

Applied Studies Summary

During the Project's planning phase from 2003-2007, the Science Team with participation of the other Project participants determined the most important gaps in our knowledge about South Bay ecosystem functioning or restoration that may hinder our ability to achieve the Project Objectives. The key Project uncertainties identified were:

- **Sediment dynamics**, especially the extent to which tidal habitat restoration might result in the loss of slough and Bay tidal mudflat habitat (links to Project Objective 1A and 1C).
- **Bird use of changing habitats**, especially the extent to which tidal habitat species can be recovered while maintaining the diversity and abundance of nesting and migratory waterbirds observed during pre-ISP conditions (links to Project Objective 1B).
- **Effects on non-avian species**, especially the extent to which restoration and management will affect fish and other critical species in the South Bay ecosystem (links to Project Objective 1C).
- **Mercury**, especially the extent to which Project restoration and management actions might result in an increase in bioavailable mercury in the food chain above pre-ISP levels (links to Project Objective 4).
- **Water quality**, especially the effects of pond management regimes on slough and Bay water quality and important species (links to Project Objective 4).
- **Invasive and nuisance species**, especially the invasive *Spartina* hybrids, red foxes, California gulls, and mosquitoes (links to Project Objective 5).
- **Public access and wildlife**, especially the extent to which various forms of public access and recreation can be integrated into the Project without significantly affecting wildlife (links to Project Objective 3).
- **Social dynamics**, especially the extent to which the local population in the South Bay will actively support the Restoration Project over time (links to all Project Objectives, but especially Project Objectives 2 and 3).

The Project's Science Syntheses (available from the managing agencies or on the Project website) provide more information on the connection between these uncertainties and the Project Objectives.

The Science Team then developed a list of the highest priority applied studies, to be researched through hypothesis testing and modeling, in order to reduce the eight key uncertainties. The table below lists the 21 applied studies questions and when research is expected to occur. Each of these questions will require multiple studies in order to develop adequate information for management. In addition, numerical modeling is essential to address questions and develop predictive power. Specifically, sediment dynamics questions, water quality, mercury transport, bird carrying capacity, and effects of human population dynamics all require modeling. Results from many of the applied studies and models are needed to proceed from Phase 1 into later phases.

Key Scientific Uncertainties and Applied Studies

<p><u>Key Uncertainties</u>, in italics, are followed by specific, high-priority <u>Applied Study Questions</u> (in bold) with a brief explanation of the importance of each question.</p>	<p>Where Studies are Planned</p>
<p><i>Sediment Dynamics. Is there sufficient sediment available in the South Bay to support marsh development without causing unacceptable impacts to existing habitats?</i></p>	
<p>1</p>	<p>Will sediment accretion in restored tidal areas be adequate to create and to support emergent tidal habitat ecosystems within the 50-yr projected time frame? Sediment deposition has varied greatly over the last 150 years. Large-scale restoration occurring over decades will also affect sediment dynamics throughout the South Bay and regional study will be required to understand these changes.</p>
<p>2</p>	<p>Will sediment movement into restored tidal areas significantly reduce habitat area and/or ecological functioning (such as plankton, benthic, fish or bird diversity or abundance in the South Bay)? Sediment accretion into the restored ponds is expected to reduce the amount of mudflat in the South Bay, but it is not known whether mudflat loss will be significant in terms of acreage or its effect on South Bay ecology. Such changes are expected to occur over decades.</p>
<p>3</p>	<p>Will restoration activities always result in a net decrease in flood hazard? Increased tidal prism will scour slough channels within a relative short time frame (months to years) and reduce flood hazard. Changes in tidal elevations and prism in sloughs occurring over months to years may potentially increase flood hazard.</p>
<p><i>Bird Use of Changing Habitats. Can the existing number and diversity of migratory and breeding shorebirds and waterfowl be supported in a changing (reduced salt pond) habitat area?</i></p>	
<p>4</p>	<p>Will the habitat value and carrying capacity of South Bay for nesting and foraging migratory and resident birds be maintained or improved relative to current conditions? Overall ecosystem changes and effects must be measured and compiled over decades to understand the overall implication of South Bay restoration on migratory birds. Some factors that could affect bird numbers are changes in disease and predation rates, food availability, and nest competition.</p>
<p>5</p>	<p>Will shallowly flooded ponds or ponds constructed with islands or furrows provide breeding habitat to support sustainable densities of snowy plovers while providing foraging and roosting habitat for migratory shorebirds? Simple changes to existing pond management or simple habitat alteration may significantly benefit nesting snowy plovers while still providing nesting and foraging habitat for other species, but the extent of potential benefits is not known.</p>

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<i>Bird Use of Changing Habitats. (continued)</i>		
6	Will ponds reconfigured and managed to provide target water and salinity levels significantly increase the prey base for, and pond use by waterfowl, shorebirds and phalaropes/grebes compared to existing ponds not managed in this manner? Ponds managed as small-scale salt pond systems may provide enhanced benefits for wide range of birds. But, the extent to which they can improve the prey base and increase foraging shorebird densities in the short and long-term is not known.	Phase 1 at E12/13
7	To what extent will the creation of large isolated islands in reconfigured ponds maintain numbers (and reproductive success) of terns and other nesting birds in the South Bay, while increasing densities of foraging birds over the long term compared to ponds not managed in this manner? Changing salt pond island configurations may result in significant increases in nesting and foraging bird densities but to what extent is not known.	Phase 1 at A16 & SF2
8	Will pond and panne habitats in restoring tidal habitats provide habitat for significant numbers of foraging and roosting shorebirds and waterfowl over the long term? Naturally-maintained pond and panne habitat within marshes could potentially provide significant habitat for many species that currently use ponds. But, little is known about the extent of potential benefits to waterbird species on short or long timescales.	Phase 1 at E8A/9/8X
9	How do California clapper rails and/or other key tidal habitat species respond to variations in tidal marsh habitat quality and what are the habitat factors contributing to that response? Increased tidal habitat is expected to boost populations of California clapper rails and other key species, but the data on the conditions that produce high quality habitat for survival and reproduction are needed.	As appropriate habitat develops
<i>Effects on Non-Avian Species. Can restoration actions be configured to maximize benefits to non-avian species both onsite and in adjacent waterways?</i>		
10	To what extent will increased tidal habitats increase survival, growth and reproduction of native species, especially fish and harbor seals? The extent to which restoring tidal habitats will affect native species, including steelhead, harbor seals, native fish and oysters, is unknown. This question requires long-term study on local and regional scales relevant to the species examined.	During and after Phase 1

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<i>Mercury. Will mercury be mobilized into the food web of the South Bay and beyond at a greater rate than prior to restoration?</i>		
11	Will tidal habitat restoration and associated channel scour increase MeHg levels in marsh and bay-associated sentinel species? Restoration actions could increase the bioavailability of mercury in sediment and water. Bioavailable mercury becomes a problem when it leads to deleterious accumulation in wildlife and people. Sentinel species, such as some invertebrates, fish and birds, are a cost effective way to monitor this toxic pollutant.	ISP at A8 and Phase 1 at E8A/9/8X & A8
12	Will pond management increase MeHg levels in ponds and pond-associated sentinel species? Pond management could increase the bioavailability of mercury in sediment and water over pre-ISP conditions. Sentinel species, such as some invertebrates, fish and birds, are a cost effective way to monitor this pollutant.	Phase 1 as part of A8 study
<i>Water quality: Will restoration adversely affect water quality and productivity?</i>		
13	What is the effect of a) pond management, including increased pond flows and associated managed pond effects, and b) increased tidal prism from tidal habitat restoration on water quality, phytoplankton and fish diversity and abundance, and food web dynamics in South Bay? Pond management and resulting water discharges to the Bay have the potential to decrease slough and Bay water quality and affect Bay species, but little is known of the short or long-term effects of pond management on the South Bay ecosystem. Restoring tidal action to ponds will increase the tidal prism and tidal currents in South Bay. South Bay phytoplankton dynamics at the base of the food web are dependent on hydrodynamics and mixing.	Phase 1
<i>Invasive and Nuisance Species. Can invasive and nuisance species such as <u>Spartina alterniflora</u> (or the invasive <u>Spartina</u> hybrid), corvids and the California gull and, if warranted, raptors such as the northern harrier, be controlled. If not, how can the impacts of these species be reduced in future phases of the project?</i>		
14	Where not adequately eradicated, does invasive <i>Spartina</i> and hybrids significantly reduce aquatic species and shorebird uses? The Invasive Spartina Project is a comprehensive program to control <i>Spartina alterniflora</i> hybrids to a level at which native species are not threatened. If this Project is not successful, this applied studies question would need investigation.	Depends on Invasive Spartina Project results
15	Will California gulls, ravens, and crows adversely affect (through predation and encroachment on nesting areas) nesting birds in managed ponds? Data indicate that a number of native predatory species are increasing in population and are negatively affecting native breeding birds, but the extent of the impacts are not known.	Phase 1 at A6, A16, & SF2

	Where Studies are Planned	
<p><i>Public Access and Wildlife. Will trails and other public access features / activities have significant negative effects on wildlife species?</i></p>		
16	<p>Will increases in boating access significantly affect birds, harbor seals or other target species on short or long timescales? While there is a strong constituency for increased boating access, there is almost no information in the San Francisco Bay on the immediate or long-term effects of recreational boating on birds or other target species in different habitat types.</p>	During and after Phase 1
17	<p>Will landside public access significantly affect birds or other target species on short or long timescales? Information on the short and long-term effects of general and specific trail uses, such as dog walking, on birds and other key species in different habitat types (ponds, sloughs, tidal habitat) is mostly lacking, as is information on effective mitigation measures.</p>	Phase 1 at E12/13, A16, & SF2
18	<p>Will public access features provide the recreation and access experiences visitors and the public want over short or long timescales? The public's desire for recreational uses changes over time. Understanding and providing the opportunities people value, to the extent feasible, is essential for the Project engender stewardship and public support in the short and long-term.</p>	Phase 1
<p><i>Social Dynamics. How can the Project gain support from the public now and into the future?</i></p>		
19	<p>Will voters, advocacy groups, elected officials, and government agencies support the project (especially in terms of funding) over the short timescale at the local and regional spatial scales? While the Project does not seem to generate opposition and habitat restoration seems popular in the Bay Area, there are factors that may impede public and political support, such as competing funding initiatives and very local community concerns.</p>	Phase 1
20	<p>What are the benefits and costs associated with the project sites and will they be shared equitably among communities, businesses, municipalities, and/or government agencies at local and regional scales? Cities/municipal governments may worry about economic costs and benefits attributable to the Project that will spill over into jurisdictions, especially concentrated costs, but also benefits attributable to the Project. The project will also generate regional benefits (and perhaps costs).</p>	During and after Phase 1
21	<p>Will impacts associated with population growth and development adjacent to the project sites and beyond be successfully managed over the long timescale at the regional scale? Population growth, densification, and development in the South Bay and the region as a whole will affect the ability of adaptive management to reach the project objectives. There is some information on population growth, but little information on how the particular patterns of growth and development will affect the project sites.</p>	During and after Phase 1