Introduction and Overview

Annual Review Workshop for SONGS Wetland Mitigation

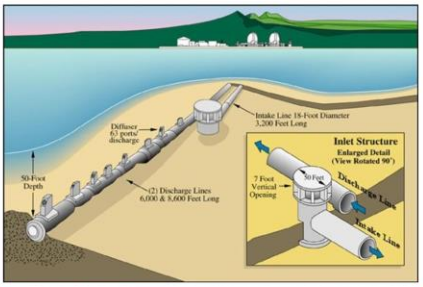
May 7, 2013

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)

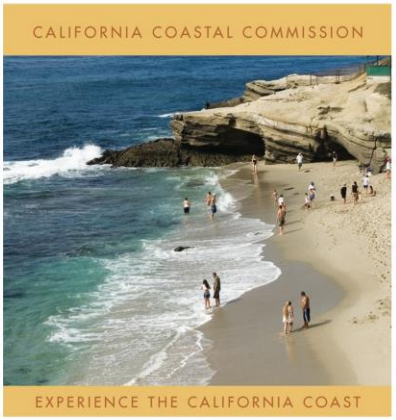
- **SONGS reactors are cooled by a single pass seawater system.**
- **Units 2 and 3 have separate intake lines located in about 30 feet of water offshore of the power plant.**
- **Power plant heated cooling water kills fish eggs, larvae and small immature fish.**
- **SONGS operations projected to cause 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 are 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
- The water is 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 kills fish eggs, larvae and small immature fish; these losses are 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

Enforcement 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.**

- 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

Goal

Out-of-kind compensation for in-plant losses of larval and juvenile fish caused by the operation of SONGS Units 2 & 3.

Wetland restoration in Southern California
Restoration of at least 150 acres of wetlands, excluding buffer & transition
Restoration performs for a period of time equal to the operating life of Units 2 & 3

Performance Standards

Physical and biological standards were established to evaluate the performance of the wetland restoration project.

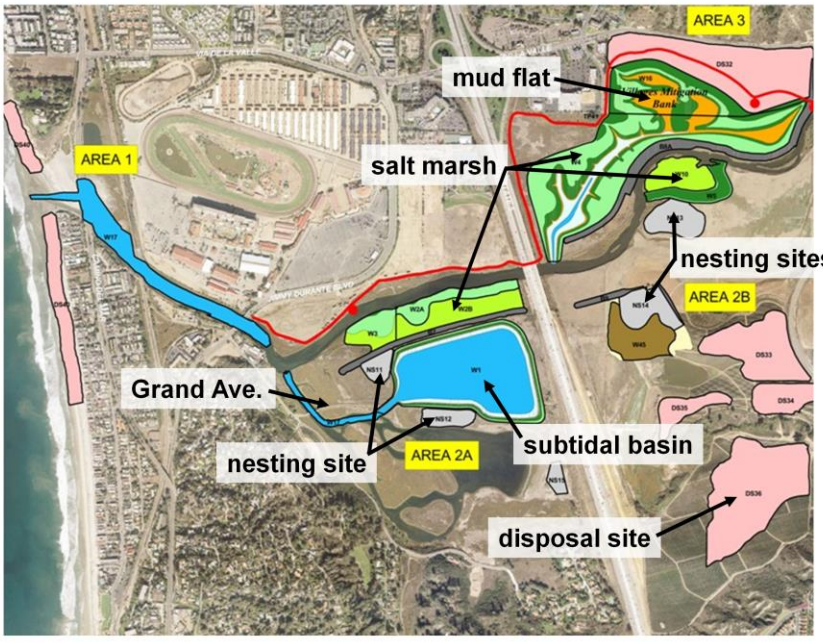
Evaluation

Data from independent long-term monitoring used to determine:
(1) whether the performance standards are met
(2) the causes for any failures to meet the standards
(3) the most appropriate methods for remediation

- It was decided that the goal of out-of-kind compensation for the in-plant losses due to SONGS operations will most likely be met if:
  - -Wetland restoration is within southern California to ensure that the compensation for the lost resources will occur locally rather than at a distant location far from the impacts.
  - -Wetland restoration creates or substantially restores 150 of wetlands
  - -Wetland restoration project performs for a period of time equal to the operating life of 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.
- Evaluation of the restoration project involves long-term independent monitoring to determine whether the performance standards are met, the cause for any failures to meet the standards and the most appropriate methods for remediation should the standards not be met.
- Independent monitoring of project performance is done by university scientists from UCSB who report to the CCC and not SCE.

- This map shows the locations of SONGS, the impact site, the San Dieguito Lagoon Wetlands Restoration Project site 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

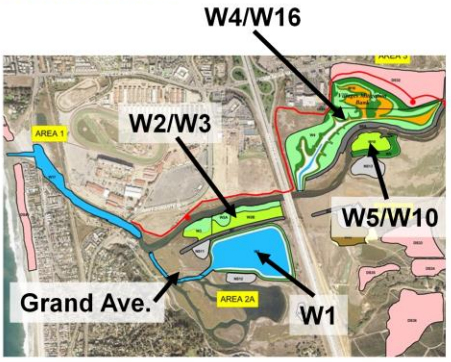


Source: Final Restoration Plan for San Dieguito Wetlands

- This slide shows the design plan view of the restoration project that was approved by the CCC.
- For reference, this is the Del Mar Racetrack, San Dieguito River and inlet to the Pacific Ocean, and I5 Freeway.
- The project included the creation of tidal salt marsh, indicated by shades of green, mudflat, indicated by the light brown, and subtidal basin, indicated by blue.
- In addition, 4 nesting sites, shown in gray, were constructed, which were 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

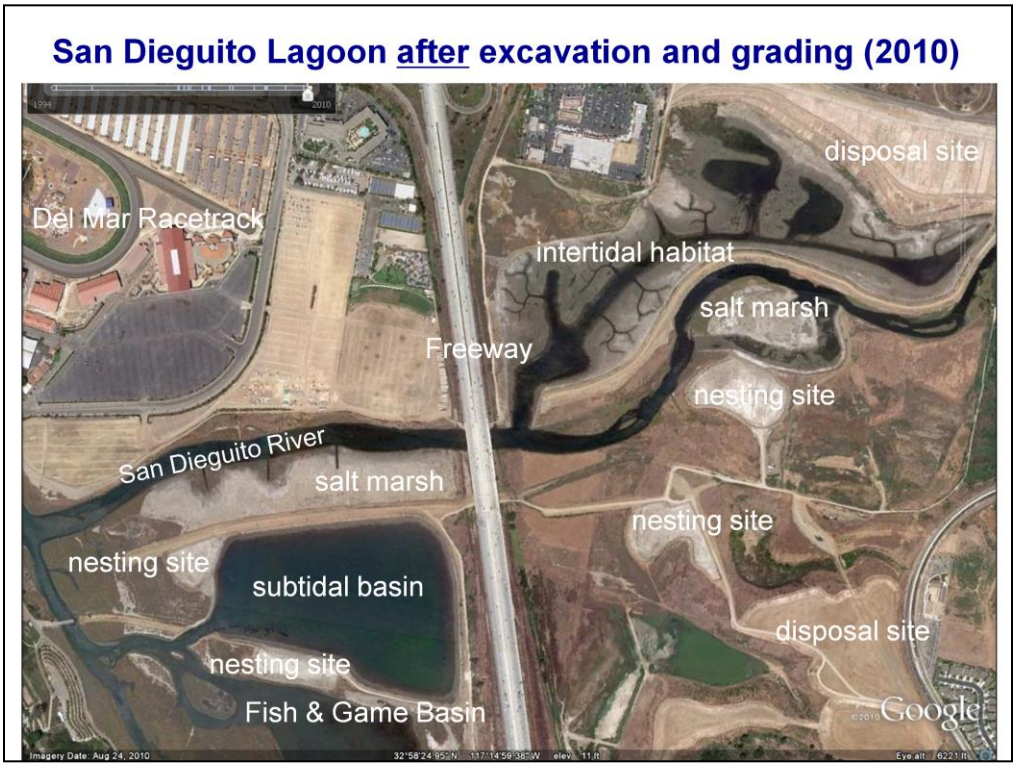
Project Task	Completion Date
Start date	**September 2006**
Construction of:	
W1	January 2008
W4/W16 & W5/W10	December 2008
W2/W3	
Initial grading	February 2008
Tidal creeks	November 2010
Berms	February 2009
Additional wetland (Grand Ave)	February 2011
Planting:	
W1	November 2011
W4/W16 & W5W10	November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

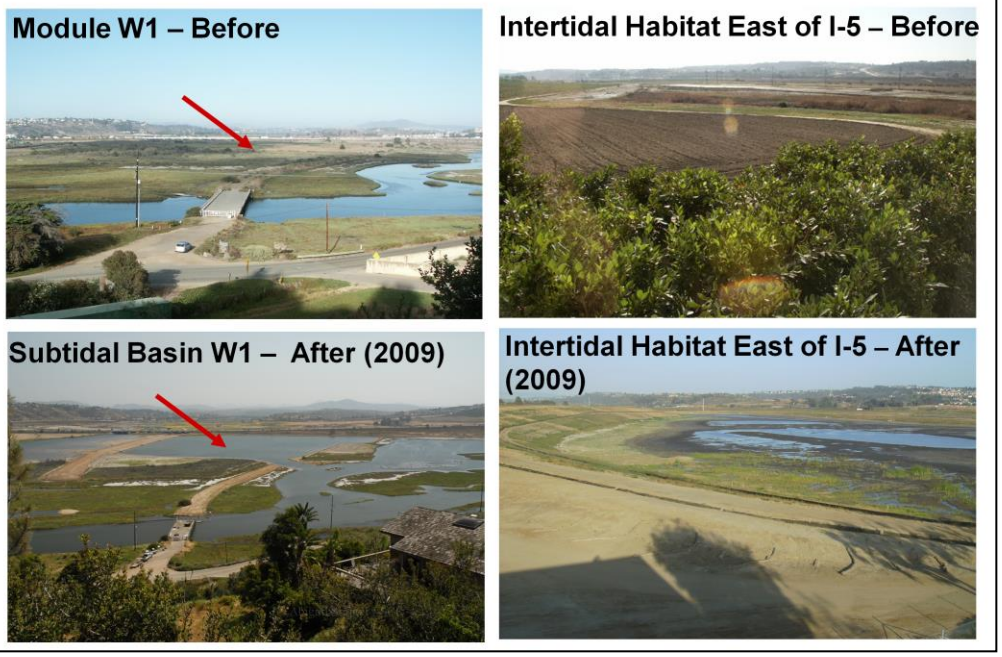
San Dieguito Lagoon before excavation and grading (2003)

- 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.

Before and After Construction



- A couple of on the ground views of the Module W1, location of the subtidal basin before and after construction
- Intertidal habitat east of the I5 freeway before and after construction.

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**
- **On-going management tasks**
- **Key findings for 2012**

View of constructed habitat (March 2013)

- Turn to a brief overview of the status of the San Dieguito Wetlands Restoration, including the biological resources, on-going management tasks, and key findings for 2012.

Salt Marsh Vegetation

- **A high cover of marsh vegetation is characteristic of relatively undisturbed, natural tidal wetlands in region**
- **Vegetation provides habitat for invertebrates as well as nesting and foraging habitat for birds**
- **San Dieguito Wetlands Restoration entails construction of 92 acres of vegetated salt marsh**
  - Pickleweed (*Salicornia virginica*) and other species expected to become established in mid and high marsh
  - Cordgrass (*Spartina foliosa*) expected to become established in low marsh

Mugu Lagoon

Carpinteria Salt Marsh

- A high cover of salt marsh vegetation is characteristic of relatively undisturbed, natural tidal wetlands in the region
- Vegetation provides habitat for invertebrates as well as nesting and foraging habitat for birds, including the endangered Belding's Savannah Sparrow and Light Footed Clapper Rail.
- San Dieguito Wetlands Restoration entails construction of 92 acres of vegetated salt marsh.

  - Pickleweed (*Salicornia virginica*) and other species are expected to become established in the mid and high marsh.
  - Cordgrass (*Spartina foliosa*) is expected to become established in low marsh.

Methods of Achieving Plant Establishment

- **Rely on natural recruitment – mid and high salt marsh**

  Expected that pickleweed and other species would recruit naturally

- **Plant plugs or fragments in small patches to allow for natural spread**

  Cordgrass plugs planted in low marsh

  Fragments or plugs of pickleweed and other species planted in high marsh

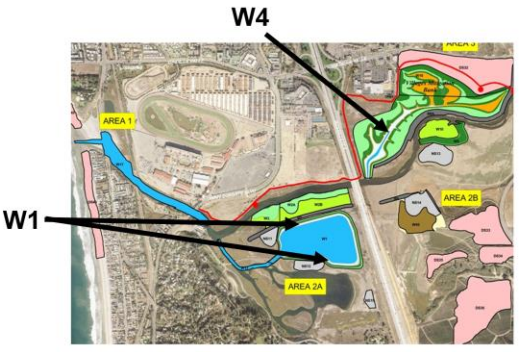
Natural recruitment at lower elevations in W2/3

Flats of salt marsh plants

- Two methods were proposed in the Final Restoration Plan to achieve plant establishment.
- Rely on natural recruitment of vegetation in the mid and high salt marsh.
  - Expected that pickleweed and other species would recruit naturally.
- Plant plugs or fragments in small patches to allow for natural spread
  - Cordgrass plugs planted in low marsh.
  - Fragments or plugs of pickleweed and other species planted in the high marsh where natural recruitment is likely slow.

Salt Marsh Vegetation

Development of vegetation is promising in some areas

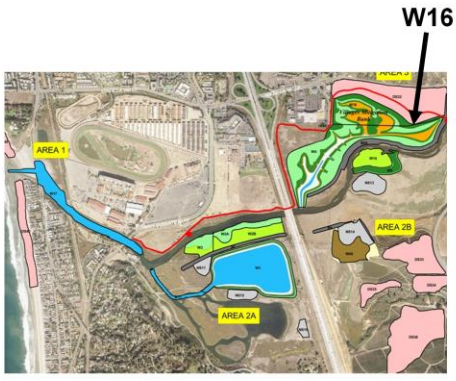


- The development of vegetation has been very promising in some areas.
- Notably the growth of pickleweed, Salicornia, along the border of the basin, module W1 and the growth of Spartina in some areas of module W4.

Salt Marsh Vegetation

Development of vegetation was initially promising along the northern border of W16 but plants now remain brown and appear stressed

Northern border of W16

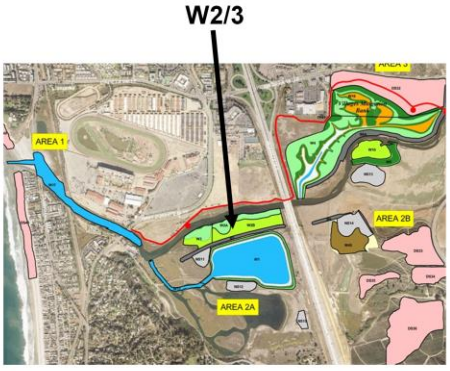


- **Vegetation planted along the northern border of W16 January-March 2009**
- **Plants remained brown during the growing season in July 2012**

- In other areas, particularly along the northern border of W16, development of vegetation was initially very promising, but more recently plants have turned brown and remained brown during the growing season, suggesting that they are stressed.
- The top photo shows the initial growth of plants planted in early 2009.
- The bottom photo shows what the plants looked like in July 2012, at a time of year when one would expect that they would be green.
- However, inspection of stems indicated that only a small percentage of the brown plants were actually dead.

Salt Marsh Vegetation

Development of vegetation has been poor in modules W2/3



- **Vegetation slow to establish through natural recruitment except at lower elevations or in depressions**
- **Plug plantings were unsuccessful**

- Lastly, vegetation has done very poorly in modules W2/3, located adjacent to the San Dieguito River.
- Vegetation has been slow to establish through natural recruitment except at the lowest tidal elevations or in depressions, as illustrated in the photos.
- Plantings of pickleweed and other species at higher tidal elevations in 2009 were unsuccessful.
- These modules were graded by design to create high marsh habitat and with little change in elevation over distances exceeding 100m.
- These high elevation areas are hit by the tides infrequently and when they are, tidal waters sit on the surface where evaporation contributes to high soil salinities.

Construction of Tidal Creeks in Modules W2/3
Completed November 2010

- One possible solution to improve inundation of the marsh plain was to extend the linear channels that were initially constructed to better convey tidal water further away from the river channel.
- In November 2010, SCE extended the linear channels to form tidal creeks shown here, and did some re-grading lowering elevations of some areas around the creeks.

Current Status of Vegetation in W2/3

- **Tidal creeks improved movement of tidal waters away from river channel**
- **Recruitment of vegetation has occurred along the edges of the constructed creeks**
- **Vegetation cover on the high marsh plain remains sparse**

- Tidal creek extensions improved movement of tidal waters away from the river channel.
- Recruitment of vegetation has occurred along the edges of the constructed creeks.
- However, vegetation cover on the high marsh plain remains sparse.
- SCE is aware of the problem and is evaluating options to address the poor plant establishment in these modules.

Restored Wetland is Supporting Birds, Fish, Macroinvertebrates and Eelgrass

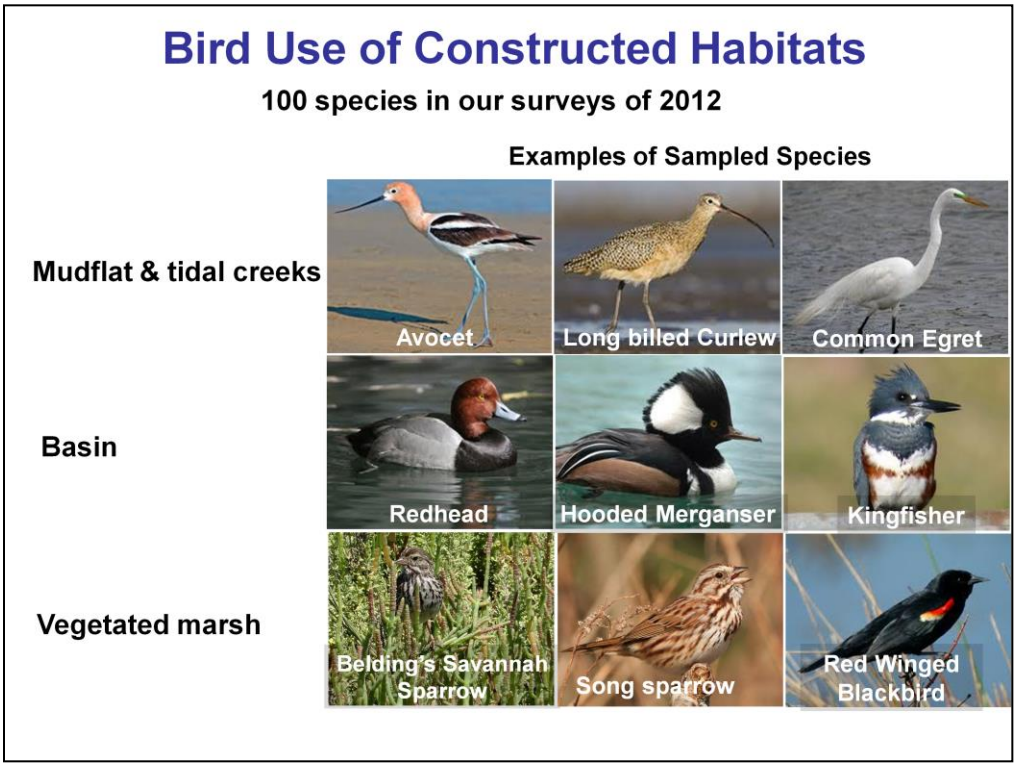

Shorebirds feeding


Fiddler crab


Osprey with fish


Eelgrass in constructed basin (W1)

- While there is an issue with vegetation in some portions of the wetland, the wetland is supporting birds, fish, invertebrates, and eel grass and did so even during construction .
- The invertebrates and fish are providing food chain support to birds. Picture of an osprey with a captured fish taken at the site.



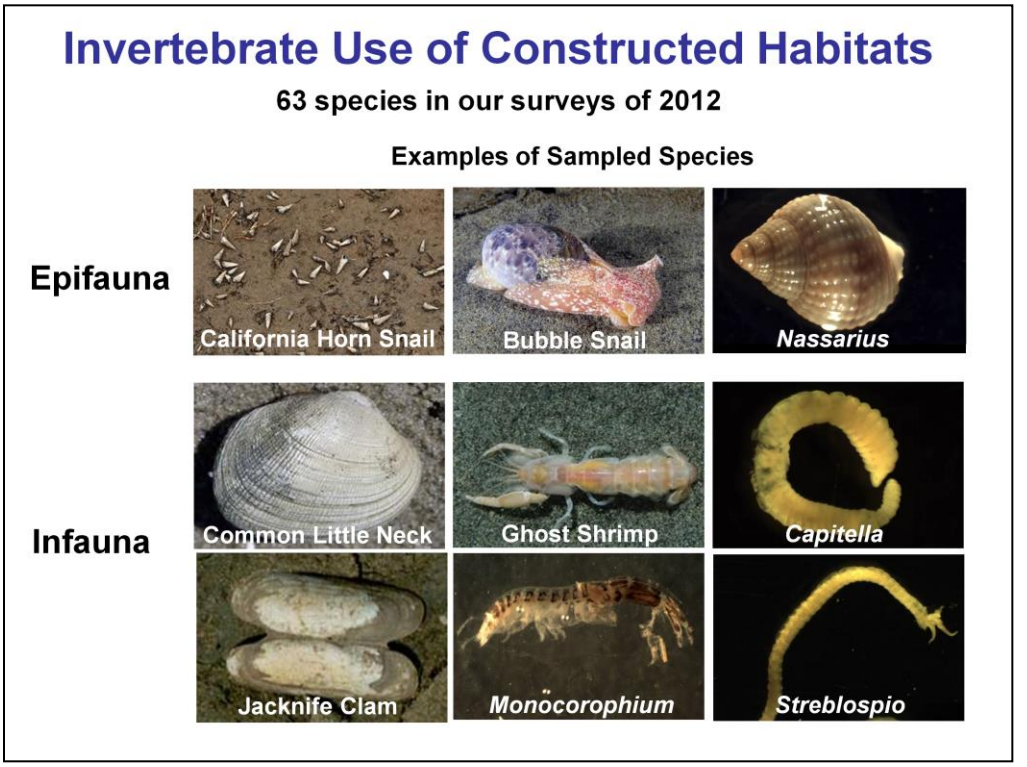
- During our surveys in 2012 we recorded 100 species of birds.
- Examples of some of these species are shown here and include avocets, long billed curlew, egrets, redheads, hooded merganser and kingfisher, and the state listed endangered Belding's Savannah Sparrow, song sparrows, and red-winged blackbird in the vegetated marsh.

Fish Use of Constructed Habitats

21 species in our surveys of 2012

Examples of Sampled Species

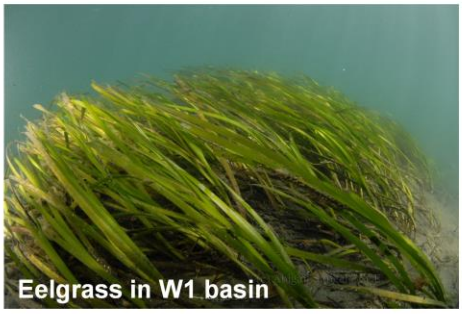
- During our surveys in 2012 we recorded 21 species of fish.
- Examples of some of these species are shown here and include topsmelt, killifish, pipefish (get 3 species), staghorn sculpin, mudsuckers, two common small gobies, the arrow and shadow goby, diamond turbot and the round stingray (3 types of rays).



- During our surveys in 2012 we recorded 63 species of invertebrates.
- There were 5 species of epifauna, invertebrates that live on the surface, 3 are shown here: California horn snail, the snail Nassarius, which is thought to be a scavenger, and the Bubble Snail, which feeds on algae
- The remaining species were infauna, those forms that live in the sediment and include clams, common littleneck and jacknife, ghost shrimp, and much smaller forms such as this amphipod crustacean, and small worms, which can be very abundant.

Eelgrass in Constructed Habitat

- **Eelgrass recruited to inlet channel and entrance to W1 prior to the final inlet opening in September 2011.**
- **Eelgrass impacted by final inlet channel construction transplanted to W1 in January 2011.**
- **Eelgrass now covers ~80% of the bottom in W1.**



- 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 impacted by final inlet channel construction was transplanted to W1 in January 2011.
- There has been considerable recruitment of eelgrass.
- Eelgrass now covers ~80% of the bottom in W1.

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.**

- There are important on-going management tasks associated with ensuring that the restoration project is successful.
- One task concerns inlet maintenance.
- Inlet closure can adversely affect dissolved oxygen concentration in the lagoon.
- Low DO concentrations can lead to invertebrate and fish kills.
- 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.

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 could 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.
- Tamarisk has recruited into the restoration site, but was immediately removed.
- SCE has an active weed abatement program to control weeds on the berms.

Monitoring Plan & Publications

Monitoring Plan for the San Dieguito Lagoon Restoration Project

Publications:

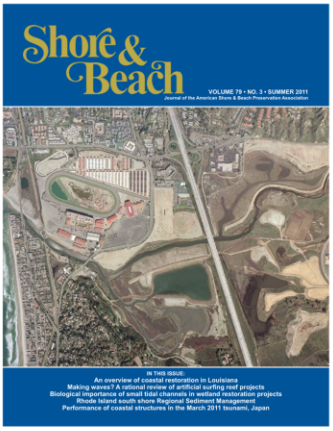
Page et al. 2003. *Bull So Calif Acad Sci* 102:130-142

Steele et al. 2006. *Estuaries and Coasts* 29: 630-638

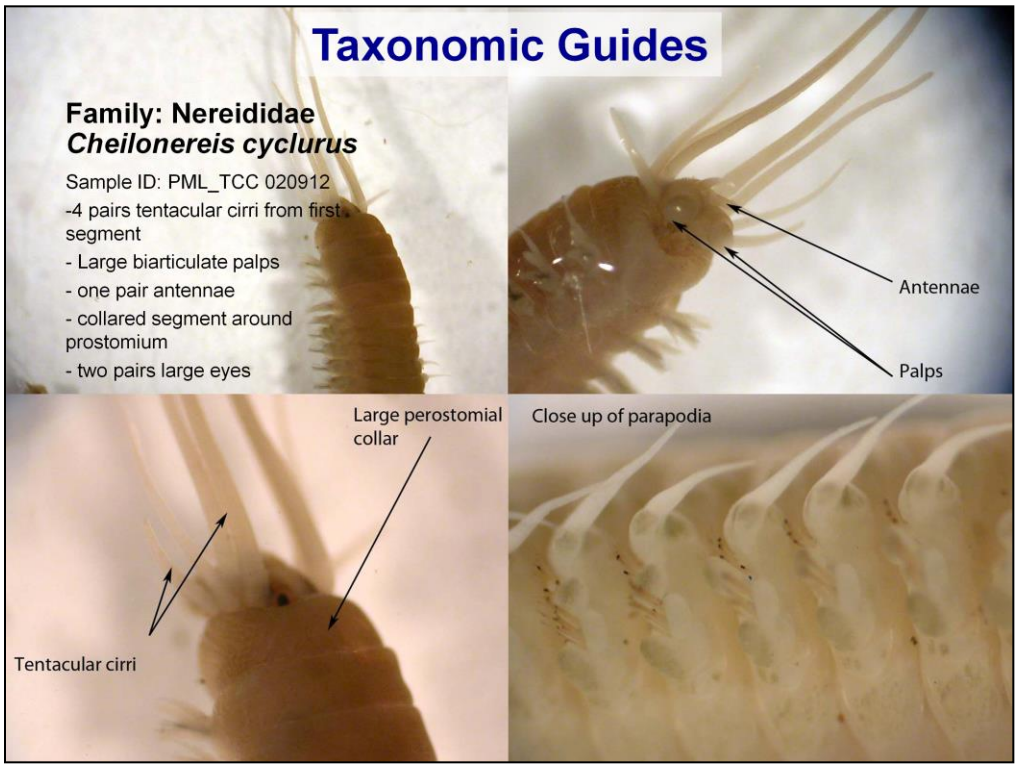
Steele et al. 2006. *Estuaries and Coasts* 29:1172-1184

Steele et al. 2007. *Estuaries and Coasts* 30: 344-347

Litzba et al. 2011. *Shore and Beach* 79: 17-27



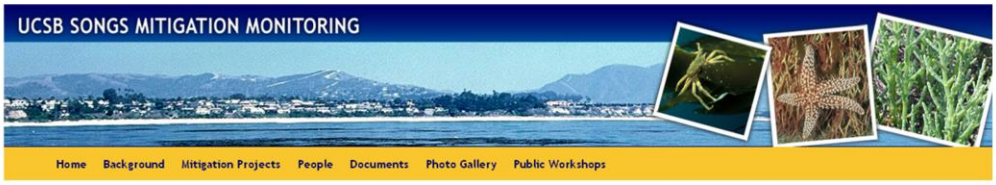
- In addition to fulfilling our obligations under the SONGS permit, there have been a number of ancillary products produced in support of the monitoring program.
- These include the Monitoring Plan, which provides a description of the performance standards and methods of sampling and evaluating the performance standards.
- Elements of the Monitoring Plan are currently being used in other restoration projects in the region.
- Publications in the scientific literature pertaining to the development or refinement of monitoring methods.



- Ancillary products also include the compilation of taxonomic guides to facilitate the identification of specimens sampled during monitoring in the San Dieguito Wetlands and the reference wetlands, such as the polychaete worm shown here.

San Dieguito Wetlands Restoration Project
Key Findings

- The restored San Dieguito Wetlands have been colonized by salt marsh vegetation, invertebrates, fish, and eelgrass.
- A large number of bird species are using constructed habitat.
- The restoration site is currently providing habitat and food chain support for endangered and economically important species.
- Plant establishment has been highly variable within and across constructed wetland modules
- 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 2012:

- The restored San Dieguito Wetlands have been colonized by salt marsh vegetation, invertebrates, fish, and eelgrass.
- A large number of bird species are using constructed habitat.
- The restoration site is currently providing habitat and food chain support for endangered and economically important species.
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