, 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.
- Macroalgal cover in San Dieguito Wetland was similar to values in Tijuana Estuary and Carpinteria Salt Marsh.

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 uncommon in Mugu Wetland.

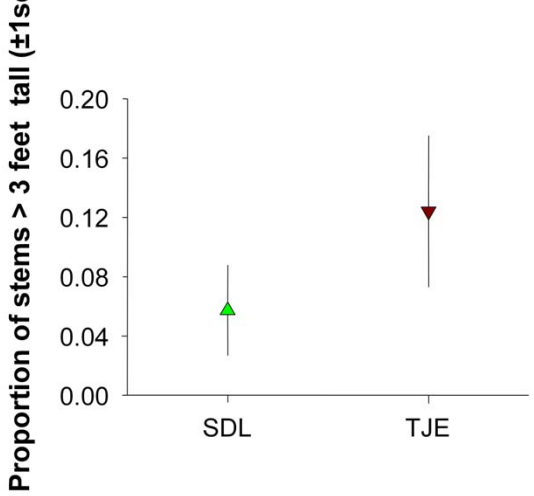
Method of Assessing *Spartina* Canopy Architecture

- **Four patches of *Spartina* sampled in San Dieguito Wetland & Tijuana Estuary.**
- **Maximum heights (excluding flowering stalks) of all stems in 10 0.1 m^2 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 in SDL

- This slide summarizes the method of assessing Spartina canopy architecture which were identical to the methods developed by Zedler, 1993 and are currently in use in the Tijuana Estuary.
- Four patches of *Spartina* are sampled in San Dieguito Wetland and Tijuana Estuary.
- *Spartina* sampled in 0.1 m2 quaddrats 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



Patches of *Spartina* in SDL

- The mean proportion of stems >3 feet (or 91 cm) tall is significantly lower in San Dieguito Wetland than in Tijuana Estuary.
- The growth of Spartina in the restoration site is encouraging.

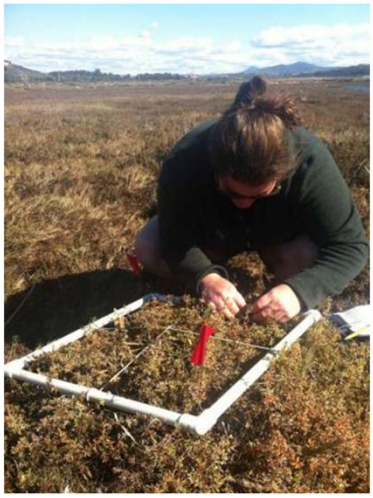
Performance Standard: Reproductive Success

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 is an absolute standard that is evaluated only in San Dieguito Wetland.
- It requires that certain plant species, as specified in the work program, shall 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, Pickle weed, Salty Susan, Spiney Rush, and Sea Lavender. The seventh species is Parrish's Glasswort, widely distributed in mid to high intertidal salt marsh.
- These are the most common plant species in San Dieguito Wetland and span a tidal range from low to high.

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 sampling stations 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 inspected of 7 common species at sites through SDL for the setting of seed in summer-fall when seed set is greatest.
- 10 sampling stations per plant species distributed throughout the wetland.
- Seed set identified from a subsample of mature flowers of each species.

Performance Standard: Reproductive Success

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

- All 7 species produced seed in 2012.

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

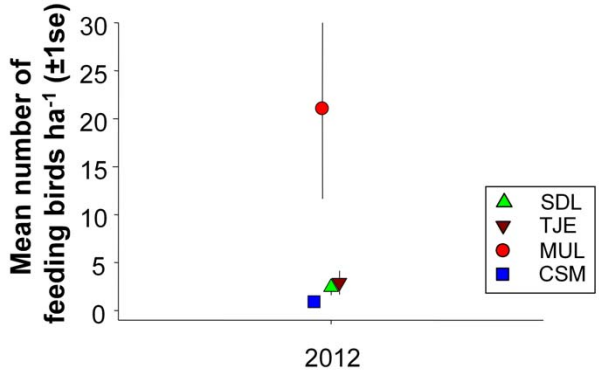
- Food chain support is one of the more important functions of coastal wetlands.
- This standard specifies that the food chain support provided to birds shall be similar to that provided by the reference sites, as determined by feeding activity of the birds.

Methods Used to Assess Food Chain Support

- **Data collected in the same plots 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 the selected plots consists of average across the 18 survey dates.**
- **Mean densities of feeding birds in San Dieguito Wetland 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 Wetland.
- However the density of feeding birds was higher in San Dieguito Wetland than in Carpinteria Salt Marsh.
- Therefore, the restored wetland is on track to meet the standard for food chain support.

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 final performance standard is an absolute standard that 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.
- For example, the Asian mussel can occur in dense mats that exclude native benthic organisms.
- This boring isopod burrows into channel banks and at high densities can enhance bank erosion.

Methods used to Assess Exotics

- **Monitoring data for fish, invertebrates, birds and vegetation are evaluated relative to this standard.**
- **If standards for fish, invertebrates, birds or vegetation are not met, surveys will be done to determine if exotic species are responsible.**
- **To adaptatively manage for exotic species, a special survey that covers as much of the wetland as possible that looks for exotic species is conducted once per year.**

- To assess whether exotic species are impairing wetland function, the monitoring data for fish, invertebrates, birds and vegetation are evaluated relative to this standard.
- If standards for fish, invertebrates, birds or vegetation are not met, surveys will be done to determine if exotic species are responsible.
- To adaptatively manage for exotic species, a special survey that covers as much of the wetland as possible that looks for exotic species is conducted once per year.

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 Wetland

- Although some performance standards for macroinvertebrates were not met, there was no evidence from our sampling or the special survey that exotic species were responsible. Densities of exotic species were very low.

Summary of Assessment for Absolute Standards

	Absolute Standards	SDL 2012
1	Habitat Areas	YES*
2	Tidal Prism	YES
3	Topography	YES
4	Plant Reproductive Success	YES
5	Exotic Species	YES
	Total YES	5

The San Dieguito Wetland Restoration is on track to meet all absolute standards

**Based on elevations indicated in the Final Restoration Plan*

- This slide shows a summary evaluation of the absolute performance standards.
- The San Dieguito Wetland Restoration was consistent with all 5 absolute standards in 2012.
- The results for the absolute standards are encouraging.

Summary of Assessment for Relative Standards

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

The San Dieguito Wetland Restoration did not receive as many "YES" as the lowest performing reference wetlands (MUL or CSM)

- This table provides a summary assessment of the relative performance standards for 2012.
- "Yes" indicates that values at a particular wetland are similar to in the other wetlands
- The Tijuana Estuary was the best performing wetland with 15 standards that were as good or better than those in the other three wetlands.
- Mugu Wetland and the Carpinteria Salt Marsh performed equally well, meeting 12 standards, two more than were met at the San Dieguito Wetland Restoration.
- Given that this is the first year after completion of construction, these results are encouraging.
- Standards in San Dieguito that we will be watching closely in the next three years include topography, macro-invertebrate density and species richness, and development of vegetation cover at high elevations.