Introduction and Overview

Annual Review Workshop for SONGS Wetland Mitigation

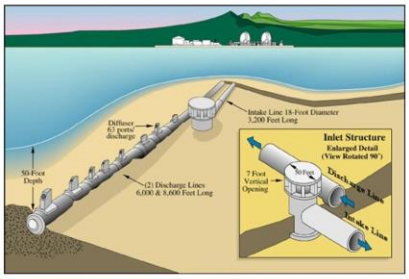
May 11, 2015

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

Wetland Mitigation Linked to the Adverse Effects of the SONGS Cooling Water System

(San Onofre Nuclear Generating Station = SONGS)

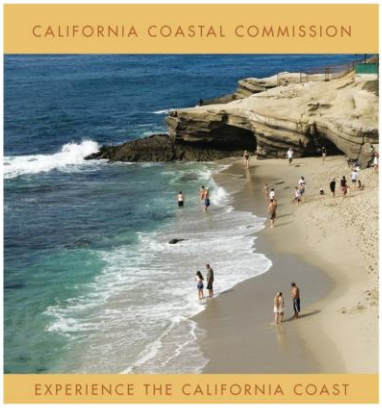
- **SONGS reactors were cooled by a single pass seawater system.**
- **Units 2 and 3 have separate intake lines located in about 30 feet of water offshore of the power plant.**
- **Power plant heated cooling water and turbulence kills fish eggs, larvae and small immature fish.**
- **SONGS operations projected to cause substantial reductions in populations of adult nearshore fish in the Southern California Bight.**



- Some background is important for understanding the purpose and rationale for the SONGS wetland mitigation project.
- The SONGS reactors were cooled by a single pass seawater system.
- Units 2 and 3 have separate intake lines that are located in about 30 feet of water offshore of the power plant
- When operational, the water was elevated 19 deg F above ambient in the plant and then discharged through an extensive diffuser system designed to dissipate the heat.
- Power plant heated cooling water was found to kill fish eggs, larvae and small immature fish; these losses were projected to cause substantial reductions in populations of adult fish in the Southern California Bight.
- Construction of Units 2 and 3 was found to be consistent with the Coastal Act only if these significant adverse impacts to fish would be mitigated.

The California Coastal Act Requires Mitigation of SONGS Marine Impacts

California Coastal Commission (CCC) responsible for implementing the Coastal Act



As mitigation for the impacts to larval and juvenile fish caused by SONGS the CCC required SCE to:

- **Create or substantially restore a minimum of 150 acres of wetlands, excluding buffer zone and upland transition area.**
- **Provide funding for scientific oversight and monitoring of the restoration project that is *independent* of SCE.**

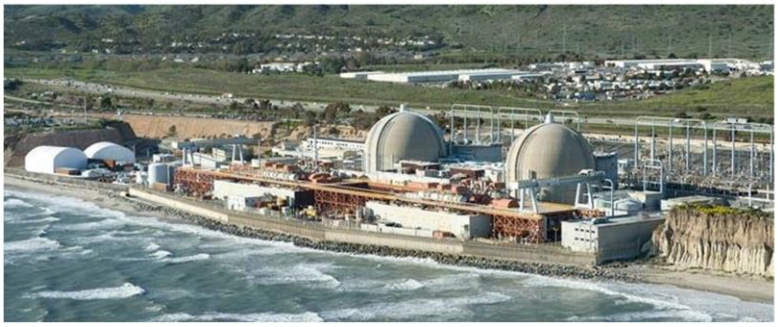
- The California Coastal Act requires the mitigation of SONGS marine impacts.
- Enforcement of the Coastal Act resides with the California Coastal Commission (CCC).
- As mitigation for the impacts to larval and juvenile fish caused by SONGS the CCC required SCE to:
  - -Create or substantially restore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

Key Elements of the SONGS Wetland Mitigation Project

- **Out-of-kind compensation for in-plant losses of larval and juvenile fish caused by the operation of SONGS Units 2 & 3.**
- **Physical and biological standards were established to evaluate the performance of the wetland restoration project.**
- **One year of mitigation credit is given for each year that the San Dieguito Wetlands Restoration Project meets the performance standards.**
- **Fulfillment of the SONGS wetland mitigation requirement occurs when the number of years of mitigation credit accrued by the San Dieguito Wetlands Restoration Project equals the total years of operation of SONGS Units 2 & 3, including the decommissioning period to the extent that there is continuing discharge of cooling water.**

- To summarize key elements of the SONGS Wetland Mitigation Project:
- The mitigation project is out-of-kind compensation for in-plant losses of larval and juvenile fish caused by the operation of SONGS Units 2 & 3.
- Physical and biological standards were established to evaluate the performance of the wetland restoration project to ensure that the restored wetland provides ecosystem functions that are similar to relatively undisturbed tidal wetlands in the region.
- One year of mitigation credit is given for each year that the San Dieguito Wetlands Restoration Project meets the performance standards.
- Fulfillment of the SONGS wetland mitigation requirement occurs when the number of years of mitigation credit accrued by the San Dieguito Wetlands Restoration Project equals the total years of operation of SONGS Units 2 & 3, including the decommissioning period to the extent that there is continuing discharge of cooling water.
- Independent monitoring of project performance is done by university scientists from UCSB who report to the CCC and not SCE.

SONGS Units 2 & 3 Operating Conditions



January 2012: Operations suspended

June 2013: Permanently ceased power operations

July 2013: Transfer of fuel to spent fuel pool

Operating license modified

- No operation of reactors
- No fuel in reactors
- "Possession Only" license

www.songscommunity.com

- Operations of SONGS Units 2 and 3 were suspended in January 2012 due to premature wear of replacement steam generators.
- SCE decided to permanently cease power operations in June 2013
- SCE's operating license has been modified to "possession only" and they are no longer authorized to operate the reactors

SONGS Units 2 & 3 Intake Flows

Full Operational Flow

- 1287 Million Gallons per Day (MPD) per unit = 2574 MGD total
- Represents total allowable flows

Current Offline Flow

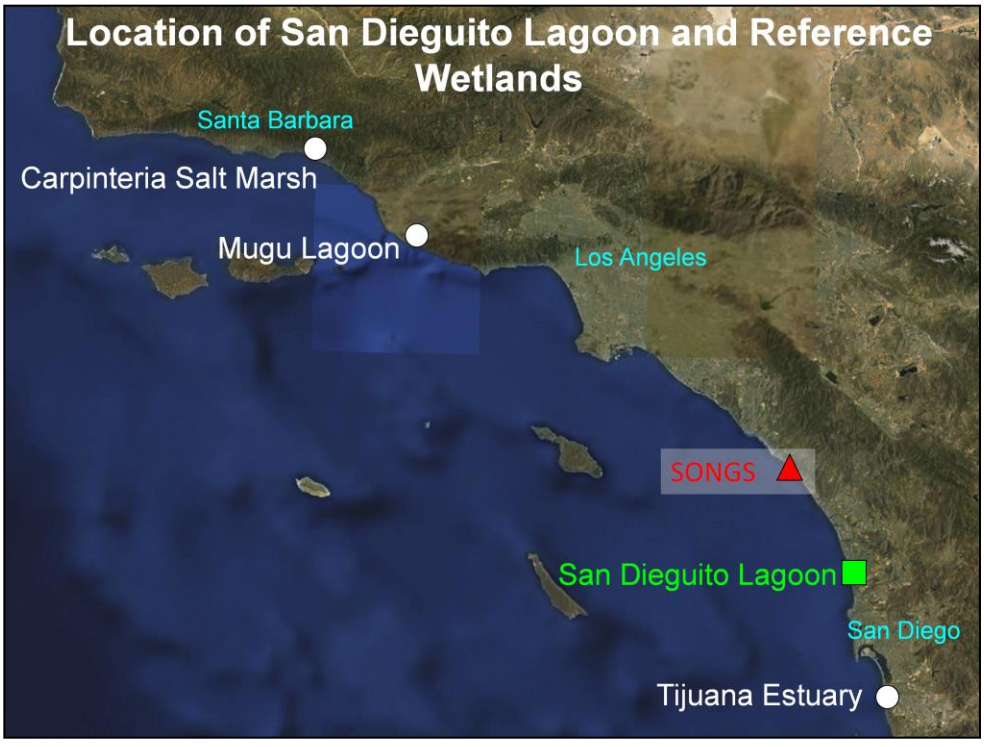
- 49 MGD per unit = 98 MGD total

Projected offline Flow (January 2016)

- 42 MGD

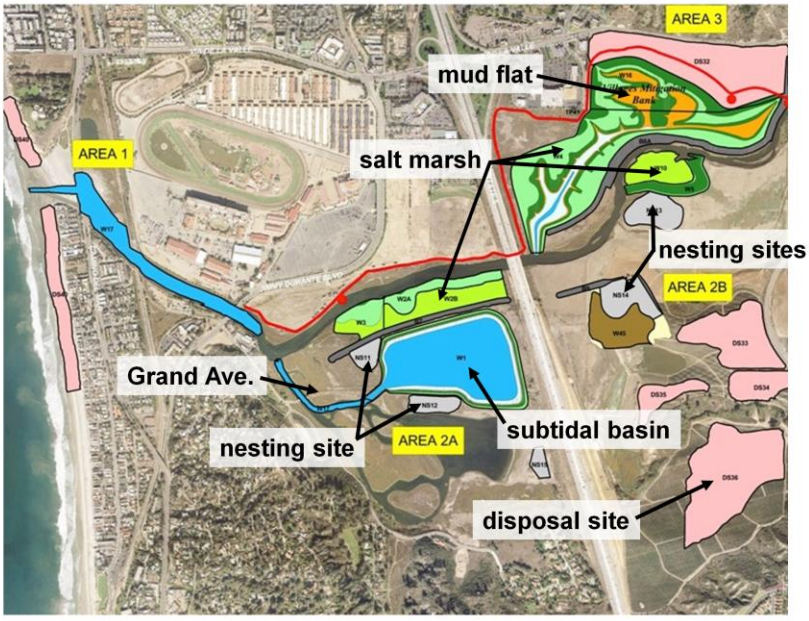
Data provided by SONGS

- Under normal operating conditions the flow rate of the cooling water systems of each Unit is about 1300 million gallons per day,
- This amounts to about 2.6 billion gallons a day for both units.
- Since the shutdown, the flow in each unit has been reduced to about 49 million gallons a day or roughly 4% of the normal operating flow.
- Marine impacts caused by SONGS cooling water system are thus expectedly much less under the current flow conditions.



- This map shows the locations of SONGS, the impact site, the San Dieguito Lagoon, site of the San Dieguito Wetlands Restoration Project, and 3 wetlands that are used as reference sites to evaluate the performance of the restoration project: Carpinteria Salt Marsh, Mugu Lagoon, and Tijuana Estuary.

San Dieguito Wetlands Restoration Design

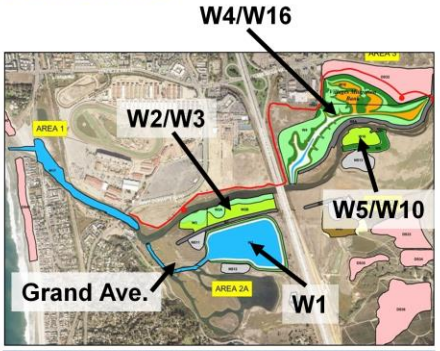


Source: Final Restoration Plan for San Dieguito Wetlands

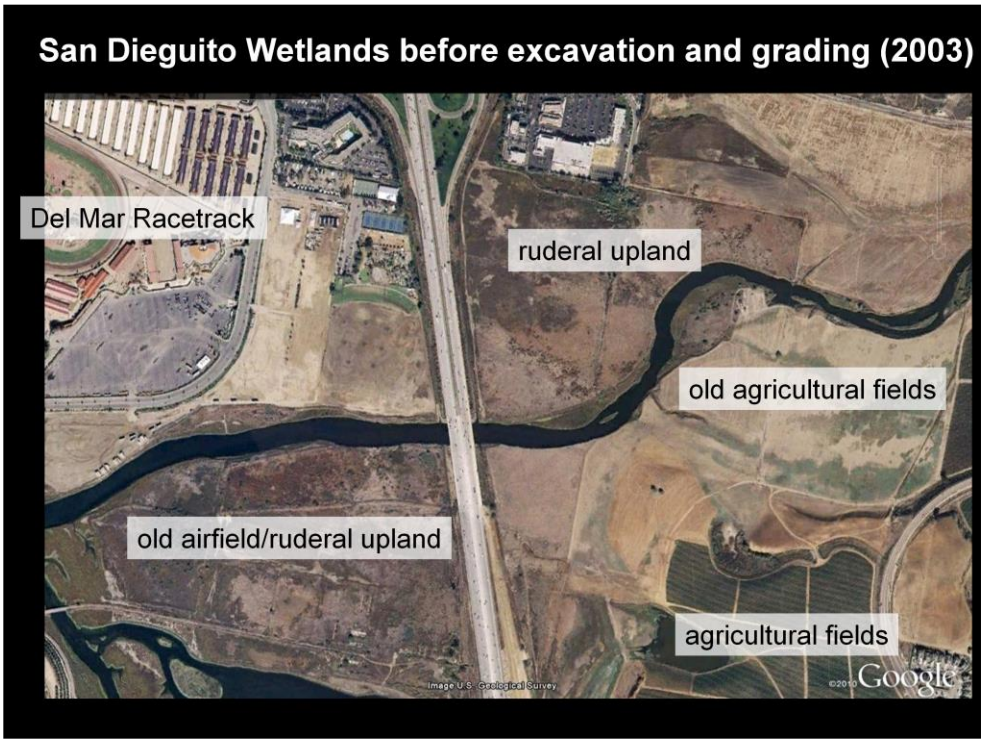
- This slide reviews the San Dieguito Wetlands Restoration design that was approved by the CCC.
- For reference, the restoration project lies to the south and east of the Del Mar Racetrack.
- You can also see the location of the San Dieguito River, inlet to the Pacific Ocean, and I5 Freeway.
- The project included excavation and grading to tidal elevations capable of supporting tidal salt marsh, indicated by shades of green, mudflat, indicated by the light brown, and subtidal habitats, indicated by blue.
- In addition, 4 nesting sites, shown in gray, were constructed, which are not part of the SONGS mitigation requirement.
- The areas in pink are disposal sites that received the majority of the 2.2 million cubic yards of material excavated during construction of the wetland.
- The yellow boxes that indicate Areas 1, 2a, 2b, and 3 pertain to the staging of construction activities.

Construction Timeline

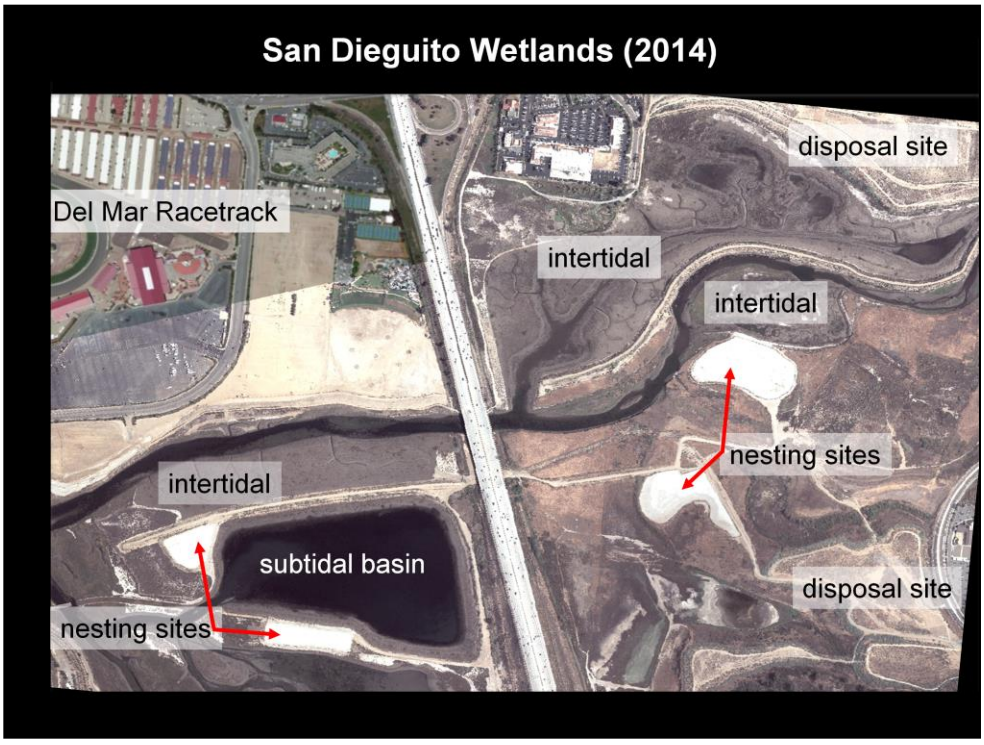
Project Task	Completion Date
Start date	**September 2006**
Construction of:	
W1	January 2008
W4/W16 & W5/W10	December 2008
W2/W3	
Initial grading	February 2008
Tidal creeks	November 2010
Re-grading	March 2014
Berms	February 2009
Additional wetland (Grand Ave)	February 2011
Planting:	
W1	November 2011
W4/W16 & W5W10	November 2011
W2/W3	November 2009
Final inlet dredging	September 2011



- This slide summarizes the construction timeline.
- Construction began in September of 2006.
- Wetland construction was organized by area and module -- most excavation and grading was completed by 2008, with the addition of tidal creeks in W2/3 completed in November 2010, and re-grading of this area to lower elevations in March 2014.
- Planting of salt marsh plants, including cordgrass, Spartina in the low marsh was completed in 2011.
- Final inlet channel dredging was completed in September 2011.
- We've completed the third year of performance monitoring, which is what we will be talking about today.



- This slide shows a satellite view of the project site before excavation and grading.
- You can see the San Dieguito River and adjoining ruderal upland, including the site of an old WWII airfield, and old agricultural fields.
- You can also see a portion of a basin that was constructed in the 1980's termed the Fish and Game Basin.



- During construction, the ruderal areas and old agricultural fields were excavated and graded to create the planned intertidal and subtidal wetland habitats of the restoration project visible in this image taken the past year.

- Notice also examples of the tidal creek networks located in restoration modules on the west and east side of the freeway.
- In addition, you can see nesting and disposal sites.

Monitoring of Wetland Performance

- **Annual monitoring required to evaluate physical and biological performance standards provided in SONGS permit.**
- **Monitoring tracks ecosystem development and identifies adaptive management opportunities pertaining to physical and biological functioning of wetland.**
- **Independent monitoring is conducted by scientists from UCSB with advice from a Science Advisory Panel.**

- Following construction, annual monitoring is required to evaluate the physical and biological performance standards provided in the SONGS coastal development permit.
- Monitoring also tracks ecosystem development and identifies adaptive management opportunities pertaining to the physical and biological functioning of the wetland.
- Independent monitoring is conducted by scientists from UCSB with advice from a Science Advisory Panel.

Update on Status of San Dieguito Wetlands Restoration

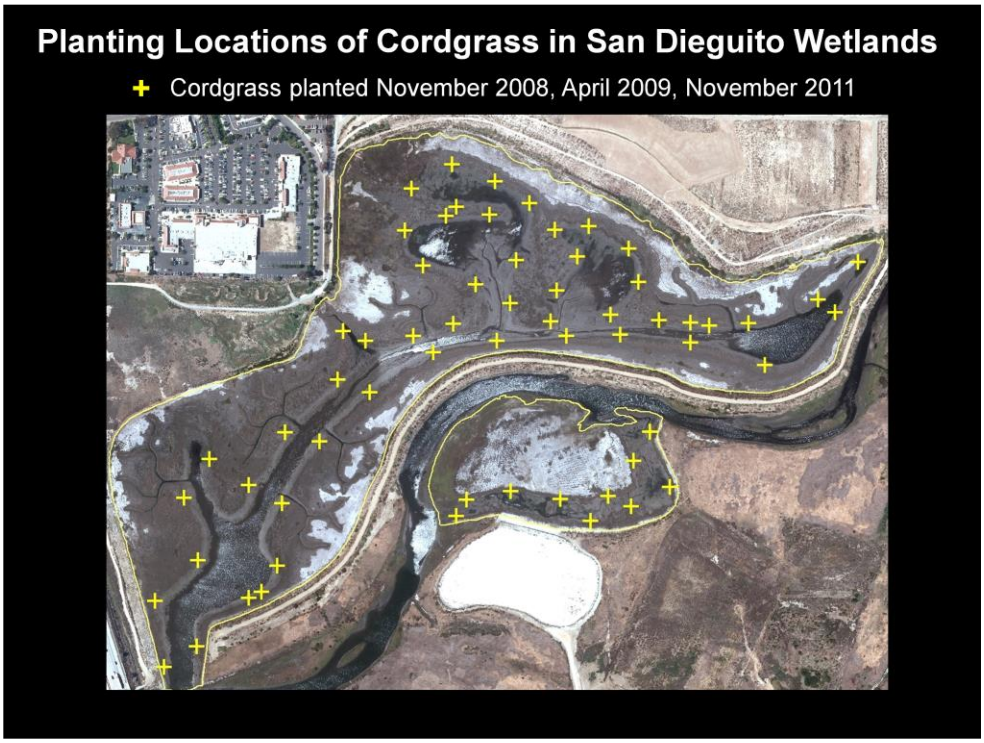
- **Biological resources**
- **Adaptive management & on-going management tasks**
- **Key findings for 2014**

San Dieguito Wetlands (September 2014)

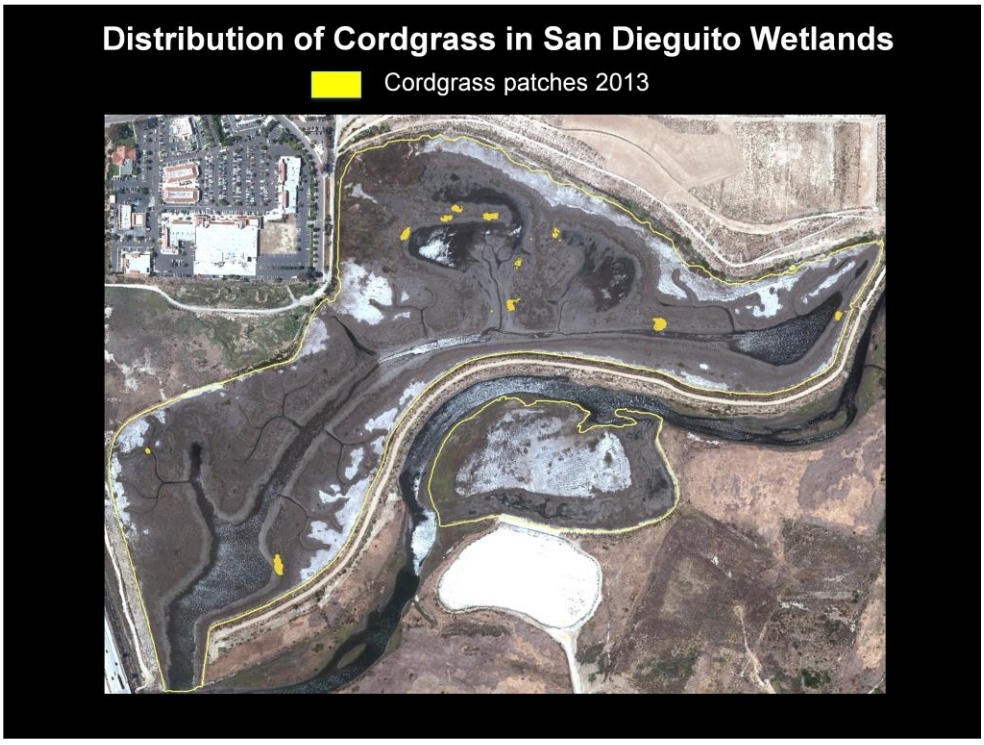
- Turn to a brief overview of the status of the San Dieguito Wetlands Restoration, including the biological resources, adaptive management and on-going management tasks, and key findings for 2014.

Salt Marsh Vegetation - Cordgrass
Current Status

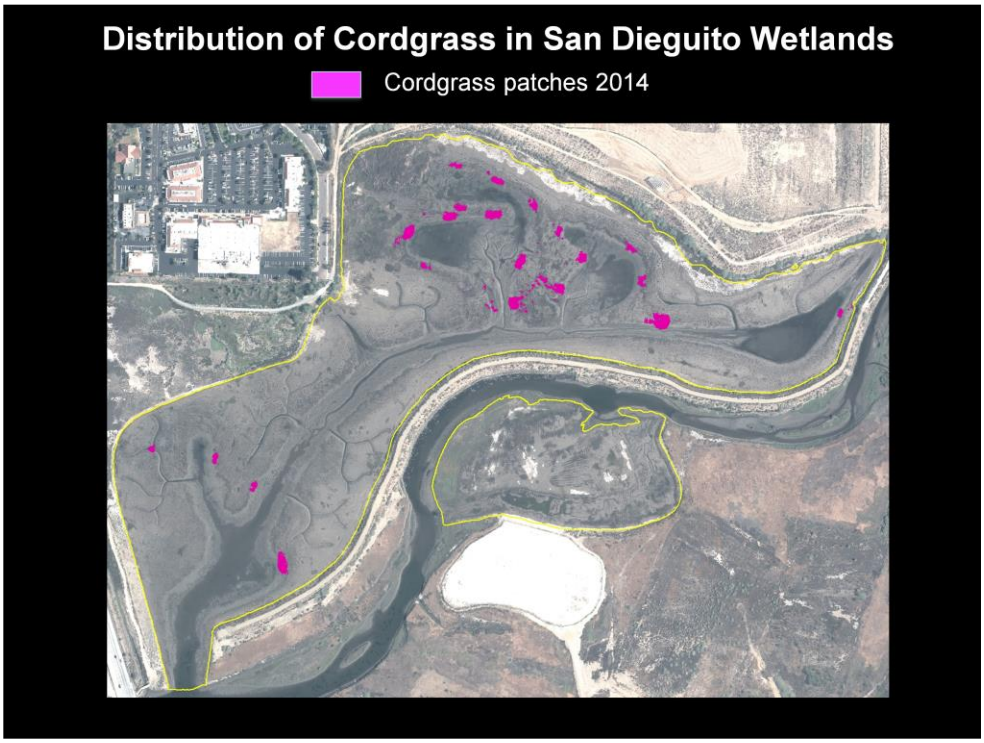
- Taking a look at vegetation, cordgrass is important nesting habitat for the Federally listed endangered Light-footed Clapper Rail.



- Cordgrass, about 20,000 plants, was planted widely throughout the restoration site with the latest planting in November 2011.
- This slide shows planting locations, indicated by the yellow crosses in the portion of the wetland on the east side of freeway where most of the planting occurred.



- For the first couple of years following planting, cordgrass performed poorly.
- You can see the distribution and size of cordgrass patches that became established, scattered in the portion of the restoration site on the east side of the freeway in 2013.



- However, cordgrass establishment has become more promising. This slide for 2014 shows the distribution and size of cordgrass patches has expanded over the past year and now encompasses over 1.1 acres for the restored site.

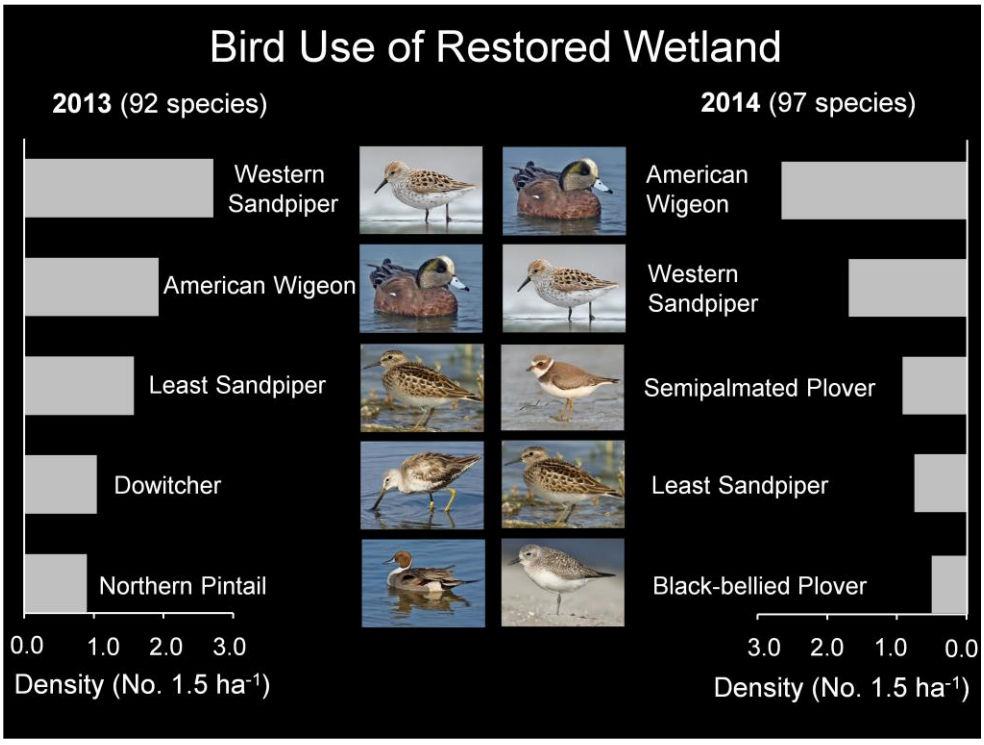
Salt Marsh Vegetation
Adaptive Management

- **Salt marsh vegetation has underperformed in portions of the restoration site.**
- **Monitoring has identified high tidal elevation and poor drainage as the cause of sparse vegetation.**
- **SCE has re-graded some of these areas lower to increase tidal inundation and improve drainage.**

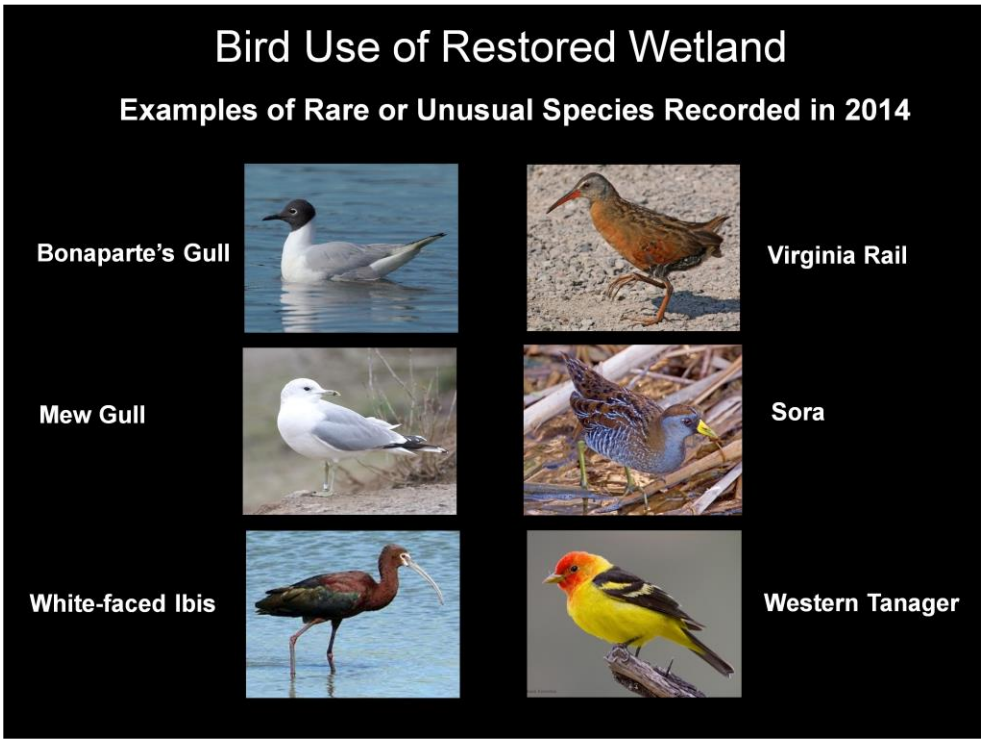
- While the development of vegetation has been promising in some areas, it has under performed in other portions of the restoration site, most noticeably on the west side of the freeway.
- In the top photo, taken in March 2013, you can see pickleweed that has colonized lower elevations, while the higher elevations were bare.
- This area remained exposed following a 2.8' NGVD high tide.
- Monitoring suggested that high elevation of the marsh plain and poor drainage were the cause of sparse vegetation in this area
- SCE was aware of this problem, and the area on the west side of the freeway was re-graded in March of last year to lower elevation of the marsh plain to increase the frequency of inundation, and re-contoured to improve drainage, which should lead to the establishment of vegetation.
- You can see in the bottom figure that this area is now wetted by even lower high tides.

Restored wetland is providing habitat for invertebrates, fish, birds & eel grass

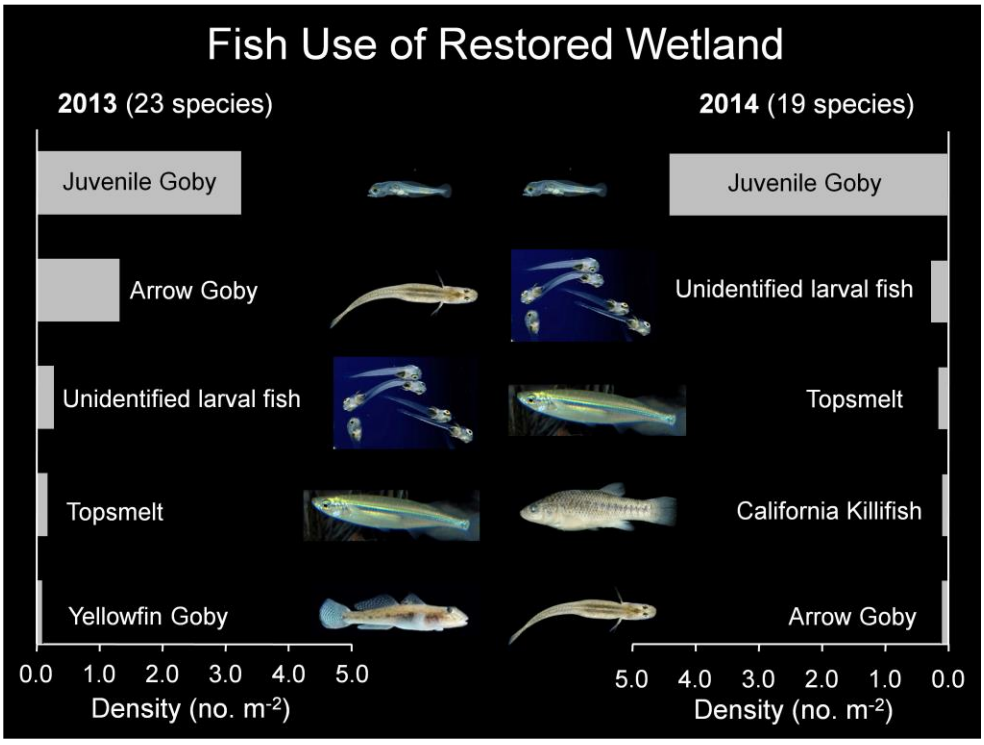
- In the third year of monitoring, the restored wetland is continuing to provide habitat for a diverse array of invertebrates, fish, and birds, and well as for eelgrass.



- During our surveys in 2014 we recorded 97 species of birds, this compares to 92 species the previous year.
- 3 of the top 5 species in terms of abundance in 2014 were also the most abundant in 2013 and included shorebirds, Western and Least Sandpipers and a duck, the American Wigeon.

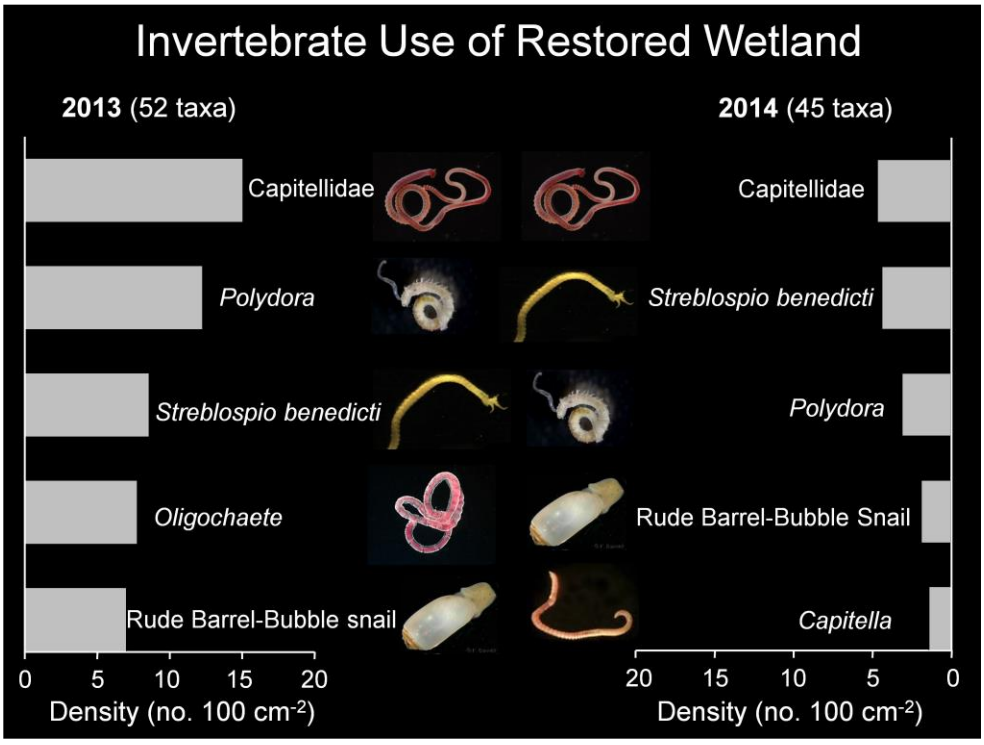


- Examples of other sampled species that were uncommon in surveys include Bonaparte's and Mew Gulls, White faced Ibis, two rails, the Virginia Rail and the Sora, that are typically secretive in marsh vegetation, and the colorful Western Tanager.



- During our surveys in 2014 we recorded 19 species of fish compared with 23 species in 2013.
- Juvenile gobies were by far the most abundant of the fish sampled in the channels, basin, and tidal creeks of San Dieguito Wetlands in both 2013 and 2014.
- Gobies are small fish important in food chain support to larger fish and birds.
- Many of these gobies are so small that it is difficult to identify them to species in the field and thus are placed in the juvenile goby category.
- In addition, larvae and juveniles of other species were abundant. These are largely members of the silverside family, which includes topsmelt, jacksmelt and grunion, which are difficult to distinguish when small.
- A promising development is that yellowfin goby, a non-native species among the top 5 most abundant species in 2013, was not abundant in 2014.

- Examples of some other species found in our surveys are shown here and include two species of pipefish, which are related to seahorses, the longjaw mudsucker, which is a large member of the goby family, reaching several centimeters in size, juvenile California Halibut, and butterfly ray and the round stingray.



- During our surveys in 2014 we recorded 45 taxa of macroinvertebrates which compares with 52 taxa last year.
- Similar to the monitoring results from 2013, small worms were the most abundant of the invertebrates sampled in the channels, basin, and tidal creeks of San Dieguito Wetlands in 2014.
- Worms are typically found burrowed in the mud to a depth of a few centimeters
- Other forms such as the small rude barrel bubble snail are found on the surface of the mud.
- These small invertebrates are important in the food chain support of larger invertebrates such as crabs, and of fish and birds.

- Examples of some other larger taxa include the California horn snail and the Bubble Snail, which feed on algae and the predatory sea slug Navanax, which feeds on the bubble snail.
- The jackknife clam and ghost shrimp are larger infauna, both of which live in the sediment, and the brown shrimp, which is more typically a southern species that we picked up in our samples this past year.

Eelgrass in Restored Wetland

- **Eelgrass recruited to inlet channel and entrance to the W1 basin prior to the final inlet opening in September 2011.**
- **Eelgrass removed for final inlet channel construction was transplanted to W1 in January 2011.**
- **Eelgrass covered ~80% of the bottom in W1 in 2013 and continues to cover most of the bottom in 2014.**


Eelgrass in W1 basin

- Eelgrass, which provides habitat for invertebrates and fish, recruited to the inlet channel and entrance to the basin, W1 prior to the final inlet opening in September 2011.
- Eelgrass removed for final inlet channel construction was transplanted to W1 in January 2011.
- There also has been considerable recruitment of eelgrass.
- Eelgrass covered ~80% of the bottom of the W1 basin in 2013, and continues to cover most of the bottom in 2014.

On-going Management Tasks
Inlet Maintenance

- **Inlet closure can adversely affect dissolved oxygen concentration.**
- **Partial blockage of the inlet by sand can affect drainage during low tides, leading to ponding.**
- **SCE has a maintenance plan to keep the inlet open to tidal exchange.**
- **Maintenance dredging of the inlet is scheduled for October 2015.**

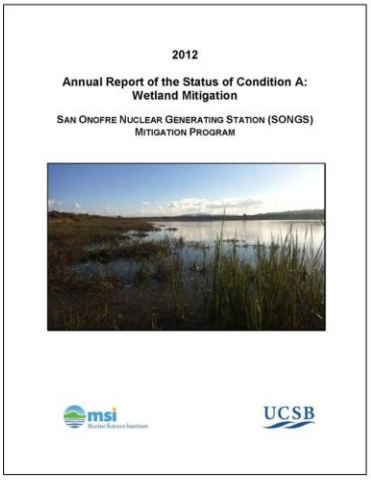
- There remain important on-going management tasks associated with ensuring that the restoration project is successful.
- One task concerns inlet maintenance.
- By halting tidal flushing, inlet closure can adversely affect dissolved oxygen concentration in the lagoon and lead to invertebrate and fish kills.
- Even partial blockage of the inlet by sand can affect drainage during low tides, leading to ponding, and the death of cordgrass, which requires good tidal flushing and cannot tolerate continued submergence.
- SCE has an inlet maintenance plan that will keep the inlet open to avoid degradation in water quality, ponding, and loss of biological resources.
- Maintenance dredging of the inlet is scheduled for mid October 2015.

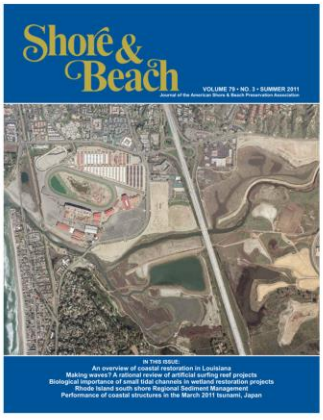
On-going Management Tasks
Non-native Species

- **Non-native species of plants are present around the edges of the restoration site.**
- **Some non-native species such as tamarisk tolerate high soil salinity and can move into the restoration site.**
- **SCE has an active weed abatement program to control weeds on the berms and disposal sites.**

- Another on-going management task is the control of non-native plants, which are present around the edges of the restoration site.
- Some non-native species such as tamarisk can tolerate high soil salinity and could move into the restoration site.
- SCE has an active weed abatement program to control weeds on the berms.

Broader benefits of monitoring





1. **Provides information that helps guide future restoration efforts**
2. **Develops and refines sampling approaches**
3. **Contributes to an understanding of the natural history and ecology of coastal wetlands**

- There are broader benefits of our monitoring program that extend beyond evaluating whether the restored wetland meets the performance standards provided in the SONGS permit.
- Our monitoring provides information that may help to guide future restoration efforts.
- It has lead to the development and refinement of sampling approaches
- Has is contributing to a better understanding of the natural history and ecology of wetland systems.

San Dieguito Wetlands Restoration Project
Key Findings

- The restored San Dieguito Wetlands have been colonized by salt marsh vegetation, invertebrates, fish, and eelgrass.
- Cordgrass establishment has increased, which is promising.
- A large number of bird species continue to use the restored wetland.
- The restoration site is currently providing habitat for endangered and economically important species.
- On-going management tasks important to wetland health include inlet maintenance and control of non-native species.

For more information go to: **http://marinemitigation.msi.ucsb.edu/**

To summarize key findings during 2014:

- The restored San Dieguito Wetlands have been colonized by salt marsh vegetation, invertebrates, fish, and eelgrass.
- Cordgrass establishment has increased, which is promising.
- A large number of bird species continue to use the restored wetland.
- The restoration site is currently providing habitat for endangered and economically important species, such as Belding's Savannah Sparrow and California Halibut.
- On-going management tasks important to wetland health include inlet maintenance and control of non-native species.