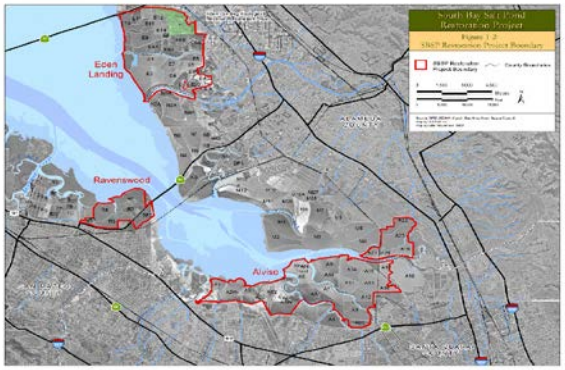
South Bay Salt Pond Restoration Project

Restoring the Wild Heart of the South Bay

Phase 1 Science Summary

Tracking Progress through Adaptive Management

Introduction



The South Bay Salt Pond Restoration Project (Project) is one of the largest restoration efforts in the United States--over 15,000 acres of former salt ponds--and is being conducted over a 50-year span. The Project's goals are to restore and enhance wetlands, especially tidal salt marsh, in South San Francisco Bay while providing for flood management and wildlife-oriented public access and recreation.

Managers plan to restore between 50% and 90% of the pond area to tidal salt marsh in phases. However, there are many uncertainties inherent in a restoration project of this size, such as the ability to balance tidal marsh restoration with the protection of pond-associated species, such as migratory and nesting birds.

To move forward while addressing uncertainty, the Project relies on adaptive management. This is a process in which Project managers and scientists use focused studies and on-going monitoring to determine if the Project is meeting the restoration targets necessary to achieve the Project goals, including sediment accumulation, maintaining sufficient pond habitat for wildlife, and avoiding increased risk of mercury contamination. If restoration targets are met, then managers can increase the amount of tidal marsh and associated habitats. Ultimately, the amount of habitat restored to tidal marsh--whether 50%, 90% or somewhere in between--will be determined through adaptive management.

During the Project's Phase 1 (2006-2016), managers restored 1,600 acres of tidal marsh and reconfigured 2,150 acres of ponds to better support pond species. Project managers and scientists thoroughly evaluated specific restoration targets and used a "stoplight" assessment to identify how well the Project progressed from 2006-2016. While uncertainty still exists, data from the past 10 years do indicate the direction of change. Each restoration target was assigned one of the stoplight colors below to describe the state of the system after completion of Phase 1:

	Positive - Conditions clearly moving toward or meeting the restoration target
	Trending positive - Conditions seem to be moving toward the restoration target
	Uncertain - Whether conditions are moving toward or away from the restoration target is unclear, either due to lack of data or because the data do not provide a clear signal
	Trending negative - Conditions seem to be moving away from the restoration target
	Negative - Conditions clearly moving away from or not meeting the restoration target

The following pages, organized into six themes, give the "stoplight" evaluation of the Project's progress in Phase 1. They also list key caveats and summarize management actions expected in Phase 2 to ensure the Project stays on track toward its restoration targets.

Sediment for Building Marshes and Mudflats

The Project will only be able to reestablish tidal marsh habitat, which supports many native and rare species, if there is enough sediment in the Bay to build marsh. Sediment suspended in Bay waters is carried into breached ponds on the tides and is deposited as mud. This mud builds up and provides the "soil" that marsh plants need to grow. In addition to building marsh in restored ponds, sediment is needed to maintain existing marshes and mudflats and help them keep pace with rising sea levels. The Project tracks tidal marsh accretion and assesses whether new marshes may be taking sediment away from existing South Bay marshes and mudflats.

Restoration Targets	Score	What this score means at the 10-year point in the Project
Tidal marsh vegetation and habitat establishment are trending toward conditions found in high-quality marshes. **Current vegetated tidal marsh** is maintained or increased.		Trending positive. Ponds opened to the tides early in the project are building mudflat and becoming vegetated faster than expected. Key marsh species are returning. Existing vegetated marsh area is maintained.
The **sediment accretion rate** in restored tidal areas will be sufficient to create and support emergent tidal habitat ecosystems within the projected 50-year timeframe.		Positive. The amount of sediment coming and going from the South Bay varies widely by year, but the swift building of mudflat and marsh in breached ponds shows there is sufficient sediment in the South Bay at this time to restore marshes.
Sediment movement into restored tidal areas will not significantly decrease **mudflat habitat**.		Trending positive. Mudflats in the Bay outside of Ponds A6 and SF2, which were opened to tidal action in Phase 1, did not decrease.

Caveats and Uncertainties

- Recent data show less sediment flowing into San Francisco Bay from upstream rivers, so the sediment supply may decline in the future.
- Future sea level rise could accelerate the Project's need for sediment so that marshes can keep pace with rising seas.
- More study is needed of the effects, if any, of the Project's tidal marsh restoration actions on South Bay mudflats.

Management Going Forward

Managers are making plans to accept clean sediment from land-side sources, such as construction sites, and from under-water dredging sites, to build marsh habitat and augment naturally-deposited sediment. The evolution of tidal marshes and mudflats will be closely tracked. Future sediment and mudflat studies are likely to occur at pond systems opened in the next project phase.

Mercury Contamination

Mercury is a potent nervous system and reproductive toxin, and it exists in low concentrations around the Bay. This pollutant is an unfortunate legacy of the California gold rush, as mercury was mined and used to extract gold from ore. In the South Bay, mercury is buried in accumulated sediment in sloughs and mudflats, and continues to seep into the Guadalupe River from closed mines in the hills south of San Jose. Mercury reaches the South Bay at Alviso Slough, in the center of the Project's Alviso Pond Complex, and can enter the food chain when sediment is stirred up by tidal action. Studies of fish and bird eggs in Pond A8, a pond connected to Alviso Slough, have found existing mercury levels high enough to harm wildlife health and reproduction. These levels can worsen if additional mercury is mobilized by increased tidal action as ponds are opened to the tides.

A Project objective is to restore Pond A8 and nearby Ponds A7 and A5 to tidal wetlands in a way that won't elevate mercury levels for fish and birds over existing Bay conditions. To monitor changes, a water control structure was installed at Pond A8 to carefully control the amount of Bay water from Alviso Slough entering the pond, and to control the amount of mercury-contaminated sediment stirred-up by water moving in and out of the pond. Researchers have repeatedly tested mercury levels in the pond and slough waters, in fish, and in bird eggs to study the impact of opening Pond A8 to controlled tidal action under various conditions.

Restoration Targets	Score	What this score means at the 10-year point in the Project
Methylmercury levels in sentinel species (species monitored for mercury) and ponds will not increase above baseline levels **as a result of construction activities.**		Negative. Studies indicated there was a spike in mercury levels in fish and Forster's tern eggs during, and in the months immediately following, pond construction and opening.
Methylmercury levels in sentinel species and ponds will not increase above baseline levels **as a result of pond management**.		Trending positive. Continued study indicated mercury levels dropped after initial construction and gate opening. There were no long-term increases in mercury as a result of restoration.

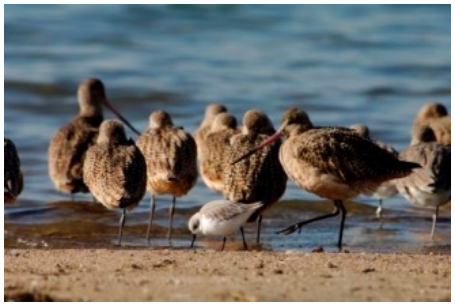
Caveats and Uncertainties

- Existing levels of mercury in the South Bay environment remain a concern for the health of species, especially nesting birds.
- Monitoring of mercury responses to Project actions will be undertaken as needed.

Management Going Forward

Each year, managers use the results from mercury research to determine how best to operate the Pond A8 water control structure. In 2017, we fully opened the structure year-round in order to improve tidal circulation. Continuing studies will guide our assessment of future Project actions.

Pond Birds in Changing Habitats



To benefit the South Bay's marsh-dependent species, such as the endangered Ridgway's rail, former salt ponds must be restored to tidal marsh. Today's salt ponds were created decades ago by building levees around marshes and replacing them with commercial, salt-making ponds. But now, almost 100 species of migratory and resident waterbirds use these ponds. Thus, a key Project goal is to manage and enhance ponds to support a greater number of pond-associated birds in a smaller footprint, as some ponds are restored to tidal marsh. Phase 1 included building nesting islands, managing salinity and water levels, and creating varied topography in ponds for a range of foraging and roosting waterbirds, as well as managing predators, such as California gulls and ravens.

Restoration Targets	Score	What this score means at the 10-year point in the Project
Numbers of **diving ducks and ruddy ducks,** and the amount of foraging and roosting habitat for **migratory shorebirds,** are maintained compared to pre-Project levels.		Trending positive. Water level and salinity management of ponds benefited many species, including migratory waterbirds, whose numbers more than doubled from 2004 to 2012.
Managed ponds provide breeding habitat to support sustainable densities of threatened **snowy plovers**.		Positive. Management to enhance plover nesting habitat with oyster shells & varying water levels showed early positive results.
The creation of large isolated pond islands will maintain numbers and reproductive success of **terns, avocets and stilts** compared to pre-Project numbers.		Negative. Phase 1 actions that breached ponds to restore tidal action caused nesting terns and avocets to abandon some areas--and they did not move to new nesting islands built for them in managed ponds.
California gulls will not adversely affect nesting birds in managed ponds.		Uncertain. California gull numbers remain high and gulls are known to prey on chicks and eggs. Efforts to keep gulls off nesting islands and away from landfills (where they feed) have shown some success.

Caveats and Uncertainties

- More work is needed to attract nesting birds to islands--including avocets, terns and snowy plovers--and to produce chicks.
- Management of predators, such as gulls, is needed to prevent encroachment on and predation of nesting waterbirds.
- Waterbirds will have less pond habitat as tidal marsh restoration proceeds, which may reduce bird numbers.

Management Going Forward

Study results are guiding the design and location of new islands and island surface toppings to benefit nesting species. We are also designing pond bottom topography based on data and observations of waterbird preferences, and refining pond operations based on bird distribution monitoring. Additional measures to enhance nesting bird habitat, including methods to reduce gull impacts, continue to be tested.

Rails, Mice and Seals

Central to the Project is the restoration of salt ponds back to high-quality salt marsh habitat. Salt marshes provide many benefits, including improved flood protection, contaminant filtering, and recreational opportunities, as well as essential habitat for many plant and wildlife species. The harbor seal, a marine mammal that is a Bay resident, uses tidal marsh edges to stay out of the water for parts of the day and they feed on fish, which are expected to increase with increasing tidal habitat. Restoring salt marsh is particularly critical for two federally-endangered species, the Ridgway's rail (formerly known as California clapper rail), and the salt marsh harvest mouse – both live only in San Francisco Bay salt marshes. Less than 10 percent of their historic habitat remains. In 2006, the Project opened 480 acres to the tides in Alviso--the "Island Ponds" (A19, 20, 21)--the first marsh restoration action for the Project.

Restoration Targets	Score	What this score means at the 10-year point in the Project
Tidal marsh habitat for **Ridgway's rails** and numbers of rails within the Project area meet recovery plan criteria.		Trending positive. Sedimentation and growth of marsh vegetation at the Island Ponds, especially in pond A21, occurred faster than expected. In summer 2014, a Ridgway's Rail was spotted at A21 and, in summer 2015, breeding rails were documented.
Tidal marsh habitat for **salt marsh harvest mice** numbers of mice within the Project area meet recovery plan criteria.		Trending positive. Salt marsh harvest mice were identified in newly-restored pond A21 in 2015, much sooner than expected.
Increases in tidal habitats increased survival, growth and reproduction of **harbor seals**.		Trending positive. Harbor seal numbers were holding at levels recorded in recent years.

Caveats and Uncertainties

- Large-scale and effective removal of invasive *Spartina* species and hybirds by the Invasive *Spartina* Project--while beneficial for some species--had a negative impact on Ridgway's rails, which were using that habitat.
- It is not well understood if tidal restoration has benefited harbor seals, but an increase in fish should provide more prey.

Management Going Forward

Because marsh has developed more slowly in the two other Island Ponds, A19 and A20, managers plan to open them further to Bay tides as part of Phase 2 construction. The Project coordinates with the Invasive *Spartina* Project to restore the native species, *Spartina foliosa*, to expand high-quality habitat for Ridgway's rails. Harbor seal and saltmarsh harvest mouse monitoring will continue.

Water Quality and Fish

The Project's ponds were originally designed to trap Bay water and, through evaporation, produce salt. This pond design impeded the water flow needed to maintain good water quality for fish and other aquatic life. Ponded conditions promote algae growth and, when the algae die and decompose, oxygen levels drop creating poor water quality, even killing fish. Soon after acquiring the ponds, the Project managers installed approximately 53 pipes and pumps to improve water flow and water quality in the managed ponds. When ponds are fully restored to tidal action, they are expected to benefit native aquatic species and potentially create nursery grounds for native fish. Both managed and restored ponds were closely observed in Phase 1 to determine whether management actions improved water quality and native fish diversity.

Restoration Targets	Score	What this score means at the 10-year point in the Project
South Bay **water quality** will remain above baseline quality levels.		Uncertain. At some times of the year and tidal cycle, the managed ponds deliver high-oxygen water to the sloughs and Bay, but at other times the water leaving the pond is low in oxygen.
The Project will avoid releasing nuisance and invasive species of **algae** to the Bay and will avoid producing **algal blooms** that caused low dissolved oxygen in managed ponds.		Trending Negative. There is no evidence of the Project releasing nuisance species of algae into the Bay. But, shallow waters in ponds are warmer than Bay waters, and can promote algae growth.
The number of **steelhead and other salmonids**, including juveniles, will increase in rearing and foraging habitats.		Uncertain. Due to the sensitivity of these species and the recent drought, little data could be collected on the response of salmon species to management actions.
The number of **native adult and juvenile fish** will increase in estuarine rearing and foraging habitats.		Trending positive. Of 58 fish species identified in restored tidal marsh, 40 were native. Restored ponds provide nursery habitat for native fish.

Caveats and Uncertainties

- The biological and chemical system in South Bay ponds, sloughs and Bay waters is complex and much remains unknown. More work is needed to assist managers with pond management.
- A continuing regulatory concern is whether migrating salmon species are accidentally trapped in managed ponds.
- Managed ponds support primarily non-native fish; despite being non-native, these fish provide prey for many other species.

Management Going Forward

Managers continue to actively monitor ponds for signs of low oxygen and fish kills, keep regulators informed, and alter water operations as much as they can to minimize algal blooms and related problems. They have installed fish screens in some ponds to protect salmon species.

Public Access and Wildlife

A key Project goal is to provide high-quality public access for the South Bay's four million residents. However, this public access must also be compatible with wildlife--especially given that south San Francisco Bay is a major migratory resting and wintering location for millions of shorebirds and waterfowl. In addition to protecting species, the Project seeks to build access that the public will find both popular and useful. Studies in Phase 1 provided managers with information on how of trail-users might be affecting habitat use by migratory waterbirds and offered guidance on the features human trail users find attractive.

Restoration Targets	Score	What this score means at the 10-year point in the Project
Public access will not **significantly affect birds** or other target species on short or long timescales.		Trending Positive. Wintering shorebirds were relatively tolerant of trail use. Wintering waterfowl at both new and existing trails stayed far from active trails, but trail designs are incorporating appropriate buffers to protect species.
Public access features will provide the **recreation and access experiences** visitors and the public want over short or long timescales.		Trending Positive. A survey of existing trail users found high satisfaction with Bay-side trails. Users wanted conveniently located trails with overlooks or views, parking, signage, restrooms, wildlife viewing, good trail maintenance and, connections to existing trails.

Caveats and Uncertainties

- Kayak launches are planned and the San Francisco Bay Water Trail includes the Project area. Studies of boating impacts to wildlife are needed.
- There is little information on the effect of trail use adjacent to tidal marsh habitat. As the Project produces more tidal marsh, studies of species' responses to trail use adjacent to such habitats will provide valuable management information.

Management Going Forward

Managers incorporated recommended trail buffer distances into several Phase 1 trail designs and will incorporate trail buffers and location recommendations, such as concentrating trails in popular public access areas, into future trail designs.