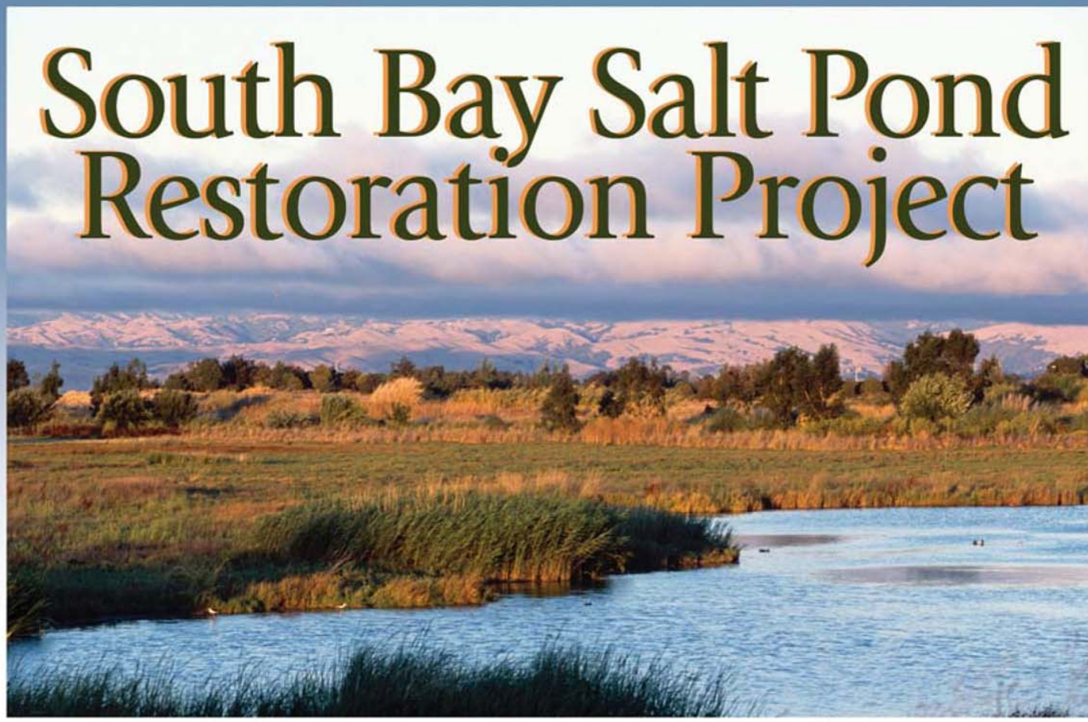

Biology and Habitats
Existing Conditions Report

Submitted to:
California State Coastal Conservancy
U.S. Fish & Wildlife Service
California Department of Fish and Game

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ACRONYMS AND ABBREVIATIONS

ADF	Alternatives Development Framework
CDFG	California Department of Fish and Game
CIR	Color infrared
ESU	Evolutionary Significant Unit
GIS	Geographic Information Systems
ISP	Interim Stewardship Plan
PG&E	Pacific Gas & Electric
PMT	Project Management team
PRBO	PRBO Conservation Science
SBSP	South Bay Salt Pond
SFBBO	San Francisco Bay Bird Observatory
SFEI	San Francisco Estuary Institute
USACOE	U.S. Army Corp of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WPCP	Water Pollution Control Plant

1. EXECUTIVE SUMMARY

The San Francisco Bay estuary is an extremely productive, diverse ecosystem, yet one that has been degraded considerably since the 1800s. The estuary has lost more than 90% of its original wetlands to diking, draining, and filling, and it has been more heavily invaded by nonnative species than any other aquatic ecosystem in North America. Despite this degradation, native wildlife diversity is high, with more than 250 species of birds, 120 species of fish, 81 species of mammals, 30 species of reptiles, and 14 species of amphibians regularly occurring in the estuary. More importantly, the San Francisco Bay supports populations of a number of species that are of regional, hemispheric, or even global importance. A number of endemic, endangered, threatened, and rare wildlife species or subspecies reside in the San Francisco Bay Area.

The South San Francisco Bay (South Bay) is a critical component of the larger estuary. Though surrounded by urban development and highly altered by the diking of wetlands for salt production, the South Bay supports some of the most important habitat remaining in the entire Bay Area for a number of wildlife species. The restoration of former salt production ponds to tidal habitats will greatly increase the acreage of these important habitat areas, and there are significant opportunities to manage these areas for wildlife instead of salt production.

This report characterizes the existing biological conditions related to the South Bay Salt Pond (SBSP) Restoration Project. The principal biological components of concern are the vegetation and habitats, the wildlife, and the area of jurisdictional habitat. This report outlines the current state of understanding of these resources in the SBSP Restoration Project, which is subdivided into three main areas: the Alviso, Ravenswood, and Eden Landing pond complexes (Figure 1). The description of existing biological conditions is an important step in the early stages of planning of the salt pond restoration. This description provides a foundation from which to evaluate and contrast a wide range of restoration alternatives, will serve to help inform the selection of the preferred alternative, and will provide baseline data for monitoring and adaptive management.

Habitats and Vegetation. Mapping conducted during 2004 of the project lands and immediately adjoining areas shows that the Alviso complex contains 7,363 acres of former salt ponds, 420 acres of salt marsh, 896 acres brackish marsh, as well as other associated Bay habitats. The Ravenswood complex contains 1,440 acres of former salt ponds, with a mix of other habitats surrounding the ponds, including salt marsh (137 acres). The Eden Landing complex contains 4,423 acres of former salt ponds and 741 acres of salt marsh. Of the over 18,000 acres mapped in the three pond complexes, 72% (>13,000 acres) consist of former salt ponds.

The dominant habitats that occur in the South Bay (south of the San Mateo Bridge) between the three pond complexes were also quantified. These include approximately:

- 14,500 acres of intertidal mudflat habitat (at –0.9 ft Mean Lower Low Water);
- 12,575 acres of active salt ponds;

- 8,330 acres of tidal wetlands; and
- 2,549 acres of planned or on-going tidal restoration projects.

Within the tidal salt marsh habitats of the South Bay, pickleweed (*Salicornia virginica*) and cordgrass (*Spartina* sp.) are the dominant species. Alkali bulrush (*Scirpus maritimus*) and perennial pepperweed (*Lepidium latifolium*) are the most common brackish marsh species, while California bulrush (*Scirpus californica*) and cattails (*Typha* sp.) are the dominant freshwater marsh species.

No special-status plants are documented to occur within the boundaries of the project. Numerous occurrences of five species, however, are documented within the Pacific Commons Preserve, just north of pond A22, including Congdon's tarplant, prostrate navarretia, alkali milk vetch, Contra Costa goldfields, and San Joaquin spearscale, are documented in the vicinity of the Alviso pond complex. Although historic populations of alkali milk vetch and Point Reyes bird's-beak are documented in the vicinity of the town of Alviso, suitable habitat for these species has been extirpated from the Alviso pond complex. Finally, several extant populations of Congdon's tarplant occur in the town of Alviso, but these populations are located well outside project boundaries.

Wildlife Resources. This report includes discussions of the species composition and structure of invertebrate, fish, reptile, amphibian, mammal, bird, and plant communities in the South Bay. These species' life histories (as they pertain to their use of the South Bay), habitat requirements and habitat use in the South Bay, and the spatial and temporal variation in these species' presence/distribution in the region are summarized, as are the occurrence and use of the South Bay by special-status plant and wildlife species.

In summary, the ecology of South Bay wildlife communities is characterized by:

- high productivity of tidal marshes, with export of organic matter from tidal marshes to tidal sloughs, channels, and mudflats, and to the Bay, supporting high abundance of invertebrates, fish, and birds;
- high productivity of salt ponds, supporting an abundance of invertebrates (particularly in higher-salinity ponds) and high numbers of fish in lower-salinity ponds, but with virtually no export of organic matter to other habitats aside from variable (and at times, very heavy) use of the salt ponds by birds;
- a heavily invaded aquatic invertebrate community dominated by non-native species;
- heavy use of South Bay habitats by waterbirds, including significant proportions of Pacific Coast migratory shorebird populations;
- highly dynamic bird and fish communities, with use of different areas varying several times a day with tide height, and with abundance and community composition varying seasonally depending on migration, precipitation, temperature, salinity, and other factors. In particular, large numbers of shorebirds forage on intertidal mudflats at low tide and use salt ponds and other alternative habitats (*e.g.*, water treatment plant ponds) for roosting and/or foraging, particularly at high tide;
- the presence of rare San Francisco Bay endemics, including the California Clapper Rail and salt marsh harvest mouse, in remnant tidal marsh habitat.

- small, isolated tidal salt-marsh remnants, with very limited escape cover for salt marsh harvest mice, effectively isolating subpopulations of this species.

Wetland Technical Assessment. Historically, the majority of the project area was exposed to the full ebb and flow of the tides. These habitats included tidal sloughs and channels, salt marshes, transition zone wetlands extending up from the marsh to the high tide line, salt pans, and mudflats. This complex of habitats comprises several different categories of jurisdictional waters including Historical and Current Section 10, and Section 404 waters.

Approximately 16,850 acres of current Section 10 and 404 jurisdictional waters, including wetlands (2,584 acres) and other waters (14,266 acres; salt ponds, mudflats, salt pan and open water) were identified on site and in tidal areas immediately adjoining the site. The remainder of the project site (*i.e.*, uplands; approximately 1,421 acres) met none of the regulatory definitions of jurisdictional waters under Section 404 of the Clean Water Act nor Section 10 of the Rivers and Harbors Act.

2. INTRODUCTION

This document provides the existing biotic conditions of the South Bay Salt Pond (SBSP) Restoration Project. The goal of the project is the restoration and enhancement of wetlands in the South San Francisco Bay while providing for flood management and wildlife-oriented public access and recreation. To accomplish the restoration goals, it is necessary to have an understanding of the existing natural landscape.

This report is one volume in a set of five existing conditions reports. Additional Existing Conditions Reports include:

- Hydrodynamics and Sediment Dynamics
- Water and Sediment Quality
- Flood Management and Infrastructure
- Public Access and Recreation

Additional companion documents include the Data Summary Report (PWA and others 2004a), the Initial Opportunities and Constraints Summary Report (PWA and others 2004c), and the Mercury Technical Memorandum (Brown and Caldwell 2004).

The description of existing biological conditions is an important step in the early stages of salt pond restoration. This description provides baseline data to evaluate and contrast a wide range of restoration alternatives, and will serve to inform the selection of the preferred alternative. The alternatives development process (PWA and others 2004b) builds upon the project objectives and, in conjunction with the Initial Opportunities and Constraints Summary (PWA and others 2004a), will shape the early formulation of restoration alternatives. As such, the existing conditions data include biological information for species identified in the SBSP Restoration Project's list of detailed project objectives, including the current spatial location and biological description of habitats for those species.

The Existing Biological Conditions Report contains the following sections:

Section 4. Habitats and Vegetation. This section presents the existing conditions for habitats and vegetation in the South Bay, including overall habitat assessment and maps and the occurrence and potential for reintroduction of special-status plant species.

Section 5. Wildlife Resources. This section presents the existing conditions for wildlife in the South Bay. Included in this section are discussions of species composition and structure of invertebrate, fish, reptile, amphibian, mammal, and bird communities in the South Bay. Details of these species' life histories (as they pertain to their use of the South Bay), habitat requirements and habitat use in the South Bay, and the spatial and temporal variation in these species' distributions in the region are discussed. The occurrence and use of the South Bay by special-status wildlife species is also summarized.

Section 6. Wetland Technical Assessment. This section presents an assessment of the extent of potential jurisdiction by the U.S. Army Corps of Engineers (USACE).

Existing biological conditions described in this document include habitats, vegetation and wildlife that exist within the SBSP Restoration Project area (Figure 1) at the onset of restoration planning. The Initial Stewardship Plan (ISP) (Life Science 2003) describes the operation and maintenance of the ponds prior to the long-term restoration plan and, as such the ISP represents the existing condition (Appendix A). Since the ISP implementation began in July 2004 and will continue to be implemented through 2007, assumptions have been made in the Existing Biological Conditions report regarding biological functions and values that will be present once the ISP is fully operational, but prior to the implementation of the SBSP Restoration plan. The ISP will continue beyond 2007 for many ponds, until tidal restoration or managed pond condition is "implemented" in phases of the SBSP Restoration Project.

2.1 Regional Setting

The San Francisco Bay estuary is an extremely productive, diverse ecosystem. Despite the loss of more than 90% of the original wetlands in the Bay Area to diking, draining, and filling (Goals Project 1999), wildlife diversity is high, with more than 250 species of birds, 120 species of fish, 81 species of mammals, 30 species of reptiles, and 14 species of amphibians regularly occurring in the estuary (Siegel and Bachand 2002). More importantly, the San Francisco Bay supports populations of a number of species of regional, hemispheric, or even global importance. A number of endemic, endangered, threatened, and rare wildlife species, or subspecies, reside in the San Francisco Bay Area.

The South San Francisco Bay (South Bay) is a vital component of the larger estuary. The South Bay supports some of the most important habitat remaining in the entire Bay Area for a number of wildlife species, in spite of the surrounding areas being highly urbanized and the Bay itself having been dramatically altered by the diking and filling of wetlands for salt production and urban development (Goals Project 1999).

The term "South Bay" is typically used to refer to the portion of the Bay south of the San Mateo Bridge, which differs in several physical and ecological aspects from the Central Bay, North Bay, San Pablo and Suisun Bays, and the Delta portions of the San Francisco Bay estuary. The study area for this existing conditions document includes the open waters of the Bay up to the upper reaches of tidal action, the tidal and nontidal wetlands and former salt evaporation ponds adjacent to the Bay, and the upland areas immediately adjacent to these features. This area is bordered by the Central Bay to the northwest and is surrounded by urban development on all other sides. While this study area is larger than the actual project area, this landscape-level description will be important when considering restoration options and the concomitant benefits and impacts of those options.

2.2 Study Area

The 15,100 acre SBSP Restoration Project area consists of three main areas on the shoreline of the southern San Francisco Bay: the Ravenswood, Alviso and Eden Landing pond complexes (Figure 1).

The 1,440-acre Ravenswood pond complex is managed by the U.S. Fish and Wildlife Service (USFWS) and is located in San Mateo county; the 7,363-acre Alviso pond complex is managed by the USFWS and is located in Santa Clara County; and the 4,274-acre Eden Landing pond complex is managed by the California Department of Fish and Game and is located in Alameda County.

3. HABITATS AND VEGETATION

3.1 Introduction

The existing conditions, as documented in this report, actually refer to the ISP condition; since the ISP actions are still in the process of being implemented, it is necessary to use some pre-ISP terminology. For example, ponds that are the subject of the proposed restoration effort are technically no longer salt-production ponds. However, because the vast majority of research conducted on these ponds was performed when they were functioning as salt ponds, the term "salt pond" will be used to refer to these ponds. The observed, or predicted, changes in habitat as ISP controls become operational will be noted where appropriate, and any necessary distinction between the "salt ponds" included in the restoration plan and ponds retained for salt production by Cargill will be explicitly noted.

The ISP is designed to circulate water through the former salt ponds and dischargevia sloughs or directly to the Bay to minimize adverse effects on habitat values and salinity levels during long-term planning of the restoration project (Life Science 2003). Through a series of new and existing water-control structures and pumps, the ponds will be managed under the following regimes:

- Managed water flow
- Seasonal ponds
- Batch ponds to increase salinities (for salt pond specialist species such as *Phalaropes* spp.)
- Full or muted-tidal
- Actively managed for wildlife resources

Appendix A outlines the specific ISP management of each individual pond.

3.2 Habitat Mapping Methodology

3.2.1 Base Imagery

The City of San Jose acquired IKONOS imagery from a satellite pass that occurred at noon on May 8, 2004. The tidal elevation at this time was –0.9 ft Mean Lower Low Water (MLLW) near the mouth of Coyote Creek in the Alviso complex. The satellite images were purchased by the City of San Jose, which donated them for use in the SBSP restoration planning. The 1-meter Multispectral (4-bands) CIR & True Color IKONOS satellite imagery is projected in UTM NAD83 (meters) Zone 10 North. Habitat mapping was based upon the imagery obtained and completed at a 1:2400 (1" = 200') scale using the IKONOS imagery as a base layer.

3.2.2 Habitat Mapping and Area Calculations

Habitat mapping was assisted using two laptop computers (Panasonic Toughbook 18) equipped with GIS software (ArcView 9). These computers and software allow the IKONOS imagery to be used for mapping in the field, or in the office.

The initial mapping was conducted off-site. Initial habitat boundaries and classifications were identified using the IKONOS imagery and was based on the signatures of the photographic imagery. Topographic features, marsh boundaries, and tentative habitat types (based on photographic signatures) were mapped in the office prior to field visits.

Extensive ground-truthing of the preliminary mapping was conducted during site visits to the entire SBSP Restoration Project area during July and August, 2004. Marshes were observed primarily from levee trails, unimproved salt pond levees and Pacific Gas and Electric (PG&E) walkways. Due to lack of access to the interiors of many sections of tidal marsh in the project area, mapping of miscellaneous features in the interior of the marshes and individual ponds was not possible.

The GIS database was downloaded and backed up weekly. The digitized boundaries of habitat areas were reviewed for consistency and quality. Plant association acreages and color-coded figures for the entire project area were generated in GIS (ArcView 9.0).

3.3 Habitats and Vegetation

Research has shown that a number of variables control the distribution of plant species in coastal marshes, including depth and duration of flooding over the marsh surface (Mendelssohn and McKee 1988; Pennings and Callaway 1992; Webb and Mendelssohn 1996; Webb and others 1995), accumulation of phytotoxins such as hydrogen sulfide in marsh soils (DeLaune and others 1983; King and others 1982; Koch and Mendelssohn 1989; Webb and Mendelssohn 1996; Webb and others 1995), interstitial nutrient concentrations (Bradley and Morris 1990; Koch and Mendelssohn 1989; Koch and others 1990; Morris 1980), and soil mineral and organic matter content (DeLaune and others 1979; Nyman and others 1990). Natural variability in abiotic factors such as precipitation, tidal fluctuation, and evapotranspiration, as well as anthropogenic changes to those factors such as freshwater discharges, non-point source pollution (nutrients and sediments), and regional/global climate changes (drought, temperature, sea level) influence these variables (Boyer and Zedler 1999, Kennish 2001). Among these variables, hydroperiod and salinity are the primary abiotic factors that control the distribution of the dominant plant species in a tidal marsh (H. T. Harvey & Associates and others 1982; Josselyn and San Francisco State Univ. 1983; Zedler and others 1992; Zedler and others 1999).

Competition between different plant species (interspecific) with similar environmental tolerances also influences their distributions. Although environmental tolerance and competitive ability are inversely related (Bertness 1991; Grace and Wetzel 1981; Zedler 1982), competition still plays a role among species with similar tolerances (Ervin and Wetzel 2002, Huckle and others 2002). For example, Zedler

(1982) found that competitive interactions occur in salt marshes, and concluded that pickleweed does compete with cordgrass for light and to some extent, nutrients. Furthermore, competitive interaction is what allows the successful invasion of non-indigeneous species into wetland habitat that commonly alters plant distribution (Vitousek 1990, Hooper and Vitousek 1997).

3.3.1 Historical Habitats

The examination of the habitats that historically occurred along the South Bay provides a context in which to examine the existing conditions of the South San Francisco Bay. Estuaries typically contain a mosaic of habitats that support diverse communities of plants and animals. Historic ecological communities of South Bay are described below. Most of these communities have been greatly reduced in size due to land use changes in the South Bay. Ideally, the restoration of the South Bay's ecosystem should involve all the landscapes and their associated habitat types.

The San Francisco Estuary formed as sea level rose through the Golden Gate approximately 10,000 years ago (Atwater 1979; Atwater and others 1977). Tidal marshes began to form as the rate of sea level rise slowed relative to the rate of sediment deposition, approximately 4000 – 6000 years ago. Most of the tidal marshes in the Bay are less than 3000 years old (Atwater 1979; Byrne and others 2001; Wells and Gorman 1994). Historically the salinity gradient in the South Bay increases slightly from the Golden Gate Bridge southward (Collins and Grossinger 2004).. The modern salinity gradient is similar, however differences due to altered freshwater inputs in the South Bay are both related to regional precipitation and anthropogenic causes (Byrne and others 2001; Fox and others 1991, Malamud-Roam and Ingram 2004).

Collins and Grossinger (2004) describe three major types of historical South Bay landscapes: saline tidal marsh, riparian tidal marsh, and salt pond landscapes. The South Bay saline tidal landscape consisted of marshlands with high channel density, abundant marsh pans and salinas, moist grasslands along the backshore, large sausals, and extensive tidal flats. Shell beaches were common on the west shore and vernal pool complexes were common in the area of Alameda Creek. The South Bay riparian tidal marsh landscape existed along a salinity gradient from fresh to saline or brackish waters, influenced by perennial creeks such as Coyote Creek and the Guadalupe River. These areas had large marsh pans and a less dense channel network in the vicinity of major freshwater sources. The South Bay salt pond landscape comprised tidal marshlands dominated by salt ponds. These areas comprised roughly equal areas of tidal marsh and salt pond with minimal tidal channel network development. Small salinas and marsh pans were adjacent to the salt ponds, with moist grasslands occurring along the backshore.

Details of these habitats are outlined below based on more complete descriptions by Collins and Grossinger (2004):

> <u>Islands and Peninsulas</u>. As sea levels rose, hills were transformed into islands within the marshland or into peninsulas surrounded by marshland and connected to the mainland. Examples in the South Bay include Bay Farm Island, Point San Bruno, Coyote Point, and the Coyote Hills.

Creeks and Fans. Larger watersheds around the Bay supported modest perennial creeks, some of which reached the Bay across broad alluvial fans. Many of the smaller creeks did not reach the Bay but terminated on fans or in seasonal wetlands. The alluvial fans are important features around the estuary, and the locations of many habitat types such as seeps, springs, wetlands and creeks are determined by the size and shape of alluvial fans.

Sag Ponds. Seismic process that induce land subsidence along fault traces form sag ponds. These ponds were probably perennial, but varied seasonally in depth and size.

Dry Grassland. Vegetation dominated by grasses and sedges was widespread along the shores of the Bay, while most forests and savannas were farther from the Bay edge, existing in canyons or at higher elevations. The native perennial grasslands the predominate near the Bay were composed of perennial bunch grasses and rhizomatous grasses, especially purple needlegrass (*Stipa pulchra*) and creeping wild rye (*Leymus triticoides*).

Moist Grassland. Moist grasslands formed in flatland areas of poorly drained, clayey soils that received water inputs from direct rainfall and overland flooding. The band of moist grasslands surrounding the South Bay marshes was generally a mile or more in width, being interrupted intermittently by dry grasslands that existed on coarse soils.

Coast Prairie. This is a type of grassland that occurs in limited distribution in areas with clay soil that are exposed to marine air.

Vernal Pools. Vernal pools exist in areas with an impermeable hardpan, clay or bedrock substrate. The substrate prevents water from draining, but water is evaporated during the warmer months, creating these seasonally wet vernal pools. Historically vernal pool complexes existed in the South Bay near present-day Warm Springs near Alameda Creek.

Sausals. Sausals (termed by Spanish explorers) are groves of willows on flat lands, often associated with creeks that are sustained by springs, seeps, or a shallow water table. Sausals occupied large expanses in the South Bay, up to 350 acres in size, and were dominated by arroyo willows (*Salix lasiolepis*) intertwined with blackberry (*Rubus ursinus*) and wild rose (*Rosa californica*). Most sausals were located at the upland edge of the tidal marsh, while others were located along stream courses. Indigenous peoples managed some of the sausals in the South Bay for medicines and building materials.

Riparian Forest. Riparian forests border the edges of lakes and creeks. They comprise a gradient of moisture and light between an aquatic system to upland areas within a watershed. Due to steep topography, riparian forests tended to be restricted to adjacent margins of a creek. The lack of defined creek channels across the plains near the bay, and the upstream movement of saline tidal water, limited the downstream extent of the riparian forests. Historically, riparian forests extended downstream to approximately the 10-15 foot contour, within several hundred meters of the tidal marsh backshore.

Tidal Marsh-Upland Ecotone. This ecotone varied in width depending on adjacent topography and often constituted broad, distinctive habitats occupied by both salt-tolerant and upland plant species. These areas were flooded only by the highest tides. This ecotone area was dominated by salt grass (*Distichlis* sp.) and native composites. The transitional nature made this habitat difficult to map, and was inconsistently identified historically. The tidal marsh-upland ecotone integrated into seasonal wetland habitats, including vernal pools and alkali marshes, and moist grasslands. Many of these exotonal areas have been graded into steep elevational gradients, causing a decrease in number, and extirpation, of some ecotonal plant species populations.

Salt Ponds. Salt ponds are saline impoundments of estuarine water that are managed for salt production. Crystal Pond is the largest historic salt pond, covering over 1,000 acres along the eastern shore of the South Bay. The Yrgin Ohlone used Crystal Pond for salt production. Native peoples along the North Bay may have managed other salt ponds. The modification of natural salinas and pans was continued by the Spanish and into recent times for commercial salt production.

Tidal Mudflats. Tidal mudflats occur in areas where both inorganic sediment deposition and erosive wave action and tidal currents occur, between Mean Lower Low Water (MLLW) and Mean Tide Level (MTL), or at the shore of tidal marshland. Historically, most of the mudflats occurred around the main bays of the estuary, but many were associated with shallow tidal channels that extended landward from the bays into marshlands. The upper limit of the tidal mudflats is determined by the lower limits of marsh vegetation. The duration of tidal inundation inhibits most vascular plant growth in tidal mudflats, vegetative cover is less than ten percent in tidal mudflats. The potential lateral extent of tidal mudflats tends to increase with distance into the South Bay because tidal ranges increase with distance south from the Golden Gate, while the low tide datums remain fairly constant. The extent that the potential extent becomes tidal mudflat depends on sediment supply. The broad slopes of the intertidal zone explains the historical abundance of tidal mudflats around the South Bay.

Beaches. Beaches are formed by sand or shells being deposited by waves or tidal currents. Sandy beaches existed on both sides of the South Bay and beaches of shell hash, mostly derived from native oyster beds, were fairly common on both sides of South Bay north of the Dumbarton narrows.

Lagoons. A lagoon is a perennial impoundment of water that is subject to occasional or episodic connection to tidal action. Freshwater inputs occur through creeks, seeps, or springs, which can make the lagoon brackish once the tidal connection is closed. Historically, lagoons formed behind barrier beaches but no lagoons are known to have existed in the South Bay.

Shallow Bays, Deep Bays, and Subtidal Channels. Shallow bays exist between MLLW and the minus 18-foot bathymetric contour. Excluding the intertidal zone, about 65% of the aerial extent of the estuary is shallow bay. This large area of tidal bay is a distinguishing characteristic of the San Francisco Estuary. Deep bay exists between the minus 18-foot bathymetric contour and the deepest reaches of the estuary. About 35% of the aerial extent of the estuary, bayward of the intertidal zone, is deep bay. Shallow bay channels link the larger intertidal sloughs and local creeks to deep bay channels. The channels in the deep bay trace the ancient rivers that drained through the Golden Gate prior to sea level rise. The shallow channels were historically maintained in part by the tidal prism of the intertidal zone.

Tidal Marshland. Tidal marshes exist in intertidal areas and support at least 10% cover of vascular vegetation adapted to intertidal conditions. The ancient marshlands began developing about 3,000 years ago when the rate of sea level rise slowed enough to allow intertidal vegetation to colonize and persist on tidal flats(Atwater and others 1979). Historically, the bayshore was adjacent to large areas of shallow bay that were not subject to great storm surges, and thus suitable for the formation of tidal flats and marshes. At the time of Euro-American contact, the estuary was surrounded by broad expanses of tidal flats and tidal marsh in which the bay-marshland boundary was in equilibrium with sediment supply (Goals Project 1999). The eroding and prograding foreshores are evident from the first US Coast Survey of the estuary (1850-66). This survey predates the land use changes that were later associated with rapid human settlement.

Those areas that were historically salt marsh have largely been converted to salt ponds in the South Bay. Many of the existing marshes, located between the levees of the salt ponds and the channels or open Bay, have formed more recently. The present day channel-side brackish marshes are likely similar to the edges of the historical marshes that at one time contained patches of lower salinity marshes within a larger matrix of salt marsh habitat (San Francisco Estuary Institute 1999). The formation of new alkali bulrush-dominated marshes in a matrix of salt marsh habitats has been observed in the Alviso Complex. This is further evidence of the highly dynamic nature of vegetation trends in South San Francisco Bay. These changes from historical conditions appear driven by large-scale environmental factors such as changes in local freshwater inputs (including discharge of treated effluent) and landscape-scale changes such as salt pond construction (San Francisco Estuary Institute 1999) and subsequent changes in channel morphology.

Marsh Channels. Tidal marsh channel formation in the San Francisco Bay has been well studied (Fagherazzi and Furbish 2004; Kamman Hydrology and Engineering 2004; Pestrong 1965; Pestrong 1969; Pestrong 1972; Siegel 2002). Larger channels on tidal flats become fixed in place as the natural levees or banks become colonized by vascular plants (Beeftink and Rozema 1988). The density of channels decreases as marsh plain evolves upward through the tidal range (Ahnert 1960; Allen 2000). The size, density and meander of marsh channels are influenced by salinity (or freshwater inputs), island area, and watershed basin area, and ebb and flood cycles. During very early stages, when vegetation was scarce, channels formed and filled until the marsh plain evolved upward to the threshold for plant colonization (Siegel 2002). The direction of dominant flow through marsh channels may shift from flood to ebb as low-order marshes evolve from tidal flats.

Historically in South San Francisco Bay, the channel-side vegetation in the middle reaches of the Alviso Slough complex may have been dominated by brackish (alkali bulrush) and freshwater species (tules), based on observations dating as far back as the mid-1800s (San Francisco Estuary Institute 1999). Salt marsh habitat dominated by pickleweed and saltgrass likely occurred inland of the channel-side vegetation (San Francisco Estuary Institute 1999).

Marsh Plain. Marsh plain forms as tidal marshes mature and gain elevation (Harrison and Bloom 1977). The tidal marsh gradient flattens, the tidal prism decreases and the cross sectional area of the channels decrease. The area of poorly drained marsh plain increases and soil salinity on the plain probably increases. During early stages of marsh formation, the vertical accretion of the marsh plain can outpace sea level rise. As the marsh plain develops upward through the tidal range, the frequency and duration of inundation decreases, and less sediment is delivered to the marsh plain via the channel network. As the plant cover becomes denser it filters inorganic sediment, particularly near the channel banks, with marsh pans and salinas restricted to the interior marsh plain away from inorganic sedimentation. Tidal marsh vertical accretion tends to maintain equilibrium with sea level rise(Watson 2004). The oldest marshes have continued to build upward at an average rate of about 2 mm per year. Both the rate of seal level rise, and the amount of suspended sediment entering the estuary vary spatially and temporally. For example tidal marshlands in the far South Bay subsided more than one meter between 1920 and 1965 due to groundwater extraction (Poland and Ireland 1988). During this time the amount of inorganic sediment in the marsh soil and the overall accretion rate, increased, as needed to sustain the high marsh (Watson 2004).

Salinas. Salinas are natural impoundments of tidal water less than 30 cm deep on the high marsh plain. They tend to be longer than wide, and to parallel the extreme high tide contour. Historically there was an almost continuous band of salinas at the landward edge of nearly all of the South Bay tidal marshlands. Some salinas were managed as “salt ponds” by the Ohlone and later by Euro-americans.

Marsh Pans. Marsh pans are topographic depressions on mature tidal marsh plains. They are most common in areas most distant from any tidal source and exist on drainage divides between channel networks, and on the backsides of natural levees. Marsh pans range in age from less than 50 years to more than 1500 years. Formative processes include entrapment of salts, persistent saturation of benthic sediments that inhibits plant growth, and isolation from in-filling suspended sediment. As the pan becomes isolated from tides and the pan is intercepted by the water table, aquatic bacteria, diatoms, and macroinvertebrates form the sediment that accumulated in the pan. Elevation of the pan bottom is controlled by bacterial and diatom production. Connection to the tidal channel promotes vegetation establishment and results in degradation of the marsh pan.

More recently, significant modification of the South Bay marshes took place in the form of diking of the marshes to retain and concentrate bay water for the production of salt. Beginning in the middle to late 1800’s through the 1940’s, the construction of levees led to the direct loss of tens of thousands of acres of tidal marsh in the South Bay (Collins and Grossinger 2004). Apart from these direct impacts, the construction of the salt pond levees has led to dramatic changes in the physical processes influencing marsh development in these areas. By diking off these large expanses of marsh habitat, the tidal prism (the volume of water that moves in and out of an area during a tidal cycle) was drastically reduced. The results of this decrease in tidal prism are still being observed in the South Bay, particularly in the Alviso Complex.

The original slough channels were much broader than the existing channels, as is evident from historic aerial photography, as well as from the fact that the majority of the levees were constructed at or near the edge of the channel. The reduced tidal volume (and therefore reduced tidal velocities) resulted in the gradual filling of the slough channels with sediment and the formation of new tidal marsh along the edges of the salt pond levees. As marsh plants become established, they assist with sediment capture and accelerate the accretion process. The result is a series of narrow, relatively young, marsh strips that are sometimes connected to larger remnant marsh areas. The habitat value of these narrow marshes are typically lower as they tend to have less plant species diversity and have very abrupt transition zones, thereby affording little escape cover during high tides.

3.3.2 Habitat Terminology

The habitats that currently exist in the Bay, and that are referred to in this report, are defined below.

Salt Pond: A constructed pond utilized for the commercial production of salt via solar and wind evaporation. The salt ponds within the project area are no longer operated as commercial salt ponds, and are managed under the Initial Stewarsdhip Plan by CDFG and USFWS.

Subtidal-Open Water: Deepwater habitat below Mean Lower Low Water (MLLW) that occurs below the elevation of the tidal mudflats. This habitat is permanently inundated.

Tidal Mudflat: Intertidal habitat (*i.e.*, regularly flooded and drained by the tides) that is not vegetated with emergent, vascular plants. This habitat type occurs within tidal channels and along the interface between tidal salt marsh and the subtidal-open water habitats of the Bay. Elevation is from MLLW to the elevation of the lowest vegetation.

Tidal Salt Marsh: Vegetated intertidal (*i.e.*, regularly flooded and drained by the tides) habitat dominated by emergent, vascular plant species adapted to high interstitial soil salinities. Average interstitial soil salinities of tidal salt marsh habitat in the South San Francisco Bay (South Bay) are greater than approximately 27 ppt (H. T. Harvey & Associates 2002b). Dominant species in the South Bay include Pacific cordgrass (*Spartina foliosa*), pickleweed (*Salicornia virginica*), marsh gumplant (*Grindelia stricta*), saltgrass (*Distichlis spicata*), alkali heath (*Frankenia salina*), and jaumea (*Jaumea carnosa*). Tidal salt marsh includes higher-order slough channels within the marsh plain and high marsh/upland ecotone habitat along the upper elevation periphery.

Tidal Brackish Marsh: Vegetated intertidal habitat dominated by emergent, vascular plant species adapted to intermediate (brackish) interstitial soil salinities. Average interstitial salinities of tidal brackish marsh range from 15 ppt to 20 ppt in the South Bay (H. T. Harvey & Associates 2002b). Dominant species in the South Bay include alkali bulrush (*Scirpus maritimus* and *S. robustus*) and perennial peppergrass (*Lepidium latifolium*), an introduced species. Higher-order slough channels within the marsh and high marsh/upland ecotone habitat are included.

Tidal Brackish-Salt Marsh Transition: Habitat containing plant species common to both tidal salt marsh and tidal brackish marsh. Tidal brackish-salt marsh transition habitat includes the plant associations that form along the salinity gradient between tidal salt marsh and tidal brackish marsh habitats. Cordgrass occurs at the lowest elevation along the edge of the marsh, and alkali bulrush and pickleweed co-occur on the marsh plain.

Tidal Freshwater Marsh: Vegetated intertidal habitat dominated by emergent, vascular plant species adapted to low interstitial soil salinities. Average interstitial salinities of freshwater marsh are between 0 and 4 ppt in the South Bay (H. T. Harvey & Associates 2002b). Plant species include cattail (*Typha angustifolia* and *T. latifolia*), California bulrush (*Scirpus californicus*), and hardstem bulrush (*Scirpus acutus*).

Tidal Marsh: This term includes tidal salt marsh, tidal brackish-salt marsh transition, tidal brackish marsh, and tidal freshwater marsh.

Tidal Habitats: This is a "catch-all" term that includes all intertidal habitats of the South Bay.

3.3.3 Tidal Marsh Plant Ecology

Species Descriptions

Below are brief discussions of the general ecology of the most common marsh species present in South San Francisco Bay.

Pickleweed (*Salicornia virginica* and *S. europaea*). These related species are members of the Chenopodiaceae. Pickleweed (*Salicornia virginica*) has a widespread distribution on both the Atlantic and Pacific coasts. It covers a greater area of the salt marsh habitat in the Bay than any other species.

Salicornia europaea is an annual while *Salicornia virginica* is a perennial plant. Pickleweed is adapted to saturated soils and high salinities. Aerenchymous tissue in the stem and root allow diffusion of oxygen to the roots. The root system does not go as deeply as that of cordgrass, thus grows at slightly higher elevations. Pickleweed is a succulent and can store excess salts within vacuoles. It does not secrete salts, but rather accumulates salts and then looses the plant parts that have accumulated the salts.

Annual pickleweed (*Salicornia europaea*) occurs on the low marsh at elevations below the perennial pickleweed. Pickleweed (*Salicornia virginica*) occurs on the middle salt marsh zone, intergrading at its lower limits with cordgrass at elevations below MHW and extending into the high marsh zone, above MHHW. Pickleweed is found in nearly all types of marshes around the Bay. It is the most salt tolerant plant of those occurring in Bay marshes. It can minimize competition pressures by living in physical conditions that are intolerable to most other plant species. Monotypic expanses of pickleweed dominate young tidal salt marsh plains, which become more diverse with time. Erect forms also appear in the high or upper salt marsh zone. Pickleweed can also co-dominate in middle-zone brackish marshes. Pickleweed is not able to tolerate extended immersion during high water, which eliminates it from the lower tidal elevations that are preferred by cordgrass and bulrushes.

Pickleweed can easily colonize new substrates with little or no management. Pickleweed spreads rapidly by vegetative means and by seed. The main requirements for pickleweed colonization are that seeds are able to disperse into areas with soil salinities between 15 and 50 ppt (H. T. Harvey & Associates and others 1982).

Pickleweed can be found in the high marsh or peripheral halophyte zone (MHHW and above). The peripheral halophyte zone is a transition zone from typical tidal marsh wetland species to upland species. Pickleweed is the preferred vegetation of the endangered salt marsh harvest mouse.

Cordgrass (*Spartina foliosa* and *S. alterniflora* [hybrids]). Pacific cordgrass (*Spartina foliosa*) is native to the San Francisco Bay and San Pablo Bay and is a member of the grass family (Poaceae). The distribution of Pacific cordgrass is limited to the Pacific coast of North America and extends from Humboldt Bay to Bahia de la Magdelena in Baja California (Macdonald and Barbour 1974). It is absent from many bays along the outer coast, but is common throughout the San Francisco Bay and San Pablo Bays. It is similar to many grasses, having sheathed leaves surrounding a rigid culm that arises from an underground rhizome. It produces a single inflorescence containing many small flowers with male and female parts within the same flower. Physiological adaptations of Pacific cordgrass include a C-4 photosynthetic pathway and hydathodes that secrete sodium chloride from the plant.

Pacific cordgrass is found at the lowest marsh elevations throughout the Bay, generally in monospecific stands between MTL and MHW. Cordgrass can tolerate considerable tidal submergence because it has a system of air passages that transport oxygen to the roots. Cordgrass cannot tolerate high salinities during seed germination or during growth periods. Cordgrass dominates the low salt marsh zone and fringes tidal marsh channels.

Pacific cordgrass grows best at lower salinities (less than 15 ppt), but will continue to grow at reduced rates at salinities as high as 35 ppt (Josselyn and San Francisco State Univ. 1983). While Pacific cordgrass can grow at lower salinities, competitive interactions with other species (such as alkali bulrush) limit its spread. Pacific cordgrass disperses via seeds or vegetative fragments.

There are four non-native cordgrasses that have been introduced to the Bay. Of these, smooth cordgrass (*Spartina alterniflora*) and it's hybrids with the native Pacific cordgrass (*Spartina alterniflora* x. *S.*

foliosa) present the greatest threat to the South Bay tidal marsh ecosystems. The non-native cordgrass *S. alterniflora* and non-native hybrids are collectively referred to as *S. alterniflora* [hybrids].

The non-native *S. alterniflora* [hybrids] has become widespread and is able to invade rapidly and develop monotypic stands. The taller genotypes can endure high tides, even when rooted below MTL. Colonies of cordgrass, particularly the non-native cordgrass, are found in the tidal mud flats. The colonization of previously unvegetated mudflats by non-native cordgrass has significant impacts on channel stability, sedimentation, and on shore bird foraging habitat. Dwarf forms of *S. alterniflora* [hybrids] may be able to invade higher areas of salt marsh plains. The ability of *S. alterniflora* [hybrids] to produce more pollen than the native cordgrass results in "swamping" of the non-native pollen on native plants, resulting in increased hybrid seed production. This tendency could result in the genetic assimilation of the native cordgrass into hybrid genotypes.

In 2000, the California State Conservancy established the Invasive Spartina Project (ISP) as a way to address the rapid spread of the four introduced cordgrass species within the San Francisco Estuary. The ISP has a variety of components including outreach, research, monitoring and allocation of funding for invasive *Spartina* removal. The coordination and efforts of the ISP at the local, state and federal level has driven the current process of understanding and removal of invasive Spartina. Results from a 2000-20002 survey indicate that 75% of the *S. alterniflora* [hybrids] population within the San Francisco Estuary is located within the South Bay. Additionally, regions that have been disturbed or are newly created habitat appear likely as potential areas for invasion. These two key findings may have implications for successful restoration of South Bay marshes.

Alkali heath (*Frankenia salina*). Alkali heath, a member of the Frankeniaceae family, forms part of the middle and high salt marsh mosaic with pickleweed often as the dominant plant species. It also appears in the high or upper marsh zone. Alkali heath can also appear in middle-zone brackish marshes.

Salt grass (*Distichlis spicata*). Salt grass, a member of the Poaceae family, does not tolerate extended tidal immersion or wave action and a salinity of 30 ppt is optimal for salt grass. Salt grass forms part of the middle and high salt marsh mosaic with pickleweed often as the dominant plant species. Salt grass commonly dominates the middle brackish marsh zone and appears in the high or upper salt marsh zone. Salt grass can occur on natural rises within pickleweed or along the upland edge of the marsh.

Fleshy jaumea (*Jaumea carnosa*). Fleshy jaumea is a member of the Asteraceae and forms part of the middle and high salt marsh mosaic with pickleweed often as the dominant plant species. Fleshy jaumea can also appear in middle-zone brackish marshes.

Spearscale (*Atriplex triangularis*). Like pickleweed, spearscale is a member of the Chenopodiaceae family. Spearscale forms part of the middle and high salt marsh mosaic with pickleweed often as the dominant plant species. It also appears in the high or upper marsh zone. Spearscale can also appear in middle-zone brackish marshes.

Marsh gumplant (*Grindelia stricta* var. *angustifolia*). Marsh gumplant, or Grindelia, a member of the Asteraceae, occurs in the high or upper salt marsh. These areas are elevated topographically. Grindelia can occur on natural rises within pickleweed or along the upland edge of the marsh. As a peripheral halophyte, it serves as cover for the salt marsh harvest mice during the highest tides.

Dodder (*Cuscuta salina*). Dodder belongs to the Cuscutaceae family. It is a parasitic plant that is always found in association with pickleweed. It appears as bright orange threads intertwining in among the pickleweed. It can become co-dominant in the middle marsh zone, and appears in the high or upper marsh zone. Dodder can also appear in middle-zone brackish marshes. It is conspicuous due to its orange color.

Alkali bulrush (*Scirpus robustus*) and saltmarsh bulrush (*S. maritimus*). *Scirpus robustus* and *S. maritimus* both belong to the Cyperaceae family. They occur in the South Bay and can be distinguished by slight morphological differences. The ecological requirements of these species are practically equivalent, and both species will be referred to as alkali bulrush in this description.

Alkali bulrush is leafy sedge that can reproduce vegetatively from tuberous underground rhizomes. Seeds are produced in pendulous heads at the top of the plant and are an important food source for wildlife. Alkali bulrush has important food value for waterfowl. The seeds are a prime food for ducks in the Bay.

Alkali bulrush distribution in South San Francisco Bay is highly variable in relation to interstitial salinities. Alkali bulrush occurs in the upper portions of the low marsh, often dominant in the saline end of the brackish marsh gradient. It survives best in brackish waters where salinities range from 8-30 ppt (Kantrud 1996; Metcalf 1931; Stewart and Kantrud 1972), and mostly in areas with salinities less than 20 ppt (H. T. Harvey & Associates and others 1982). It was found growing in locations where the interstitial salinities were as low as 1.1 ppt and as high as 51.8 ppt (H. T. Harvey & Associates 2001b), and in hypersaline waters with salinities exceeding 300 ppt (Hammer and Hesltine 1988; Kantrud 1996). It is believed that the occurrence of *S. robustus* in more saline areas is due to ecological displacement rather than an optimum response to the environment (Kantrud 1996; Pearcy and others 1982). As sediment salinities rise in late summer, alkali bulrush becomes dormant, making it more tolerant of higher salinities during this period than it‘s potential freshwater competitors, California bulrush and cattails. Alkali bulrush optimally produces seeds when soil salinities are below 15 ppt (H. T. Harvey & Associates and others 1982).

The interaction of salinity and duration of flooding may explain the variations in the distribution of alkali bulrush. Alkali bulrush is a plant species with a wide range of salt tolerances that may be limited in distribution by duration of flooding and phytotoxins, not salinities. Alkali bulrush can tolerate submergence almost to the degree that cordgrass can, provided soil salinity is low (H. T. Harvey & Associates and others 1982). In some cases, the duration of soil surface submergence may affect the distribution of alkali bulrush more than depth of submergence, salinity or soil organic matter content (Mall 1969).

Perennial pepperweed (*Lepidium latifolium*). Perennial pepperweed is a non-native plant species that belongs to the Brassicaceae family. It commonly occurs in the high salt marsh zone and in high brackish marsh areas. This non-native invasive is of particular concern for the conservation and recovery of rare or endangered plant species, most of which occur in the high marsh zone where perennial pepperweed is dominant. The non-native perennial pepperweed has become widespread and is able to invade rapidly and develop monotypic stands.

California bulrush (*Scirpus californicus*) and hard-stem bulrush (*S. acutus*). These species belong to the Cyperaceae family and can be distinguished by hard-stem bulrush being rounded in cross-section throughout its length and having floral bristles that are barbed. Bulrushes can occur in brackish marshes where the freshwater influence is relatively strong, but are more common in freshwater marshes. California bulrush and hard-stem bulrush is the dominant species at the lower elevations of brackish marshes, where salinity is less than 20 ppt.

Cattails (*Typha latifolia*, *T. angustifolia* and *Typha dominguensis*). Cattail belong to the Typhaceae family. These species can hybridize and can be difficult to identify. They can occur in brackish marshes where the freshwater influence is relatively strong, but are more common in freshwater marshes. In brackish marshes cattails occur in the middle marsh mixed with bulrushes.

Several important studies in the marshes of South San Francisco Bay have taken place in recent years that give us a better understanding of the ecology of these systems. A brief summary of some of the key findings of these studies follows.

Marsh Vegetation Dynamics (Alviso Complex)

Large-scale plant community changes in the marshes of South San Francisco Bay were first observed in the 1970's (H. T. Harvey & Associates 1984b). Brackish marsh plants were colonizing areas that had previously been vegetated with salt marsh plants. Early studies confirmed the observed changes in plant species composition (H. T. Harvey & Associates 1984b). Efforts were made to determine the extent of changes through time by examining historical aerial photography (CH2M Hill 1989).

As a result, detailed vegetation community mapping has been conducted in the Alviso Complex by the City of San Jose in 1989, 1991, 1994, and annually through 2004. These studies have documented changes in the distribution and extent of salt, brackish and freshwater marsh (CH2M Hill 1989; 1990a; 1990b; 1991a; H. T. Harvey & Associates 1995; 1997b; 1998; 1999a; 2000; 2001a; 2002a; 2003; 2005).

The dominant plant species of tidal salt marshes in South San Francisco Bay include pickleweed and cordgrass. The mapping efforts in the portion of the Alviso Complex studied by the City of San Jose indicate that the surface area of marsh habitat has increased by 267 acres between 1989 and 2003 within their Main Study Area (H. T. Harvey & Associates 2003). During the same period, 66 acres of new marsh has formed in Alviso Slough. The vegetation composition within these marshes is dynamic in nature and annual shifts in species composition are observed.

Tidal and Edaphic Characteristics

Additional studies have looked at the specific tidal and edaphic characteristics in the Alviso Complex (H. T. Harvey & Associates 2001b). Two hypotheses were developed: (1) the conversion of salt marsh to brackish marsh is caused by increased freshwater flows from local sources and/or delta flows (2) a certain suite of plant species is representative of each habitat type and is a product of the changes in the physical environment. The results of this study give us a better understanding of the general physical conditions affecting marsh plant distribution in the South Bay, specifically the Alviso Complex.

Water Column Salinity. The surface water results indicate that the physical conditions at the Railroad Bridge in Coyote Creek (near Drawbridge) are similar to Alviso Slough (Figure 2). The Channel Marker at Calaveras Point had significantly higher salinities than either the Railroad Bridge station or the Alviso Slough station indicating that surface waters are well mixed and heavily influenced by bay water at Calaveras Point. Complete mixing of saline bay water and freshwater did not occur at the Railroad Bridge station (in the Main Study Area) or at the Alviso Slough station (in the Reference Area). Instead, freshwater flows were moving across the denser saline waters resulting in a highly stratified system. Flooding of the marsh surface occurs at high tides, when the higher saline tidal water impounds or mixes with any out-flowing freshwater. Salinity readings at these sites were lower when the tides were low or falling and the freshwater inputs could exit the system. However, during these periods, the freshwater does not come into contact with the marsh surface, resulting in the higher salinities influencing vegetation distribution.

Interstitial Soil Salinities. Areas mapped as salt marsh habitat had the highest interstitial salinities, areas mapped as brackish marsh habitat had intermediate interstitial salinities, and fresh marsh habitats had low interstitial salinities (Figure 3). Soil bulk density shows a similar trend; salt and brackish marsh habitats had higher bulk densities than soils associated with fresh marsh species. This supports our hypothesis that the habitats differing in vegetation composition are a product of different physical characteristics.

The two dominant habitat types mapped in the vicinity of the Alviso Complex for this study were salt and brackish marsh habitats, comprising 48.5% and 47.2%, respectively, of the total study area (H. T. Harvey & Associates 2001a). Of the existing salt marsh habitat (785 acres), 75% of the area is dominated by pickleweed. Similarly, of the existing brackish marsh habitat (765 acres), 72% of the area is dominated by alkali bulrush. Comparisons between these two species can therefore be seen as indicative of salt and brackish marsh habitats in the South Bay. Marsh habitat dominated by pickleweed exhibited significantly higher soil salinity and bulk density and significantly lower pH (Table 1) than alkali bulrush. Although statistically significant, the differences in soil bulk density and pH may not be biologically significant.

Table 1 – Comparison of edaphic characteristics in marshes dominated by pickleweed and alkali bulrush.

		Bulk Density (g/cm^3)	**Soil Salinity (ppt)**	**pH**
Pickleweed	Mean	0.69	40.4	7.42
	Standard Error	0.02	1.55	0.04

	Range	0.50-0.94	6.9-71.7	6.43-8.03
	N	60	80	80
Alkali Bulrush	Mean	0.65	17.7	7.53
	Standard Error	0.01	0.82	0.03
	Range	0.34-0.87	1.1-51.8	6.48-8.17
	N	76	120	120
	P-value	0.019	6.87E-32	0.016

Salt tolerant plant species such as pickleweed and cordgrass may be negatively affected (through a decrease in stresses and an increase in plant competition) by increased freshwater sources. Therefore, extremely salt tolerant plant species such as pickleweed and cordgrass may be restricted to hypersaline marsh habitats by competitive displacement from less saline marshes by alkali bulrush. Freshwater flows that decrease the soil salinity may be responsible for an increase in plant competition. Studies of salt marsh plant species distribution on the Atlantic Coast have found that competitive dominants displace competitive subordinates to more stressful habitats (Bertness 1991; Bertness and Ellison 1987).

Tidal Marsh Habitat Elevation Survey

Table 2 shows the mean sediment surface elevation ranges of the data measured for the dominant plant species and associated habitat types (H. T. Harvey & Associates and PWA 2005). These data, collected in full tidal marshes along Coyote Creek and Mud Slough, are assumed to be representative of the full tidal marshes in the vicinity of the Island Ponds. However, the relationship between tidal marsh plant species and sediment surface elevation is expected to vary in different geomorphic and hydrologic settings within San Francisco Estuary. The mean lower elevation for Pacific cordgrass dominated marsh (1.8 feet) was approximately 1.3 feet above mean tidal level (MTL) with the mean upper elevation extending to 0.4 feet below mean high water (MHW) (Tables 2 and 3). Pickleweed-dominated salt marsh habitat extended from a mean lower elevation of 3.3 feet (0.8 feet below MHW) to a mean upper elevation of 5.0 feet (0.3 feet above MHHW) (Tables 1 and 3). Alkali bulrush was distributed across the widest elevation range from a mean low elevation of 2.1 feet (1.6 feet above MTL) to a mean upper elevation of 4.6 feet (0.1 feet below MHHW) (Tables 2 and 3). The mean upper elevation of alkali bulrush corresponds with elevation measurements recorded in a previous study along an upper reach of Coyote Slough (H. T. Harvey & Associates 1993), although the present survey recorded alkali bulrush growing at substantially lower elevations than the previous study. California bulrush and narrow-leaved cattail in the tidal freshwater marsh exhibited comparable elevation ranges and occurred at a mean low elevation comparable to Pacific cordgrass. The marsh plain for the tidal salt marsh and tidal brackish marsh surveyed was dominated by pickleweed and alkali bulrush, respectively and extended to higher mean elevations than tidal freshwater marsh (Table 3). This may be a reflection of the greater salt-tolerance of pickleweed and alkali bulrush compared to California bulrush and cattail, as the interstitial soil salinity likely increases with elevation across the marsh plain. The distribution of tidal freshwater marsh is not discussed further because the modeling results ultimately indicated that this plant association is not likely to establish at the Island Ponds.

Table 2 – Tidal Marsh Habitat and Dominant Plant Species Mean Land Elevation Ranges (± 1 standard error).

Common Name	Scientific Name	Tidal Marsh Habitat	Mean Lower Land Elevation (NGVD29 feet)	Mean Upper Land Elevation (NGVD29 feet)
cordgrass	*Spartina foliosa*[*]	tidal salt marsh	1.8 ± 0.08	3.7 ± 0.09
pickleweed	*Salicornia virginica*	tidal salt marsh	3.3 ± 0.49	5.0 ± 0.23
alkali bulrush	*Scirpus maritimus*	tidal brackish marsh	2.1 ± 0.19	4.6 ± 0.10
California bulrush	*Scirpus californicus*	tidal freshwater marsh	1.9 ± 0.17	4.0 ± 0.05
cattail	*Typha angustifolia*	tidal freshwater marsh	1.8 ± 0.24	4.2 ± 0.10

[*]Genetic test results from the UC Davis Spartina Lab indicate the native cordgrass (*Spartina foliosa*) was sampled.

Tidal Marsh Habitats and Water Column Salinity Relationship

Table 3 shows the relationship between water column salinity ranges modeled for Coyote Creek in 1994 (Gross 2003) and the distribution of tidal marsh habitats mapped along Coyote Creek in 1994 (H. T. Harvey & Associates 1994).

Table 3 – Relationship between Tidal Marsh Habitat and Water Column Salinity Ranges.[*]

Habitat	Water Column Salinity Range (ppt)	Dominant Plant Species
tidal freshwater marsh	0 - 5	*Typha* spp., *Scirpus californicus*, *Scirpus acutus*
tidal brackish marsh	5 – 10	*Scirpus maritimus* and *S. robustus*, *Lepidium latifolium*
tidal brackish-salt marsh transition	10 - 15	*Spartina* spp., *Scirpus maritimus* and *S. robustus*, *Salicornia virginica*
tidal salt marsh	> 15	*Spartina* spp., *Salicornia virginica*, *Distichlis spicata*

[*] Based on Summer 1994 data.

General Habitat Requirements

Combining the lower and upper mean elevation for each plant species (Table 4) with the water column salinity ranges on tidal marsh habitats, general ecological requirements for the tidal marsh habitats along salinity and elevation gradients can be established (Figure 4). For example, tidal salt marsh is expected to occur between 1.8 and 5.0 feet NGVD29 where water column salinity is greater than 15 ppt (Figure 4). Tidal brackish-salt marsh transition habitat is expected to occur between 1.8 and 5.0 feet NGVD29, where water column salinity is 10-15 ppt, while tidal brackish marsh is expected to occur from 2.1 and 4.6 feet NGVD29, where water column salinities are 5-10 ppt (Figure 4).

Table 4 – Tidal Marsh Habitat Elevation Ranges.

Habitat	Elevation Range (NGVD29 feet)
Subtidal-Open Water	< -4.30 (MLLW)
Tidal Mudflat	-4.30 – 1.80
Tidal Salt Marsh	1.80 – 5.0
Tidal Brackish-Salt Marsh Transition	1.80 – 5.0

3.3.4 Marsh Development

New marsh is actively forming in the Alviso Complex. Our current knowledge of how marsh develops in the South Bay is based on 15 years of detailed habitat mapping and close observation of vegetation community shifts through time. Developing mudflats are typically colonized by cordgrass and annual pickleweed, as evidenced by the new marsh forming just upstream of the mouth of Alviso Slough and at Calaveras Point. The processes of sedimentation and plant community succession will then lead to establishment of tidal salt marsh or tidal brackish habitat depending on water column and interstitial spoil salinities. The tidal salt marsh plant community will gradually change from a cordgrass-dominated community to a pickleweed-dominated community as sedimentation raises the site elevation to form a marsh plain between MHW and MHHW elevations. However, cordgrass will continue to dominate the lowest elevations and along the lower order slough channels that will form within the marsh. The bottom of these slough channels would provide narrow, sinuous corridors of intertidal mudflat habitat. The plant species diversity of the salt marsh plain would gradually increase to include a suite of native species including salt grass, alkali heath, spearscale, gumplant, jaumea, arrow-grass, and dodder. The distribution of Pacific cordgrass would gradually retreat to the edges of restored slough channels.

A tidal brackish marsh habitat will be dominated by alkali bulrush in the marsh plain between MHW and MHHW elevations. Pickleweed will also be abundant in the tidal brackish-salt marsh transitional zones.

As sediment accretion rates slow and approach equilibrium with the restored tidal regime, the process of plant succession would gradually result in the formation of plant communities comparable to the remnant tidal salt and brackish marshes around the South Bay. Vascular plant height, productivity, and diversity will also gradually increase over subsequent decades as organic matter levels and inorganic nutrient levels increase in the restored marsh soils.

3.3.5 Current Habitat Mapping Effort

To accurately assess the existing conditions, mapping was conducted over the three complexes of the SBSP acquisition area, and includes habitats along sloughs and tidal marshes outside of the salt ponds in the immediate vicinity. Although the actual South Bay ecosystem includes terrestrial-fluvial as well as estuarine interactions (Collins 2004) the mapping and analysis of such a broad area is beyond the scope of this document. Therefore, the South Bay was defined as the area of San Francisco Bay south of the San

Mateo Bridge, and specifically for this report the area of the salt ponds acquired for restoration. Since precise boundaries of the salt pond acquisition were not available in GIS, we mapped all of the salt ponds within the project area, and extended that mapping to the outboard marshes and adjacent sloughs.

During the mapping of the South Bay project area, 13 different habitat categories were utilized. These habitat types included open water, mudflat, salt marsh (pickleweed), salt marsh (cordgrass), salt marsh (other), brackish marsh, freshwater marsh, unvegetated, peripheral halophytes, upland vegetation, levee, developed and other (Figures 5-9). The quantities (in acres) of each habitat type present within the project boundaries of the SBSP Restoration Project are discussed in detail (by complex) in subsequent sections. Each of these habitats is briefly described below, and the locations of the habitats are shown on Figures 5-9.

Salt Ponds. In addition to the habitat categories listed above, the salt ponds themselves were mapped according to their prescribed management regime. The salinity and hydrologic circulation regimes outlined in the ISP (Life Science 2003) result in five types of pond management systems: System, Full Tidal, High Salinity (Batch), Seasonal, and Mixed (*e.g.*, Seasonal /High Salinity) Ponds. System Ponds will be managed to have water circulating through a series of ponds linked by water control structures that are controlled to reduce or maintain ambient salinities. Full Tidal Ponds will have levees breached to allow full tidal action to be reintroduced to the pond. High Salinity (Batch) Ponds will consist of a series of ponds, managed to maintain higher salinity levels to provide habitat for specific wildlife species. Seasonal Ponds will have no bay-water inputs; water levels will rise and recede depending on precipitation and groundwater hydrology. Mixed (Seasonal/High Salinity) Ponds will be managed differently at different times of the year, or will be managed adaptively. Appendix A lists the depth management regimes for each pond complex.

Open Water. The open water category includes a variety of habitat types, including subtidal Bay waters, tidal sloughs and channels, and areas of standing or flowing waters within the salt ponds and tidal marshes. Deep-water Bay habitat can be viewed in the map of adjacent habitats (see Section 4.5.1). Deep-water habitat does not support either terrestrial or emergent vegetation; however, eelgrass (*Zostera pacifica*) is an important submerged plant species occasionally found in the upper reaches of shallow bays. Deep bays and channels are important for large aquatic invertebrates, fishes, waterbirds, and marine mammals.

The open water habitats that were mapped in detail occur within the low-flow channel of the adjacent creeks and slough channels draining into the Bay, within the borrow ditches and former tidal meanders found within the salt ponds throughout the SBSP complex, as well as interior marsh ponds. Shorebirds, waterfowl, and other waterbirds will utilize the channels and marsh ponds.

Mudflat. Mudflat habitat occurs in intertidal areas from below MLLW to Mean Tide Level (MTL). Most of this habitat occurs just beyond the edge of wetlands along the Bay, but also occurs between the low-flow channel and edge of wetlands within the tidal reaches of slough and creek channels draining into the Bay. Mapping of this habitat in the complex-specific maps ends arbitrarily, and the full extent of this habitat is best viewed in the map of adjacent habitats (see Section 4.5.1). This habitat typically supports less than 10 percent cover of vascular emergent vegetation; this vegetation typically includes areas of colonization by cordgrass and annual pickleweed (*Salicornia europaea*) and is too sparse to map as distinct salt marsh habitat. The mudflat substrate comprises primarily fine-grained silts and clays that support an extensive community of diatoms, worms, and shellfish, as well as algal flora. Inundated mudflats provide foraging habitat for many species of fishes, and during low tides when they provide a primary food source for shorebirds.

Salt Marsh ("pickleweed dominant," "cordgrass dominant" and "other"). Areas of tidal salt marsh in the South Bay are characterized by interstitial soil salinities greater than approximately 27 ppt, on average (H. T. Harvey & Associates 2002b). Salt-marsh habitat occurs primarily along the outboard (tidal) side of existing levees separating the salt ponds from the Bay. Salt marshes typically consist of three zones in the Bay: "low" marsh dominated by cordgrass, middle marsh dominated by pickleweed, and high marsh with a mixture of pickleweed and other moderately halophytic species that can tolerate occasional high tides.

The salt marsh habitat in the South Bay consists primarily of low and middle marsh, and is dominated by pickleweed (*Salicornia virginica*), and two species of cordgrass, California cordgrass (*Spartina foliosa*), and smooth cordgrass (*S. alterniflora*), a non-native species from the east coast of North America. Current research and management programs on smooth cordgrass and its hybrids (*Spartina alterniflora* [hybrids]), can provide guidance for salt pond restoration work (California State Coastal Conservancy and U.S. Fish and Wildlife Service 2003).

The pickleweed and cordgrass salt marsh habitats are separated by elevation, whereby cordgrass typically occurs below the MHW mark and pickleweed occurs above this mark and often extends up the levee banks. The effect of sedimentation in the slough and channels draining into the Bay warrants the distinction between pickleweed and cordgrass salt marsh, as do the differences in wildlife use.

Other halophytic plant species commonly found in the salt-marsh habitat of the South Bay include alkali heath (*Frankenia salina*), salt grass (*Distichlis spicata*), saltmarsh dodder (*Cuscuta salina*) fleshy jaumea (*Jaumea carnosa*), spearscale (*Atriplex triangularis*), sea lavender (*Limonium californicum*), perennial pepperweed (*Lepidium latifolium*), and marsh gumplant (*Grindelia stricta* var. *angustifolia*). These species also typically occur above the MHW mark in the high marsh zone, up to the ecotone between salt marsh and upland habitats. While these species usually occur in areas dominated by pickleweed, species such as the marsh gumplant and perennial pepperweed sometimes occur in dense patches with less than 50% aerial coverage of pickleweed. Such areas were assigned the 'other salt marsh' classification. Areas with greater than 50% coverage of pickleweed, among any combination of other prevalent species, were classified as pickleweed salt marsh.

Brackish Marsh. Brackish marsh habitat typically occurs in the low-to-mid intertidal reaches of sloughs and creeks draining into the Bay, where the vegetation is subject to tidal inundation diluted by freshwater flows from upstream. As such, the average interstitial soil salinity of tidal brackish marsh is lower than in salt marshes, ranging from 15 ppt to 20 ppt in the South Bay (H. T. Harvey & Associates 2002b). The water-surface elevation within reaches of brackish marsh in the study area (primarily located in the upper reaches of the Alviso complex) can vary by as much as 10 feet, depending on daily tidal activity and seasonal freshwater flows from upstream, as a result of their location within this estuary system.

The vegetation in brackish marsh habitat is dominated by emergent, vascular plant species adapted to intermediate (brackish) interstitial soil salinities, including short bulrushes such as alkali bulrush (*Scirpus robustus*) and saltmarsh bulrush (*S. maritimus*). These species dominate lower, brackish, marsh habitat where sediment deposits have formed terraced floodplains between the low-flow channels and levees. The middle reaches of these channels are also dominated by the shorter bulrushes, but may also have dense stands of tall bulrushes such as California bulrush (*Scirpus californicus*) and hard-stem bulrush (*Scirpus acutus*) adjacent to the low-flow channel of creeks and sloughs. Large, dense patches of perennial pepperweed may also occur within the terraced areas in these middle reaches otherwise exclusively dominated by alkali bulrush. Other plants that can occur in brackish marshes include alkali heath, cattails along major slough channels, spearscale, and pickleweed along the high marsh/upland ecotone. Higher order slough channels and upper-creek reaches dominated by these species may also be considered brackish marsh, depending on the extent of freshwater intrusion in these areas.

Freshwater Marsh. Freshwater marsh habitat typically occurs in the upper reaches of sloughs and creeks draining into the Bay. While the upper reaches of sloughs and creeks draining into the Bay may be subject to occasional tidal influence associated with high (usually spring) tides, and/or have historically somewhat saline sediments, these reaches are otherwise flushed with freshwater on a daily basis and therefore, support mostly freshwater emergent vegetation. The water-surface elevation within reaches of freshwater marsh may also vary by as much as 10 feet depending on daily tidal activity and seasonal, freshwater flows from upstream. Broad-leaf cattail (*Typha latifolia*), and the taller bulrushes, including California bulrush and hard-stem bulrush typically dominate the freshwater marsh habitat in the upper reaches of sloughs and creeks draining into the Bay. Due to regular inundation, these species often form dense stands covering entire floodplain terraces along channels. Patches of perennial pepperweed and thickets of California blackberry (*Rubus ursinus*) also occur in regions of freshwater marsh.

Unvegetated. Unvegetated areas are typically confined to the salt pond basins of each complex, and comprise bare ground and salt flat areas. Most of the salt-pond basins were historically subject to regular tidal inundation and were vegetated with salt marsh species, but the salinity in these basins due to their use as salt ponds over decades, is now excessive and too saline to support even halophytic vegetation. While these areas typically lie below the MHW mark, they are no longer subject to tidal flooding. This habitat was sometimes present on levee side slopes below approximately MHW.

Peripheral Halophytes. Peripheral halophytes variably occur along the banks and tops of levees separating tidal areas from salt ponds, and occasionally along levees separating salt ponds from each other. The extent of peripheral halophytic vegetation is primarily determined by the salinity of the levee soils, and how recently the levee soils were excavated from borrow pits in adjacent salt ponds. Peripheral halophytes typically include non-native, ruderal ("disturbance-loving") species such as iceplant (*Mesembryanthemum nodiflorum*), New Zealand spinach (*Tetragonia tetragonioides*), Russian thistle (*Salsola soda*), and Australian saltbush (*Atriplex semibaccata*), which usually occur only above the MHHW mark. Native high marsh species also occasionally form peripheral halophytic habitat along levee banks as conditions permit. These species include marsh gumplant, alkali heath, spearscale, and saltgrass. In addition, pickleweed may also occur along with these species on levee banks; assemblages of pickleweed and peripheral halophytes were mapped as salt marsh if the pickleweed appeared to be dominant. Low-lying, or eroded levees between salt ponds are usually too saline to support halophytes. Levees contiguous with uplands are typically dominated by upland species (described below) rather than peripheral halophytes. Finally, peripheral halophytic vegetation provides important refugial habitat to salt marsh wildlife species during high tides.

Upland Vegetation. Areas within salt pond complexes dominated by ruderal and/or ornamental vegetation (landscaping) were characterized as upland vegetation habitat. This habitat typically occurs well above the elevation of most marsh habitats, and is mostly absent along levees due to relatively high salinity. This habitat is, therefore, primarily confined to the mainland perimeter of each salt pond complex.

Aside from numerous ornamental species occurring in landscaped areas adjacent to the pond complexes, most of the upland habitat is dominated by assemblages of annual, non-native plants that thrive in disturbed areas (ruderal species). This classification includes most tree, shrub and herbaceous species found in upland areas. The predominant ruderal species in the SBSP Restoration Project area include Italian ryegrass (*Lolium multiflorum*), ripgut brome (*Bromus diandrus*), black mustard (*Brassica nigra*), wild radish (*Raphanus sativus*), Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*), wild oats (*Avena fatua*), yellow star-thistle (*Centaurea solstitialis*), common sow thistle (*Sonchus oleraceus*), bull thistle (*Cirsium vulgare*), bristly ox-tongue (*Picris echioides*), rabbitsfoot grass, brass buttons, alkali heath, and coyote brush (*Baccharis pilularis*).

Levee. Levees are linear, barren, earthen structures that separate tidal areas from salt ponds, and salt ponds from each other. The levees in the South Bay salt pond complexes were typically constructed from soils excavated from borrow pits in former salt marshes which have since been developed into salt ponds; standing water can usually be found in the borrow ditches of otherwise empty salt ponds. The levee substrate is therefore primarily silty-clay in texture and saline. Dirt roadways along the upland perimeters of salt ponds or bay fronts were typically mapped as levee. Portions of levees dominated by peripheral halophytes, or upland vegetation, were categorized as either of those habitat types, rather than as levee habitat.

Developed. Developed areas within each complex include roadways, parking areas, building complexes, pump facilities, and powerline facilities. Such areas are typically maintained free of vegetation, but may occasionally support isolated ruderal upland vegetation (described above). Larger areas of upland or ornamental (landscaping) vegetation in developed settings were categorized as upland vegetative habitat.

Other. Habitats or areas that do not fit into any of the habitats previously described were categorized as ‘other’ habitat. Examples of ‘other’ habitat include protective rip-rap along some Bay waterfronts.

3.4 Special-Status Plant Species

Introduction. The special-status plant species that occur in in the South Bay area in the vicinity of the project are are discussed in this section. The SPSP complexes themselves are not expected to support special-status plants: vascular plants are entirely absent from artificial, hyperhaline ponds, and levees provide peripheral halophytic habitat bearing little resemblance to the broad, relatively heterogeneous habitat of intact upper marsh. However, special-status plants may once have occurred in the natural salt pans, sandy deposits, and slough channels of the former marsh, and habitat still exists in the general area of effect of the SBSP Restoration Project. Therefore, a brief overview of patterns of plant diversity in the marshes is provided below, followed by a special-status plant assessment and detailed species accounts. The potential for reintroduction of special-status plants is also briefly examined.

Vegetation communities of the San Francisco Bay estuary, with particular emphasis on patterns of change in the abundance of tidal wetland endemics, are discussed in detail elsewhere (Baye and others 2000). Other researchers (Josselyn and San Francisco State Univ. 1983) focused on dominant species alone (the diversity of vascular plants in the South Bay marshes is relatively low). Tidal salt marshes, in general, present challenging edaphic conditions due to the diurnal flux of inundation and exposure in the intertidal zone, perennially saturated, fine-grained soils up to and beyond mean high water, high soil salinity and near constant exposure to sun, wind, and seaspray. Only a few, mostly rhizomatous perennial, species can thrive under such conditions. These few species are successful to the point of exclusion of most potential competitors and provide the broad, uniform expanses of habitat critical for certain wildlife species. Nevertheless, course sediment deposits, remnant alluvial fans, and isolated, shallow salt pans in the upper marsh zone, as well as artificial levees and ponds, provide substrate and microhabitat diversity for a range of salt-tolerant species. Brackish areas provide still more opportunities for plant establishment. Of the species associated with salt marshes of the San Francisco Bay area, fewer than 20 (and usually far fewer in any given area) occur in the lower or middle marsh (Baye and others 2000; CalFlora 2004; Hickman 1993). The majority of species, including all the rare and endemic plants of the SPSP area, are associated with sub-habitats of the upper marsh (e.g., salt pan, intertidal marsh ponds, high marsh ecotonal areas) or with other tidal wetland habitats.

Special-status plant species occurring in the upper zones of tidal salt and brackish marshes of San Francisco Bay were never widespread. However, those with the broadest edaphic tolerances were, and some still remain, locally common. Several rare species fall into this category. For example, marsh gumplant (*Grindelia stricta* var. *angustifolia*), is limited to the upper marsh zone of San Francisco Bay but tolerates disturbed fill soils; it is abundant in South Bay marshes and was recently removed from the California Native Plant Society's Inventory of Rare and Endangered Plants (California Native Plant Society (CNPS) 2001). Similarly, Congdon's tarplant (*Centromadia parryi* ssp. *congdonii*), while limited in distribution and a CNPS List 1b species, is associated with upper marsh as well as low-lying alkaline soils; huge populations occur well east of the Bay. On the other hand, plants that have narrow edaphic associations, such as coarse substrates on high-energy shorelines, salt pan edges, or channel edges within tidal brackish marsh, are now extremely rare in the "urban estuary" of San Francisco Bay. The continued persistence of these plants is further threatened by invasive exotics, particularly perennial pepperweed, which generally respond well to disturbance and increased urban runoff.

Special-Status Plant Assessment. The potential for special-status plants to occur within the SPSB complexes and vicinity was assessed in Summer 2004. The assessment was based on the following factors: 1) the occurrence of species-specific hydrological requirements and microhabitat variables within the SPSP area; 2) the occurrence of known associated species; and 3) the proximity and date of documented occurrences and published accounts of species distributions. The assessment was performed concurrently with habitat characterization and mapping studies; all areas within the three complexes were viewed from adjacent levees or, when necessary, by boat.

The special-status plants species included in this assessment were identified from plants listed by the California Native Plant Society Inventory CNPS (2001) as currently or formerly occurring in salt marsh and saline/alkaline wetlands in Alameda, San Mateo, and Santa Clara counties. Species occurring in grassland settings were not included in this assessment since the extent of upland habitat within the pond complexes is very limited, highly saline or ruderal in character. In addition, a query of the California Natural Diversity Database (California Department of Fish and Game 2004a) was performed to identify special-status plant species occurring in similar habitats within the USGS quadrangles containing the three pond complexes. These quadrangles included Mountain View, Milpitas, Niles, Newark, San Leandro, Hayward, Redwood Point, Palo Alto, and San Mateo. All species selected from these queries were then cross referenced with the most recent state and federal listing update according to the California Department of Fish and Game (California Department of Fish and Game 2004a; California Department of Fish and Game 2004b) to verify listing status and identify any recently listed species. Finally, additional species specified by the USFWS proposed Multispecies Recovery Plan for the Tidal Ecosystem of Northern and Central California were considered (PWA and others 2004a).

Results. A total of 47 special-status plant species were identified in the geographic area of this assessment. Of these 47, only 13 are known to occur in habitats similar to those found in the three South Bay salt pond complexes (Table 5). These species include coastal marsh milk-vetch (*Astragalus pycnostachyus* var. *pycnostachyus*), alkali milk-vetch (*Astragalus tener* var. *tener*), San Joaquin saltbush (*Atriplex joaquiniana*), Congdon's tarplant (*Centromadia parryi* ssp. *congdonii)*, Point Reyes bird's-beak (*Cordylanthus maritimus* spp. *palustris*), Contra Costa goldfields (*Lasthenia conjugens*), delta tule pea (*Lathyrus jepsonii* var. *jepsonii*), Mason's lilaeopsis (*Lilaeopsis masonii*), prostrate navarretia (*Navarretia prostrata*), hairless popcorn-flower (*Plagiobothrys glaber*), delta woolly-marbles (*Psilocarphus brevissimus* var. *multiflorus*), California seablite (*Suaeda californica*), and saline clover (*Trifolium depauperatum* var.*hydrophilum*). One additional species, Pacific cordgrass (*Spartina foliosa*), has been considered for inclusion in the USFWS draft recovery plan and is common in the SBSP area, but was not included in this assessment.

No special-status plants have been documented within the boundaries of the Eden Landing or Ravenswood salt pond complexes (California Department of Fish and Game 2004a). Numerous occurrences of five species, including Congdon's tarplant, prostrate navarretia, alkali milk vetch, Contra Costa goldfields, and San Joaquin spearscale, have been documented in the vicinity of the Alviso pond complex. However, these occurrences are located exclusively within the Pacific Commons Preserve, just north of pond A22. Historic (likely extirpated) populations of Congdon's tarplant, alkali milk vetch, and

Point Reyes bird's-beak are documented in the vicinity of Alviso. The ecology, distribution, and potential for reintroduction of these species are discussed below species accounts

Mason's lilaeopsis (*Lilaeopsis masonii*). Federal Status: Species of Concern; State Status: Rare; CNPS Status: List 1B. Mason's lilaeopsis is a small, rhizomatous perennial in the carrot family (Apiaceae). Reaching heights of approximately three inches, plants form dense, turf-like colonies ranging from approximately 50 square feet to over 7,500 square feet (California Department of Fish and Game 2004a). Inflorescences of white or maroon flowers appear on short (1 inch or less), open umbels from April through November.

Mason's lilaeopsis occurs on exposed tidal meanders and flats in the northeastern portion of the San Francisco Bay area. Associated species include marsh pennywort (*Hydrocotyle verticillata*), aquatic pygmy-weed (*Crassula aquatica*), tule (*Scirpus californicus* var. *acutus*), and rushes (*Juncus* spp.) According to herbarium records catalogued by the University of California, the majority of reported occurrences of Mason's lilaeopsis are in San Joaquin, Sacramento, Contra Costa, and Solano Counties (CalFlora 2004). Although two Alameda County records exist, both apparently refer to a population south of Clifton Court Forebay at the Contra Costa County line (CalFlora 2004; California Department of Fish and Game 2004a).

Potential for occurrence in the SBSP area. Mason's lilaeopsis colonizes recently-deposited, fine-grained soils on the edges of tidal meanders, sloughs, and saline-influenced reaches of creeks and rivers. This species is not known to occur in the highly saline environment of tidal salt marsh; rather, it favors the edges of marshes with significant freshwater inputs (the "low brackish marsh" zone). As such, populations are concentrated in the northern portion of the Bay, particularly in the Delta region, where large expanses of tidal brackish marsh occur.

Populations of Mason's lilaeopsis are absent from the South Bay, perhaps due to the lack of appropriate brackish habitat. Historically, creek flows into the South Bay were intermittent, and broad expanses of riparian vegetation and seasonal wetlands ringing the bay retained runoff of rainwater prior to its reaching the marshes. Extremely high salinities at the edges of South Bay marshes are apparent in the historic distribution of salt pans and natural salt ponds (San Francisco Estuary Institute 1999). Currently, salinities in the South Bay typically approach that of seawater (Life Science 2004). This may account for the lack of historic records of Mason's lilaeopsis from the Alameda/San Mateo/Santa Clara counties region, although fringing brackish marshes do occur at Mud Slough, Coyote Creek, Artesian Slough, Alviso Slough, and Guadalupe Slough (Baye and others 2000), and are currently increasing in extent (H. T. Harvey & Associates 1997b). Furthermore, extensive brackish marsh occurs at Petaluma Marsh, and

Table 5 – Special-status plant species, their status, and potential occurrence in the South Bay Salt Ponds study area.

NAME	STATUS*	HABITAT/ DESCRIPTION	POTENTIAL FOR OCCURRENCE ON SITE
Federal or State Threatened or Endangered Species			
Contra Costa goldfields (*Lasthenia conjugens*)	FE, CNPS 1B	Saline/alkaline vernal pools, mesic areas within grassland. Known from Alameda, Solano, Monterey, Contra Costa, and Napa counties. Annual; blooms March through June.	Two large colonies associated with grassy seasonal wetlands in Fremont vicnity; otherwise occurs in disjunct populations in Monterey and North Bay. No suitable habitat present in SBSP area.
Mason's lilaeopsis (*Lilaeopsis masonii*)	SR, CNPS 1B	Exposed banks of tidal meanders and channels within brackish to freshwater marsh. Locally common in Suisun Marsh. Perennial; blooms April through November.	Not known to occur in the South Bay; historic and current records in Suisun Bay only.
California seablite (*Suaeda californica*)	FE, CNPS 1B	Sandy, high-energy shorelines within salt marsh. Relictual populations in South Bay considered extirpated; known only from Morro Bay, San Luis Obispo county.	Extirpated from the South Bay; no suitable habitat in SBSP area.
State Rare and CNPS Species			
Coastal marsh milk-vetch (*Astragalus pycnostachyus* var. *pycnostachyus*)	FSC, CNPS 1B	Coastal salt marshes, streamsides, and mesic coastal dunes in Marin and San Mateo counties. Perennial; blooms April to October.	Not known to occur in South Bay; no suitable habitat in SBSP area (Extant populations associated with maritime salt marsh).
Alkali milk-vetch (*Astragalus tener* var. *tener*)	FSC, CNPS 1B	Alkaline soils in playas, vernal pools, and adobe clay areas within grassland. Alameda, Merced, Solano, and Yolo counties. Annual; blooms March to June.	Recently rediscovered in seasonal wetlands near Fremont. Considered extirpated Santa Clara County. Currently no suitable habitat in SBSP project area.
San Joaquin saltbush (*Atriplex joaquiniana*)	FSC, CNPS 1B	Alkaline soils within chenopod scrub, meadows, playas, and grasslands in 14 central California counties. Annual; blooms April through October.	Potentially occurs in seasonal wetlands in Warm Springs vicinity; known from Pacific Commons Preserve. Currently no suitable habitat present in SBSP area.
Congdon's tarplant (*CentromadiaCentromadia parryi* ssp. *congdonii*)	CNPS 1B	Moist, alkaline soils within grassland. Tolerates disturbance. Annual; blooms June through November. Known from Alameda, Monterey, San Luis Obispo, and Santa Clara counties.	Known from Alviso vicinity. Slight potential for occurrence in peripheral halophyte or disturbed upland zones in SBSP area, but not currently associated with salt marsh.
Point Reyes bird's-beak (*Cordylanthus maritimus* spp. *palustris*)	FSC, CNPS 1B	Courser substrates within salt marsh (high marsh pans, sandy barrier beaches). Known from Marin County north to Oregon. Annual; blooms June through October.	Extirpated from the South Bay. Currently no suitable habitat present in SBSP area.
Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*)	CNPS 1B	High marsh zone in brackish and freshwater marshes. Known from Suisun Marsh (Sacramento, San Joaquin, Solano and Contra Costa counties) and Napa marshes. Perennial; blooms May through September.	Historic and current records from North Bay only.
Prostrate navarretia (*Navarretia prostrata*)	FSC, CNPS 1B	Seasonal wetlands and vernal pools within grassland and coastal scrub. Ranges from Monterey County south to San Diego. Annual; blooms April through July.	In South Bay, known only from Pacific Gardens Preserve. Currently no suitable habitat present in SBSP area.
Hairless popcorn-flower (*Plagiobothrys glaber*)	FSC, CNPS 1A	Formerly known from alkali meadows and coastal salt marshes and swamps. Extirpated throughout its range; last documented occurrence in 1954.	Presumed extinct.
Delta woolly-marbles (*Psilocarphus brevissimus* var. *multiflorus*)	CNPS 4	Dried beds of vernal pools and flats, especially in grasslands, in Alameda and Santa Clara counties north to Yolo County. Annual; blooms April to June.	Currently no suitable habitat present in SBSP area.
Saline clover (*Trifolium depauperatum* var. *hydrophilum*)	FSC, CNPS 1B	Edges of salt marshes, alkali meadows, and vernal pools along the coast from Sonoma County south to San Luis Obispo, as well as in the inland counties of Solano and Colusa. Annual; blooms April through June.	Historic collection (type locality) from Belmont; not recorded since in South Bay. Currently no suitable habitat present in SBSP area.

Mason's lilaeopsis has not been documented there. Detailed studies of the distribution and abundance of this species are not available.

Because Mason's lilaeopsis has never been documented in the SBSP area, it is not expected to occur in the project area nor will it be included in the restoration effort.

Contra Costa goldfields (*Lasthenia conjugens*). Federal Status: Endangered; State Status: None; CNPS Status: List 1B. Contra Costa goldfields is a small, ephemeral annual sunflower typically occurring in mesic depressions within open, grassy habitats. Plants are between 4 and 12 inches in height and bear one to several flowerheads from March through June. Both ray and disk flowers are yellow. Conta Costa goldfields is distinguished from other common, co-occurring *Lasthenia* species by its lack of a pappus (an appendage arising from the ovary) on individual flowers.

Contra Costa goldfields occurs in 20 widely scattered populations in Alameda, Contra Costa, Mendocino, Napa, and Solano Counties (California Department of Fish and Game 2004a). Extant populations in the South Bay area occur at the Pacific Commons preserve (seasonal wetlands) and at the nearby Don Edwards San Francisco Bay NWR, Warm Springs Unit (vernal pools and swales). Management of both preserve areas focuses on the conservation of the species (U.S. Fish and Wildlife Service and California Department of Fish and Game 2003; Wetlands Research Associates 1999).

Contra Costa goldfields is not expected to occur within tidal wetlands, but may occur in seasonal wetlands in the upland transition zone. According to the critical habitat designation for this species (Department of the Interior 2003), Contra Costa goldfields is most often found in vernal pools, swales, moist flats and depressions within grassland. However, Baye (2000) discusses the historic association of Contra Costa goldfields with saline seasonal wetlands at the marsh/upland boundary, as well as an apparent collection from a salt evaporator pond. Typical associated species include brass buttons (*Cotula coronipifolia*) and alkali heath, two common species of the upper and middle marsh, as well as the freshwater wetland species downingia (*Downingia* spp.), button celery (*Eryngium* spp.), water starwort (*Callitriche marginata*), and other species of goldfields (*Lasthenia glaberrima, L. fremontii*).

Potential for occurrence in the SBSP area. Due to the lack of suitable microhabitat for the Contra Costa goldfields with the SBSP project area, its occurrence is highly unlikely.

California seablite (*Suaeda californica*). Federal status: Endangered; State Status: None; CNPS Status: List 1B. California seablite is a succulent shrub of the goosefoot family (Chenopodiaceae) associated with sandy soils in the upper intertidal zone. Plants are woody at the base, with pale green to reddish, somewhat succulent foliage. The leaves are crowded along the branches and are round in cross-section. California seablite blooms in late summer (July to October) with small, fleshy, greenish flowers that lack petals and appear in the axils of the leaves.

Natural populations of California seablite currently occur only at Morro Bay in San Luis Obispo County, where plants colonize sandy salt marsh edges and marshy beach ridges. Colonies are patchily distributed within the upper marsh community (pickleweed-salt grass- alkali heath) in a narrow band along the perimeter of Morro bay, and are absent from the more interior portion of the marshlands (Department of the Interior 1994). Associated soils are course-grained sands and shell deposited by high tides and high-energy waves. In San Francisco Bay, the center of California seablite abundance along the Alameda shoreline corresponded closely with Merritt sands (Pleistocene marine lagoon/dune deposits), from south Richmond to Bay Farm Island. Along the San Francisco Peninsula, populations ranged from San Francisco to the Ravenswood area of Palo Alto, where California seablite was associated with beach ridges composed of oyster shell fragments.

Potential for occurrence in the SBSP area. California seablite was probably never common in the San Francisco Bay except in the few areas of historic sandy beach interface in Alameda and San Francisco counties (Baye and others 2000). Availability and accumulation of course sediments suitable for supporting California seablite is rare in the South Bay. The SBSP area is a significant distance from the Bay mouth and is subject only to low-energy wind and waves, which generally do not transport course sediment. However, very large oyster shell beach ridges and intertidal bars are still forming along the Foster City shoreline, and smaller ones occur at Bird Island, Bair Island, and Ravenswood (Baye 2004). These sites are suitable for reintroduction of California seablite, but no extant populations are known, or expected, to occur in the SBSP area.

Coastal marsh milk-vetch (*Astragalus pycnostachyus* var. *pycnostachyus*). Federal Status: Species of Concern; State Status: None; CNPS Status: List 1B. Coastal marsh milk-vetch is a stout, perennial herb in the pea family (Fabaceae) associated with maritime salt marshes, seeps, and mesic sites within dunes in Humboldt, Marin and San Mateo counties. Plants have an open, clumping habit and are densely soft-hairy, with long pinnate leaves and distinctive papery, inflated fruits. Many greenish-white or cream colored flowers appear on in the axils of leaves from April through October.

Coastal marsh milk-vetch is known from three locations in coastal San Mateo County (Pescadero Marsh, Pomponio State Beach, San Gregorio State Beach), where plants are associated with sandy-clay or gravelly soils. Little published information is available on the ecological requirements of this plant, but suitable microhabitat apparently occurs within a range of plant communities. One population occurs on a steep slope within coastal scrub, associated with coyote brush (*Baccharis pilularis*), sea lettuce (*Dudleya farinosa*), and sticky monkeyflower (*Mimulus aurentiacus*). The Pescadero Marsh population, on the other hand, persists in a diked area with peripheral halophytes, including alkali heath and marsh gumplant. Approximately 10 extant populations/occurrences are documented in Marin and Humboldt counties (California Department of Fish and Game 2004a), predominantly associated with the upper marsh ecotone. Coastal marsh milk-vetch's southern relative, Ventura marsh milkvetch (*A. p.* ssp. *lanosissimus*) is listed as endangered.

Potential for occurrence in the SBSP area. Coastal marsh milk-vetch is found exclusively on course substrates such as sandy clay and gravel and has never been observed east of the immediate coast. Despite the relative tolerance of this species to disturbed habitats such as levees, it is not expected to occur in the SBSP area due to historic and current patterns of sediment deposition. Furthermore, the SBSP area is outside the known range of this species.

Alkali milk-vetch (*Astragalus tener* var. *tener*). Federal Status: None; State Status: None; CNPS Status: List 1B. Alkali milk-vetch is a delicate annual plant associated with vernal pools, alkaline flats, and vernally moist meadows and grasslands in Alameda, Merced, Napa, Solano, and Yolo counties. Plants are between 2 and 12 inches in height, appearing in late winter as erect or ascending stems with glabrous, pinnately compound leaves. Pinkish-purple flowers appear from March through June, depending on timing of soil saturation/inundation and drying. All taxa within this species complex are associated with moist, vernally mesic soils and are extremely rare.

Alkali milk-vetch is associated with seasonal wetland species such as owl's clover (*Orthocarpus* spp.), downingia, semaphore grass (*Pleuropogon californicus*), and popcorn-flower (*Plagiobothrys* spp.), and occasionally (within alkali meadows) with peripheral halophytes such as salt grass and alkali heath. Plants occur on the upper edges of vernal pools, within grasslands underlain by heavy, moisture-retentive clay soils, and within the upper floodplains of rivers. Populations are often associated with, and threatened by, non-native annual grasses and forbs. At least one location, a population of alkali milk-vetch is threatened by management activities for waterfowl, which create perennially-inundated conditions unsuitable for supporting the species (California Department of Fish and Game 2004a). Approximately 30 extant populations/occurrences of alkali milk-vetch are documented by CDFG (California Department of Fish and Game 2004a). The majority of these occurrences is the result of intensive surveys of historic locations, and is likely an accurate representation of the actual current range of the species.

Potential for Occurrence in the SBSP area. Many historic locations of alkali milk-vetch in the South Bay (*i.e.*, Alviso, Milpitas, and "Mayfield", now Palo Alto) are now heavily developed or degraded and, until recently, the species was presumed to be extirpated from the Bay Area. However, a population of alkali milk-vetch was discovered along the upper boundaries of created vernal pools at the Pacific Commons Preserve in 1999 (Wetlands Research Associates 1999). This site is the location of a historic collection of the species, which likely persisted through years of unfavorable conditions by remaining dormant in the seedbank. It is therefore possible that other sites along the upper edges of the SBSP area, particularly those within the marsh/upland transition zone, contain viable alkali milk-vetch propagules. However, extant populations of this species are not expected to occur in the SBSP area due to the lack of appropriate seasonal wetland/alkali meadow habitat.

San Joaquin spearscale (*Atriplex joaquiniana*). Federal Status: None; State Status: None; CNPS Status: List 1B. San Joaquin spearscale is annual, grey-scaly, ascending plant in the goosefoot family (Chenopodiaceae). Like all *Atriplex* species, San Joaquin spearscale lacks petals, and flowers instead appear as dense clusters of fleshy, grey-green perianth parts in terminal inflorescences. This species flowers over a long period from April to October, depending on hydrological characteristics of the associated mesic habitat.

San Joaquin spearscale occurs on moist alkaline soils within a range of habitats, including non-native annual grassland, alkali meadow and scald, alkali sink, and the cut banks of eroded vernal pools. Huge populations occur in the vicinity of the Springtown Wetlands Preserve, most commonly associated with alkali heath, alkali weed (*Cressa truxillensis*), salt grass, and tarweeds (*Centromadia* spp.). CDFG documents 69 populations/occurrences of this species, nearly all of which were observed relatively recently and are presumed to be extant (California Department of Fish and Game 2004a).

Potential for Occurrence in the SBSP area. San Joaquin spearscale, like alkali milk-vetch, was recently discovered growing along the margins of created vernal pools at the Pacific Gardens Preserve in Fremont, adjacent to the Warm Springs Unit of the Don Edwards San Francisco Bay National Wildlife Refuge (Refuge). Plants occur along the upper edges of created vernal pools, where they are associated with non-native grasses and forbs. No other occurrences are documented in the SBSP area. Because the Pacific Gardens population likely resulted from an existing seedbank, additional areas of suitable habitat in the region may harbor dormant populations.

Congdon's tarplant (*Centromadia parryi* ssp. *congdonii*). Federal Status: None; State Status: None; CNPS Status: List 1B. Congdon's tarplant is a spiny, resinous annual herb in the sunflower family associated with moist, alkaline grasslands. Populations are frequently located within sumps or disturbed areas where water collects, and may be favored by moderate levels of disturbance that reduce the cover of non-native grasses and forbs. Unlike many of its community associates, this species matures in late summer and can flower into mid-fall; tarweeds in general are among the latest-blooming wildflowers of our area. Congdon's tarplant can be differentiated from co-occurring species of tarweed by the lack of tack-shaped glands on the leaves and flower bracts and the structure of its chaff scales (dry bracts among individual flowers).

Known populations of Congdon's tarplant occur in Monterey, San Luis Obispo, and Santa Clara counties, where CNNDB documents 62 occurrences. In the South Bay vicinity, several populations are known from disturbed annual grassland habitat in the vicinity of Alviso (H. T. Harvey & Associates 2002b; LSA Associates 1999), in the Warm Springs district of Fremont, near Milpitas, near Willow Road in Newark, and in the Sunnyvale Baylands Park (California Department of Fish and Game 2004a). Associated species include Italian rye (*Lolium multiflorum*) alkali heath, and salt grass.

Potential for Occurrence in the SBSP area. Congdon's tarplant is frequently associated with disturbed, alkaline habitats that pond water in the late winter and spring. As such, suitable habitat occurs on the margins of evaporation ponds or within the peripheral halophyte zone along the levees. However, soils in these areas are likely too saline to support Congdon's tarplant.

Point Reyes birds-beak (*Cordylanthus maritimus* ssp. *palustris*). Federal Status: Species of Concern; State Status: None; CNPS Status: List 1B. Point Reyes bird's-beak is a decumbent, grey-green annual herb in the snapdragon family (Scrophulariaceae). The foliage of this plant is purplish and salt-encrusted; like all species of *Cordylanthus*, it is parasitic on the roots of other plants (hemiparasitic). Seeds of Point Reyes bird's-beak germinate in December and seedlings appear in late winter or early spring. Dense spikes of white and pink flowers are produced through the summer (June to October). Of the three subspecies of *C. maritimus* occurring in California, two are endemic to coastal salt marshes. Point Reyes bird's-beak is a few-branched plant of the north coast, while salt marsh bird's-beak (*C. m. maritimus*) is highly branched and a rare associate of south coast marshes. The endangered soft bird's-beak (*C. mollis* ssp. *mollis*) is a closely-related species now limited to the Delta and Napa marshes.

Point Reyes bird's-beak was once a fairly common associate of high sandy salt marshes in the South Bay, (Baye and others 2000; California Native Plant Society (CNPS) 2001), where plants colonized the small, infrequently-flooded flats on courser alluvial substrates. Such salt pan habitat is now extremely rare in the region due to diking, but populations persist in remnant habitat in the central Bay, and have colonized old mounds of dredge material near Mill Valley (California Department of Fish and Game 2004a) and other artificial features in Marin County (Baye and others 2000). South Bay populations were recorded nearly a century ago near Palo Alto, Redwood City, Alviso, and at Alameda Marsh. These populations were not located in directed searches of former habitat and Point Reyes bird's-beak is now considered extirpated from the South Bay.

Potential for Occurrence in the SBSP Area. This species has not been observed in Alameda, Santa Clara, or San Mateo counties since 1917 (California Department of Fish and Game 2004a). Furthermore, the artificial dikes, levees, and ponds of the project area are not suitable for supporting natural populations of Point Reyes bird's-beak.

Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*). Federal Status: Species of Concern; State Status: None; CNPS Status: List 1B. Delta tule pea is a robust, climbing perennial plant in the Pea family (Fabaceae) associated with freshwater and brackish marsh. Plants often occur in large colonies, where they are found twining through associated vegetation or as tangled masses; individual plants can reach six feet in length. Rose-purple flowers appear from May through June, after which plants gradually senesce to overwinter as underground rootstocks. Key characters distinguishing Delta tule pea from common taxa, include the co-occurring California tule pea, are compound leaves with elongated tendrils and 10-16 leaflets, broadly-winged stems, and lack of hairs on the stems and leaves.

Populations of Delta tule pea are restricted to the edges of marshes and sloughs with significant freshwater inputs. Plants typically occur in relatively well-drained areas, often on slight topographic relief above the marsh plain (Baye and others 2000), and are most frequently associated with cattail, bulrush, California rose (*Rosa californica*), and coyote brush (*Baccharis pilularis*). Several populations are associated with plants more typical of the high salt marsh, including saltgrass, pickleweed, and jaumea. The center of population distribution is in the Delta region, where plants may co-occur with other rare species such as Suisun Marsh aster (*Aster lentus*) and Mason's lilaeopsis. Delta tule pea is reported to occur in the vicinity of Niles in Alameda County, but is considered extirpated in Santa Clara County (California Native Plant Society (CNPS) 2001).

Potential for Occurrence in the SBSP area: Although reportedly extant in Alameda County (California Native Plant Society (CNPS) 2001), no populations of Delta tule pea have been documented in the South Bay area (California Department of Fish and Game 2004a). Like Mason's lilaeopsis, Delta tule pea is associated with a brackish to freshwater marsh habitat that was never common in the SBSP area. The artificial ponds, levees, and associated habitat of the project area are not suitable for supporting this species.

Prostrate navarretia (*Navarretia prostrata*). Federal Status: Species of Concern; State Status: None; CNPS Status: List 1B. Prostrate navarretia is a small annual herb in the Phlox family (*Polemoniaceae*) associated with vernal pools and mesic, alkaline areas within grassland. Plants have a stalkless, central flower head with many prostrate flowering branches spreading radially from beneath, and leaves are long, narrow, and deeply pinnately-lobed. White to violet flowers appear from April through July as dense clusters surrounded by spiny bracts.

Prostrate navarretia is associated with relatively course-grained sediments in small depressions within mesic areas. Associated species include the typical vernal pool indicator species coyote-thistle (*Eryngium vaseyi*), popcorn-flower (*Plagiobothrys* spp.), and spike rush (*Eleocharis macrostachya*). The majority of known populations of prostrate navarretia occur in southern California, where plants are associated with the large vernal pool complexes of the Santa Rosa Plateau, mima mound topography in Los Angeles County, and mesas south through San Diego. Significant populations also occur on military lands in southern Monterey County and at the Kesterson National Wildlife Refuge near Merced. In the South Bay area, prostrate navarretia is known only from the seasonal wetlands and created vernal pools at the Pacific Commons Preserve.

Potential for Occurrence in the SBSP Area: Prostrate navarretia will not be affected by the SBSP project, as populations are not known or expected to occur outside of the Pacific Gardens Preserve.

Delta woolly-marbles (*Psilocarphys brevissimus* var. *multiflorus*). Federal Status: None; State Status: None; CNPS Status: List 4. Delta woolly-marbles is an annual, vernal-pool endemic in the Sunflower family (Asteraceae) with silky-hairy foliage and several spreading stems from the base. Plants are grey-green throughout and produce small (less than 1 cm) oval heads of pale, cobweb-like flowers from May through June. Delta woolly-marbles occur along the drying edges of vernal pools within grassland.

Potential for Occurrence in the SBSP Area: Populations are not known, or expected, to occur in the project area. No suitable vernal pool habitat occurs in the vicinity outside of the Pacific Gardens Preserve and adjacent Warm Springs seasonal wetland area, neither of which currently support populations of Delta woolly marbles.

Saline clover (*Trifolium depauperatum* var. *hydrophilum*). Federal Status: Species of Concern; State Status: None; CNPS Status: List 1B. Saline clover is a very small, fleshy annual plant in the Pea family. Plants are decumbent to erect, with pink-purple, white-tipped flowers appearing from April through June. Flowers become inflated as fruits mature.

This species is associated with saline-alkaline soils within grasslands, seasonal wetlands, and, at Moss Landing in Monterey County, along the margins of upper salt marsh habitat. Throughout most of its known range, saline clover is associated with typical seasonal wetland plants such as meadow barley (*Hordeum brachyantherum*), semaphore grass, and downingia, or with alkali associations of brass buttons, saltgrass, and Italian rye. Populations near Moss Landing occur at the brackish marsh-grassland ecotone.

Potential for Occurrence in the SBSP Area. Historic records of saline clover from seasonal wetlands in the Belmont and Alameda areas document extirpated populations; and no extant populations are known from the South Bay area. No suitable habitat occurs in the SBSP vicinity outside of the Pacific Gardens Preserve and adjacent Warm Springs seasonal wetland area. Therefore, saline clover will not be affected by the SBSP project.

3.5 Specific Vegetation and Habitat Resources

3.5.1 Adjacent Habitats

Historically, the margins of San Francisco Bay were surrounded by a mosaic of wetland habitats, dominated by tidal salt marsh, but also included large expanses of upland ecotone, intramarsh ponds, salt pan, sinuous channel networks, beaches, lagoons and sausals (Collins 2004). However, these habitats have been dramatically modified from anthropogenic activities such as bay filling and diking for agriculture, salt production and flood protection. While the habitats within the salt pond complexes are the focus of this report, the areas that currently surround the three pond complexes are quantified in this section. These adjacent habitats provide the landscape context for the SBSP restoration planning, and therefore are important in considering the overall existing biological conditions in the South Bay. Figure 10 highlights some of the larger habitat types (apart from developed areas) that surround the salt pond complexes.

Approximately 14,500 acres of intertidal mudflat habitat (at –0.9 feet MLLW tide) are located in the South Bay adjacent to the three pond complexes (Figure 10). Mudflats are located on the bay side of the pond complexes and provide important habitat for resident and migratory bird populations in the South Bay, and are foraging habitat for Bay fishes and invertebrates.

Active salt ponds constitute the largest non-mudflat habitat surrounding the SBSP complexes and cover 12,575 acres adjacent to the pond complexes (Figure 10). These active salt ponds (managed by Cargill) are for the most part located on the eastern side of the South Bay between the Eden Landing and Alviso pond complexes. There are additional active salt ponds to the west of the Ravenswood complex, also managed by Cargill. To the north of the Eden Landing complex there are 795 acres of managed ponds currently operated by CDFG and the East Bay Regional Parks District.

Tidal wetlands comprise the greatest acreage of vegetated habitat adjacent to the ponds, occupying 8,330 acres of the surrounding habitat. The tidal wetlands are mainly located in narrow strips between the mudflats and the Cargill and SBSP pond complex levees. The tidal wetlands also extend upstream along the Alameda Flood Control Channel, Newark Slough, Mowry Slough, and Coyote Creek as well as isolated patches of larger historic marshes such as Greco Island, Dumbarton Marsh and Triangle Marsh. These tidal wetlands are primarily tidal salt or tidal brackish marsh. In addition there are 2,549 acres that have planned or on-going tidal restoration projects. There are a number of smaller muted tidal/diked marsh areas occupying 1,024 acres in total in the vicinity. An additional 588 acres of current pond habitat have been categorized as projects related to the SBSP Restoration Project (Pond A4, Moffett Field, and Mosley Tract).

There are 1,098 acres of upland (mostly non-native grassland habitat) located near the SBSP pond complexes, including the Coyote Hills Regional Park, and Shoreline Regional Park. There are 513 acres of grassland/vernal pools located in the southeastern extent of the project vicinity in the Warm Springs area. The upland grassland and vernal pool areas are landward from the pond complexes, between the pond complexes and urbanized areas. There are an additional 755 acres of parks and/or golf courses in a similar topographic position as the grasslands.

Additionally, there are 1,618 acres of water or sewage treatment facilities in the project vicinity, and an additional 588 acres of water treatment-related ponds. Landfill areas (active or closed) comprise 1090 acres of the surrounding habitat. Other urban features include airports and highways in the area.

The sections below summarize the habitats and vegetation distribution of the three main South Bay salt pond complexes. Most of this information is based on data collected prior to ISP implementation. We do not anticipate any immediate changes in the vegetation communities as a result of the ISP, except for minor direct impacts in areas where ISP-related construction activities (such as the placement of water control structures) will occur.

3.5.2 Alviso Complex

The Alviso complex includes salt marsh, brackish marsh, freshwater marsh and peripheral halophyte marsh habitats (Table 6, Figures 5 and 6, refer to Figure 1 for creek and slough locations). The salt marsh habitat occurs on the outboard levees along the western extent of the Alviso complex. Salt marsh dominated by cordgrass occurs on the lower elevations of the marsh that border mudflat areas. A new cordgrass salt marsh island is forming at the mouth of Alviso Slough. Pickleweed-dominated salt marsh occurs at higher elevations, just above the cordgrass-dominated fringes of the salt marshes. The pickleweed salt marsh communities extend upstream into Mountain View Slough, Stevens Creek, Guadalupe Slough and Alviso Slough. Cordgrass borders occur along Mountain View Slough, Guadalupe Slough and Alviso Slough. Salt marsh is replaced by brackish marsh moving upstream along Guadalupe and Alviso Slough. Brackish marsh habitat dominates the outboard levees near the junction of Mud Slough and Alviso Slough. Moving upstream, the brackish marsh initially contains patches of pickleweed salt marsh within the marsh plain, and becomes primarily brackish marsh to the east of the Artesian Slough junction. Cordgrass salt marsh exists along the fringing lower elevations and brackish marsh covers the marsh plain in the transition from salt marsh to brackish marsh along Coyote Creek. Brackish marsh dominates Triangle marsh and extends into the lower reaches of the Artesian Slough. Artesian Slough becomes dominated by freshwater marsh upstream (south) of Pond A17.

Lagre areas of mudflat and open water bay habitats are found in the Alviso complex (Table 6), but were only mapped in areas immediately adjacent to the salt pond levees (Figures 5 and 6). Large expanses of newly formed mudflat habitat exist downstream of the Island Ponds (A19, A20 and A21), including at the mouth of Alviso Slough and Guadalupe Slough. Mudflat occurs along Charleston Slough at the western extent of the complex. There are small areas of mudflat surrounded by open water adjacent to Pond A12 and surrounded by freshwater marsh at the end of the reach to the south of the Island Ponds. Open water habitat exists along the Mountain View Slough, Stevens Creek, Alviso Slough, Artesian Slough, and the upper reaches of Coyote Creek in the Alviso complex.

Levees separate many of the individual ponds in the Alviso complex. Upland vegetation borders sections of the freshwater and brackish marshes. Unvegetated islands exist within several of the salt ponds.

Table 6 – Habitat Types mapped in the Alviso Complex.

Habitat Type	**Acres**
Salt Marsh (Total)	420
Pickleweed dominated	287
Cordgrass dominated	123
Dominated by other salt marsh species	10
Brackish Marsh	896
Fresh Marsh	173
Peripheral Halophytes	118
Marsh habitats subtotal	**1,607**
Mudflat	587
Open Water	251
Bay habitats subtotal	**838**
Levee	394
Upland Vegetation	130
Unvegetated	77
Developed	14
Other	1
Total	**3,061**

The salt ponds in the Alviso complex include System, Full Tidal, High Salinity (Batch), Seasonal, and Mixed (Seasonal /High Salinity) Ponds (Table 7, Figures 5 and 6). The System Ponds are primarily grouped in the western extent of the Alviso complex, with two being separated from the other System Ponds by the three high salinity ponds, which occur south of the Mud Slough-Coyote Creek junction. The Mixed (Seasonal/High Salinity) Ponds are at the southern portion of the Alviso complex at the upper reaches of Alviso Slough and Guadalupe Slough in the pond complex. The three Island Ponds (A19, A20, A21) are not yet fully tidal. The two seasonal ponds (A22, A23) lie in the northern portion of the Alviso Pond complex. Please see Appendix A for details on the ISP operations of all ponds.

Table 7 – Salt Pond Types in the Alviso Complex.

Pond Number	Management Regime	Acres
A1	System Pond	274
A2W	System Pond	432
AB1	System Pond	141
A2E	System Pond	313
AB2	System Pond	141
A3W	System Pond	559
A5	System Pond	609
A6	System Pond	332
A7	System Pond	253
A9	System Pond	364
A10	System Pond	249
A11	System Pond	262
A14	System Pond	337
A16	System Pond	242
A17	System Pond	131
	System Pond Subtotal	**4,638**
A19	Full Tidal	265
A20	Full Tidal	64
A21	Full Tidal	148
	Full Tidal Subtotal	**477**
A12	High Salinity	308
A13	High Salinity	267
A15	High Salinity	251
	High Salinity Subtotal	**826**
A22	Seasonal Pond	266
A23	Seasonal Pond	446
	Seasonal Pond Subtotal	**712**
A3N	Mixed (Seasonal/High Salinity)	160
A8	Mixed (Seasonal/High Salinity)	407
A8S	Mixed (Seasonal/High Salinity)	143
	Mixed (Seasonal/High Salinity) Subtotal	**710**
	Overall Total	**7,364**

Note that the baseline conditions for this report are the conditions that are predicted to be present once the ISP is fully operational. The ISP controls become operational at different times for different complexes.

Table 8 – Summary Table for the Alviso Complex.

Habitat Type	Acres	Proportion of Total
Salt Ponds	7,364	71%
Marsh Habitats	1,607	15%
Bay Habitats	838	8%
Other	617	6%
Total Area Mapped	**10,425**	

3.5.3 Special-Status Plants

The Alviso Complex encompasses significant areas of natural marsh vegetation, including nearly 900 acres of brackish marsh and over 400 acres of salt marsh. Despite this prevalence of native habitat, most special status plant species are not expected to occur in the Alviso Complex due to the absence of specific microhabitat associations. Of the 13 species considered in this analysis, 5 species (Contra Costa goldfields, alkali milkvetch, Delta woolly marbles, prostrate navarretia, and saline clover) occur in vernal pools, ephemeral wetlands, or other seasonally-inundated depressions. These habitats, while once extensive on the upper marsh plain between tidal creeks, are now entirely absent from the Alviso Complex, although over 500 acres of vernal pools and mesic grasslands at the Warm Springs Unit of the Refuge, which abuts Pond A22. Similarly, the relatively coarse, well-drained substrates of beach ridges and the upper alluvial fan, which support California seablight, Point Reyes bird's-beak, and coastal marsh milk-vetch, are also absent from the Alviso area. Finally, the brackish marsh species Delta tule pea and Mason's lilaeopsis are considered absent from the South Bay marshes, which probably never provided substantial suitable habitat.

However, fill soils associated with levees provide an artificial ecotonal habitat that is marginally suitable for special status plants of relatively dry, alkaline areas. For example, Congdon's tarplant has been reported from the mouth of Stevens Creek, where a small, remnant occurrence of an historic population was observed in hard-packed gravel in a levee road north of the end of Crittendon Road (California Department of Fish and Game 2004a). Populations are also known from slightly saline grasslands in the Warm Springs district, and historic observations are reported from Cooley Landing in Menlo Park and from East Palo Alto (in the vicinity of the Ravenswood Complex). Congdon's tarplant was once common along salt marsh edges in the South Bay (Munz and Keck 1959) and, as evidenced by recent observations of small remnant colonies, has a slight potential for occurrence on levees and adjacent upland areas throughout the SBSP area. Similarly, a historic observation of San Joaquin spearscale in the Warm Springs district may correlate with the recent reappearance of this species at a restoration site at the Pacific Commons Preserve. Like many annual plants, San Joaquin spearscale may ride out years of unfavorable conditions by remaining dormant in the seedbank, and evidence suggests that plants respond favorably to disturbance (California Department of Fish and Game 2004a). The restoration of tidal action associated with the ISP may improve, or create, habitat for San Joaquin spearscale and other annuals of the saltmarsh-upland transition zone. These potential changes cannot be accurately predicted at this time, but are not expected to be substantial.

3.5.4 Ravenswood Complex

The Ravenswood complex primarily includes salt marsh and peripheral halophyte marsh habitats (Table 9, Figure 7). This complex is surrounded by salt marsh, consisting of cordgrass salt marsh along the lower elevation fringes of the salt marsh and pickleweed salt marsh in the higher elevation marsh plain. There are some patches of salt marsh dominated by other species, particularly along the southern edge of the Ravenswood complex. Peripheral halophyte habitat borders the salt marsh in much of the transitional zone to upland areas. Upland vegetation is also found at higher elevations around the salt marsh boundary, often bordering the levees. There is one small area of freshwater marsh along the southern boundary of the Ravenswood complex.

Mudflat and open water bay habitats are found in Ravenswood complex (Table 9). Mudflat habitat has formed at the mouth of Ravenswood Slough. A large expanse of mudflat lies to the north and east of the Ravenswood complex, which is not highlighted in the figure but can be noted in the aerial photography. Open water habitat exists throughout the Ravenswood complex in the historic slough channels.

Levee separates the individual ponds in the complex. Highway 84 leading onto the Dumbarton Bridge, bisects the Ravenswood Slough and divides the pond complex.

Table 9 – Habitat Types mapped in the Ravenswood Complex.

Habitat Type	**Acres**
Salt Marsh (Total)	137
Pickleweed dominated	92
Cordgrass dominated	37
Dominated by other salt marsh species	8
Brackish Marsh	1
Fresh Marsh	1
Peripheral Halophytes	14
Marsh habitats subtotal	**153**
Mudflat	20
Open Water	263
Bay habitats subtotal	**283**
Levee	80
Upland Vegetation	33
Unvegetated	17
Developed	36
Other	10
Total	**612**

All ponds in the Ravenswood complex will be managed as System Ponds under the ISP (Table 10).

Table 10 – Salt Pond Types in the Ravenswood Complex.

Pond Number	Management Regime	Acres
R1	System Ponds	446
R2	System Ponds	136
R3	System Ponds	269
R4	System Ponds	295
R5	System Ponds	29
S5	System Ponds	28
SF2	System Ponds	237
	System Pond Subtotal	**1,440**
	Overall Total	**1,440**

Note that the baseline conditions for this report are the conditions that are predicted to be present once the ISP is fully operational. The ISP controls become operational at different times for different complexes; the ponds in the Ravenswood complex may not be implemented for several years.

Table 11 – Summary Table for the Ravenswood Complex.

Habitat Type	Acres	Proportion of Total
Salt Ponds	1,440	70%
Marsh Habitats	153	7%
Bay Habitats	283	14%
Other	176	9%
Total Area Mapped	**2,051**	

3.5.5 Special Status Plants

In general, the Ravenswood Complex lacks suitable microhabitats for special status plants. Specifically, no seasonal wetlands, salt pans and other high marsh sub-habitats, or newly-accreted brackish marsh occurs in this area. Although a slough meander in the southeast corner of the complex supports freshwater marsh vegetation (likely due to stormwater runoff from an adjacent corporate park), dense growth of alkali bulrush and cattail precludes the occurrence of seasonal wetland species in this area. As previously discussed, Congdon's tarplant historically occurred in the vicinity of the Ravenswood Complex, and was recently documented less than one mile south of pond SF2. Fill soils along levees provide marginally-suitable habitat for this species. Soft bird's-beak also historically occurred in the Ravenswood vicinity, where herbarium specimens were collected at the mouth of Redwood Creek (1908) and at Cooley's Landing (1900). However, soft bird's-beak is now extirpated from the South Bay (Baye 2000; California Native Plant Society (CNPS) 2001).

No extant populations of California seablite are known from, or expected to occur in, the SBSP area. However, very large oyster shell beach ridges and intertidal bars are still forming along the Foster City shoreline, and smaller ones occur at Bird Island, Bair Island, and Ravenswood (Baye 2004). Therefore, suitable habitat for the reintroduction of California seablite may be present in the Ravenswood Complex.

3.5.6 Eden Landing Complex

The Eden Landing complex includes salt marsh, brackish marsh, freshwater marsh and peripheral halophyte marsh habitat (Table 12, Figures 8 and 9). Large areas of pickleweed salt marsh lie to the west of the Eden Landing complex at the mouths of the Old Alameda and Mount Eden Creeks, commonly known as the 'Whale's Tail' marsh. 'Whale's Tail' marsh is bordered by the developing cordgrass salt marsh in 'Cargill Marsh' (also known as 'New Marsh') to the east and mudflat to the west. Brackish marsh exists further upstream in Old Alameda Creek and continues along the eastern boundary of the pond complex. The lower reaches of the Mount Eden Creek, which intersect the northern ponds in the complex, consist of pickleweed salt marsh. The northeastern ponds are bordered by open water and peripheral halophytes inland along Eden Creek. Pickleweed salt marsh dominates the lower reach of the Alameda Creek Flood Control Channel along the southern boundary of the pond complex. In addition, small oystershell beach ridges are found within the northern 'Whale's Tail' marsh, and a small oystershell beach ridge is located on the north end of the outboard marsh of Pond E2.

Mudflat and open water bay habitats are found in the complex (Table 12). Large expanses of mudflat extend to the west of the Eden Landing complex, and are not mapped in Figures 8 and 9, but are visible in the aerial photography. Open water habitat exists in Old Alameda Creek, North Creek, along Mt. Eden Creek and as internal marsh ponds within the 'Whale's Tail' marsh.

Table 12 – Habitat Types mapped in the Eden Landing Complex.

Habitat Type	Acres
Salt Marsh (Total)	741
Pickleweed dominated	641
Cordgrass dominated	93
Dominated by other salt marsh species	7
Brackish Marsh	16
Fresh Marsh	8
Peripheral Halophytes	58
Marsh habitats subtotal	**824**
Mudflat	36
Open Water	74
Bay habitats subtotal	**110**
Levee	256
Upland Vegetation	120
Unvegetated	58
Developed	2
Other	-
Total	**1,369**

The Eden Landing ponds consists of a variety of ISP management regimes, including System Ponds, Seasonal Ponds, Mixed (Seasonal/System and Seasonal/High Salinity) Ponds and System Ponds/High Salinity Ponds (Table 13). The three Mixed (Seasonal/High Salinity) ponds are grouped in the northeast part of the complex, while the only Mixed (Seasonal/System) pond is located just to the southeast of those ponds. System Ponds/High Salinity Ponds follow Old Alameda Creek separating the Eden Landing complex. The southern part of the Eden Landing complex consists of System and Seasonal Ponds with two System Ponds/High Salinity Ponds in the middle. The remaining ponds in the northwest part of the complex are also System Ponds.

Table 13 – Salt Pond Types in the Eden Landing Complex.

Pond Number	Management Regime	Acres
E1	System Ponds	289
E2	System Ponds	676
E5	System Ponds	163
E6	System Ponds	193
E9	System Ponds	358
E10	System Ponds	252
EC2	System Ponds	27
	System Ponds Subtotal	**1,958**
E1C	Seasonal Pond	149
E4C	System Ponds	174
E5C	System Ponds	149
E6C	System Ponds	80
	Seasonal Ponds Subtotal	**552**
E8X	Mixed (Seasonal/System)	31
	Mixed (Seasonal/System)	**31**
E12	Mixed (Seasonal/High Salinity)	108
E13	Mixed (Seasonal/High Salinity)	119
E14	Mixed (Seasonal/High Salinity)	154
	Mixed (Seasonal/High Salinity) Subtotal	**382**
E4	System Ponds/High Salinity Ponds	187
E6A	System Ponds/High Salinity Ponds	305
E6B	System Ponds/High Salinity Ponds	266
E7	System Ponds/High Salinity Ponds	213
E8	System Ponds/High Salinity Ponds	169
E8A	System Ponds/High Salinity Ponds	241
E11	System Ponds/High Salinity Ponds	119
	System Ponds/High Salinity Ponds Subtotal	**1,500**
	Overall Total	**4,423**

Note that the baseline conditions for this report are the conditions that are predicted to be present once the ISP is fully operational. The ISP controls become operational at different times for different complexes.

Table 14 – Summary Table for the Eden Landing Complex.

Habitat Type	Acres	Proportion of Total
Salt Ponds	4,423	76%
Marsh Habitats	824	14%
Bay Habitats	110	2%
Other	435	8%
Total Area Mapped	**5,792**	

Of the over 18,000 acres mapped in the three pond complexes, 72% (>13,000 acres) consist of salt ponds (Table 15). Please note that the acreages presented are only those habitats that were mapped immediately adjacent to those salt ponds. For example, the 'Bay Habitats' category (which includes existing mudflat), drastically underrepresents the amount of that habitat immediately adjacent to the salt ponds. Refer to Figures 5-9 for the extent of the mapping boundaries; for a broader context of surrounding habitats, see Section 4.5.1 (Figure 10).

Table 15 – Overall Summary Table for all three complexes (Alviso, Ravenswood, and Eden Landing).

Habitat Type	Acres	Proportion of Total
Salt Ponds	13,227	72%
Marsh Habitats	2,584	14%
Bay Habitats	1,231	7%
Other	1,228	7%
Total Area Mapped	**18,270**	

3.5.7 Special-Status Plants

In general, the Eden Landing Complex is not expected to support special-status plants due to the absence of suitable, microhabitat associations. Furthermore, no historic records of special-status plants are documented from the Eden Landing area. As discussed in previous sections, however, upland fill soils along levees and adjacent to project sites provide marginally suitable habitat for Congdon's tarplant, and changes associated with the ISP management actions may provide habitat for other disturbance-dependent annuals such as San Joaquin spearscale.

No extant populations of California seablite are known, or expected, to occur in the SBSP area. However, very large oyster shell beach ridges and intertidal bars are still forming along the Foster City shoreline, and smaller ridges and bars occur at Bird Island, Bair Island, and Ravenswood (Baye 2004). Therefore, suitable habitat for the reintroduction of California seablite may be present in the Eden Landing Complex.

4. WILDLIFE RESOURCES

4.1 Introduction

The San Francisco Bay estuary is an extremely productive, diverse ecosystem. Despite the loss of more than 90% of its original wetlands to diking, draining, and filling (Goals Project 1999; Harvey and others 1988) wildlife diversity is high, with more than 250 species of birds, 120 species of fish, 81 mammals, 30 reptiles, and 14 amphibians regularly occurring in the estuary (Siegel and Bachand 2002). More importantly, the San Francisco Bay supports populations of a number of species that are of regional, hemispheric, or even global importance. A number of endemic, endangered, threatened, and rare wildlife species or subspecies reside in the San Francisco Bay area.

The South San Francisco Bay area is a critical component of the larger estuary. Though surrounded by urban development and highly altered by the diking of wetlands for salt production, the South Bay supports some of the most important habitat remaining in the entire Bay area for a number of wildlife species. This section presents a description of the existing conditions for wildlife resources in the South Bay, including discussions of the species composition and structure of invertebrate, fish, reptile, amphibian, mammal, and bird communities in the South Bay. Detail on these species' life histories, habitat requirements, and habitat use in the South Bay, and the spatial and temporal variation in these species' presence/distribution in the region are discussed, and the occurrence and use of the South Bay by special-status wildlife species is also summarized.

Description of the existing wildlife use of the SBSP area requires a broader perspective than just the ponds themselves, both to place the use of existing ponds into the context of the larger estuary and to capture the interchange that occurs between these ponds and other habitats in the region by a number of wildlife species, particularly birds. Within the South Bay region, a number of different geomorphic units/habitat types are present, as described in the "Habitats and Vegetation" section above. Within these habitat types, slight variations in microhabitat conditions and plant structure or species composition may result in important changes in ecological conditions that affect wildlife populations and communities, and such slight changes are discussed in the following sections where important. However, for the sake of describing wildlife use of the SBSP study area, these habitat types can generally be divided into several broad categories – open waters of the Bay, tidal sloughs and channels, intertidal mudflats, vegetated tidal marsh, "salt ponds"[1], and upland habitats surrounding the Bay and wetland areas.

[1] Note that the baseline conditions for this report are the conditions that are predicted to be present once the ISP is fully operational. Thus, the ponds that are the subject of the proposed restoration effort are technically no longer salt production ponds after ISP implementation. However, because the vast majority of research that has been conducted on these ponds was performed when they were functioning as salt ponds, the term "salt pond" will be used to refer to these ponds. The observed or predicted changes in wildlife use as ISP controls become operational (which will not occur for years in some ponds, such as those in the Ravenswood Complex) will be noted where appropriate, and any necessary distinction between the "salt ponds" that are included in the restoration plan and the ponds that have been retained for salt production by Cargill will be explicitly noted as necessary.

It should be noted that the South Bay includes several important features not directly involved in the SBSP project, but that support (or have the potential to support) significant wildlife resources. Bair Island, located north of Redwood City on the southwest side of the Bay, consists of approximately 3,200 acres of former salt evaporation ponds on the west side of San Francisco Bay in Redwood City. Approximately 1,400 of those acres were transferred from private landowners to the ownership of the CDFG and USFWS, with the goal of restoring the Bair Island complex to tidal marsh. The EIR/S for the Bair Island Restoration Project was released to the public in September 2004. Bair Island supports, or has in the past supported, regionally important populations of several wildlife species, including herons, terns, California Clapper Rails (*Rallus longirostris obsoletus*), salt marsh harvest mice (*Reithrodontomys raviventris*), and others. In addition, approximately 1,200 acres of salt ponds in the Redwood City complex and more than 10,000 acres in the Newark complex have been retained by Cargill for continued salt production. These ponds are expected to provide habitat for wildlife to some unknown extent. In the Alviso area, salt ponds A4 and A18 are not part of the SBSP project, but these ponds provide habitat for waterbirds as described below for the SBSP project ponds.

4.1.1 Overview of Wildlife Resources in the South Bay

The diversity of habitat types present within the South Bay is largely responsible for the high numbers of wildlife species that occur here, while the high productivity of these habitats provides the resources necessary for some of these species to achieve substantial numbers. This section provides a general overview of the wildlife communities associated with the major habitat types; it is followed by a more detailed discussion of the biology of different groups of species present in the SBSP study area.

The primary basis for the complex food webs that characterize the interlinked habitats and biotic communities of the South Bay is the high productivity of the tidal salt marshes and aquatic plants, primarily phytoplankton, growing within the waters of the Bay itself; the streams that flow into the South Bay provide a secondary input of nutrients and energy to the system. This plant material provides food for a variety of invertebrates (which then serve as prey for numerous vertebrate species) and for some South Bay vertebrates as well.

Subtidal Habitats. The open waters of South San Francisco Bay extend from a maximum depth of 25+ feet in the channel between the San Mateo and Dumbarton Bridges up to the Mean Lower Low Water (MLLW) elevation. However, the majority of the South Bay, particularly the area southeast of the Dumbarton Bridge, is 6-12 feet deep or less. The open waters of the Bay support a high diversity of benthic and pelagic macroinvertebrates; though most of the dominant invertebrates are non-native species, they nonetheless support large fish populations. Piscivorous (fish-eating) birds such as the Forster's Tern (*Sterna forsteri*), California Least Tern (*Sterna antillarum browni*), and Double-crested Cormorant (*Phalacrocorax auritus*) ply the open waters of the Bay for fish, while diving ducks such as Greater Scaup (*Aythya marila*), Lesser Scaup (*Aythya affinis*), Canvasbacks (*Aythya valisineria*), and Surf Scoters (*Melanitta perspicillata*) dive for bivalves, crustaceans, and other invertebrates in shallower subtidal areas. The types of birds that can exploit the subtidal areas are limited to those that can forage from the air (*e.g.*, terns) and those that are able to swim, and bird diversity in the open Bay waters is fairly low. However, large densities of diving ducks occur in some areas where appropriate depths and concentrations of benthic invertebrates, particularly bivalves, provide a rich food source. Some species, such as gulls, also roost on the Bay, especially at night.

The tidal sloughs and channels that carry water between salt ponds and marsh remnants, and through the marshes, provide important habitat for large numbers of benthic and pelagic invertebrates and fish. These detritus-rich channels serve as important nurseries and feeding areas for estuarine fish. California bay shrimp (*Crangon franciscorum*) spawn in the open ocean but spend much of their lives feeding in the brackish waters of South Bay sloughs (Baxter and others 1999). Diving ducks generally avoid the smaller tidal channels but can be found in abundance, particularly during the nonbreeding season, near the mouths of the larger tidal sloughs and in the open waters of the Bay. Thousands of diving ducks also roost and forage in the artificial lagoons in Foster City and Redwood Shores, north of the Ravenswood Complex, in winter. Dabbling ducks such as the Gadwall (*Anas strepera*), Green-winged Teal (*Anas crecca*), Northern Shoveler (*Anas clypeata*), and Mallard (*Anas platyrhynchos*) reach high densities in the smaller and shallower channels, where they feed on aquatic plants (including algae, submerged aquatic vegetation, and plankton) and invertebrates. Terns often forage in the larger and mid-sized channels, and several species of herons and egrets forage in the shallows for fish.

Intertidal mudflats. Intertidal mudflats are expanses of unvegetated mud lying between MLLW and the lower marsh zone. These flats are generally covered by shallow water during high tide, but are uncovered at low tide. Narrow mudflats occur along the edges of the tidal sloughs and channels, and on the outboard side of some salt pond levees, while much more extensive flats are present at the mouths of the major sloughs and along the edge of the Bay. Mudflats are dynamic depositional features, changing in extent and location depending on the nature of erosion and deposition of sediments.

Detritus from tidal marshes, phytoplankton that settles in the water column, and algae and diatoms growing on the intertidal mudflats are responsible for the high productivity of benthic invertebrates on mudflats (Life Science 2003; Warwick and Price 1975). Crustaceans, polychaete worms, gastropod and bivalve mollusks, and other invertebrates live on or just below the surface of the mud. During the daily high tides, fish school over the mudflats to feed on these invertebrates. As the tide recedes and the flats emerge, the fish retreat to subtidal areas while considerable numbers of birds, primarily shorebirds, leave their high-tide roosts and feed on the flats. These mudflats are primarily responsible for the importance of the San Francisco Bay area to West Coast shorebird populations, with an average of 67% of all the shorebirds on the West Coast of the U.S. using San Francisco Bay wetlands (Page and others 1999). Gulls and some dabbling ducks forage on the exposed mudflats as well. Because benthic invertebrates often recede deeper into the mud as the tidal elevation drops, especially large concentrations of foraging birds usually occur right at the edge of the receding or rising tideline. Although the largest numbers of shorebirds forage on the broad flats along the edge of the Bay at low tide, some shorebirds, gulls, and large waders (e.g., herons and egrets) feed on the exposed flats along sloughs and channels, and the smaller channels in the brackish and salt marshes are the favored foraging areas for the state and federally endangered California Clapper Rail.

Shorebirds, gulls, terns, American White Pelicans (*Pelecanus erythrorhynchos*), and ducks often use exposed mudflats as roosting or loafing areas when they are available, as will Pacific harbor seals (*Phoca vitulina richardsi*). When the tides rise, most of these birds will return to roosting areas in salt ponds or other alternate habitats.

Tidal Marsh. Current tidal marshes in the South Bay are mere remnants of their former extent, but they still support high densities, and fairly high diversity, of wildlife species, including several San Francisco Bay endemics. The state and federally endangered salt marsh harvest mouse and the salt marsh wandering shrew (*Sorex vagrans halicoetes*) occur in the salt marshes of the South Bay, particularly where pickleweed is present. The California vole (*Microtus californicus*) occurs here as well, and is often the most common small mammal in tidal marshes. California Clapper Rails nest in cordgrass, denser stands of pickleweed, and marsh gumplant, particularly in the lower marsh zone where numerous small tidal channels are present, in both salt and brackish tidal marshes. Due to the relatively low mobility of these marsh obligates, expansive, unfragmented marshes with high connectivity to other large marshes and ample high-tide refugia (*e.g.*, upland transitional zones) provide the optimal landscape configuration for these species by allowing for large population sizes in a given area and facilitating dispersal among marshes. Higher-elevation areas, such as natural levees along higher-order channels and upland transitional zones on the upper sides of tidal marshes, are important during spring tides, when rails, salt marsh harvest mice, and passerines must seek cover from high water (and from the avian predators that hunt the marshes during these tides). However, very little high-quality tidal salt marsh habitat with these attributes is present in the South Bay.

The Alameda Song Sparrow (*Melospiza melodia pusillula*), endemic to the Central and South San Francisco Bay, nests in dense herbaceous vegetation in salt and brackish marshes as well, while the Savannah Sparrow (*Passerculus sandwichensis*) nests in pickleweed and peripheral halophytes in the upper marsh and upland transitional zones. The Saltmarsh Common Yellowthroat (*Geothlypis trichas sinuosa*) nests in tidal and nontidal brackish and freshwater marshes, and possibly in low densities in salt marsh habitat as well (Ray 1919;Steve Rottenborn, pers. obs.), in the South Bay. Several species of ducks, and in a few locations herons and egrets, also nest in the tidal marshes of the South Bay (Gill 1977), and California Black Rails (*Laterallus jamaicensis coturniculus*) winter in small numbers in these marshes. Non-breeding birds, including larger shorebirds, swallows, blackbirds, and other species roost, occasionally in large numbers, in the tidal marsh, and tidal marshes (and mudflats) in several South Bay areas are used as haul-outs and pupping sites by harbor seals.

Salinas, salt pans, and marsh ponds are lentic habitats within the tidal marsh that may be inundated permanently, seasonally, or only during high tides, depending on elevation and connectivity to tidal channels (Collins 2004). Such features generally occur in the higher marsh, at the upper ends of tidal channels, near drainage divides, and near the landward edge of the marsh. Ponds not subject to flooding at high tide, or that are flooded only shallowly at high tide, provide shallow-water habitat ideal for foraging by shorebirds and waterfowl; such features may be used regardless of tidal stage, but they are particularly important at high tide when the favored foraging habitat of many shorebirds (intertidal mudflats) is flooded. More permanent ponds provide valuable brooding and foraging habitat for breeding waterfowl, while higher-salinity salt pans and ponds support high densities of brine shrimp (*Artemia* *franciscana*) and brine flies (especially *Ephydra millbrae*), which in turn serve as prey for waterfowl and shorebirds. Large numbers of herons, egrets, shorebirds, and waterfowl use marsh ponds as roosting sites as well. Marsh ponds were a common component of historical marshes in the South Bay, varying in size and abundance within the marsh according to the salinity regime (Grossinger 1995), prior to diking of these marshes for salt ponds, but today these features are sparsely dispersed in the remnant tidal marsh in the South Bay.

A study of the birds using tidal marshes and salt ponds in the South Bay, conducted by PRBO, found that salt ponds supported more bird species than salt marsh, but that salt marsh provided habitat for more bird species more consistently than salt ponds (Stralberg and others 2003). The overall density of birds was much lower in salt marshes than in salt ponds, although the densities of passerines, rails, and raptors were higher in salt marsh than in salt ponds. Some species of dabbling ducks, such as the Cinnamon Teal (*Anas cyanoptera*), Mallard, Gadwall, and Green-winged Teal, were also present in higher densities in salt marsh than in salt ponds. Within salt marshes, more small shorebirds, gulls and terns, and diving ducks were found at high tide, with more dabbling ducks at low tide.

Tidal marshes are nearly as important to the aquatic components of the San Francisco Bay ecosystem (*i.e.*, benthic invertebrates of subtidal areas and mudflats, fishes, seabirds, and shorebirds that forage primarily on intertidal mudflats) as they are to the species that use these marshes directly. Detritus from tidal marshes forms much of the foundation for the food web that ultimately provides sustenance for these species, providing nutrients and carbon for a significant component of the aquatic flora and fauna of the Bay (Harvey and others 1977; Warwick and Price 1975).

Salt Ponds. Artificial salt ponds have been present in the San Francisco Bay estuary since the 1850s (Josselyn and San Francisco State Univ. 1983). Although natural salt ponds and pans occurred here historically, they were not nearly as extensive as the current ponds (Nichols and Wright 1971), and creation of the salt evaporation ponds in the South Bay has resulted in the loss of significant area of tidal and non-tidal wetlands. The SBSP project focuses on approximately 15,100 acres of existing salt ponds. Another 11,000+ acres of current or former salt ponds are also present in the South Bay. Most of the Newark/Mowry ponds are owned by the USFWS but are used by Cargill for salt production. Former salt ponds in Redwood City are owned by Cargill but are not currently being used for salt production.

Generally, salt ponds in the South Bay are characterized by expanses of non-tidal open water, bare mud, or bare salt flats surrounded by mostly barren levees. Vegetation is sparse and is limited primarily to some levees. Due to the paucity of vegetation, salt ponds provide little to no cover for small mammals or reptiles, and provide nesting habitat only for species that nest on the bare levees and the occasional islands that have been created (by breaching of levees or deposition of material dredged from borrow ditches) within the ponds.

The South Bay salt ponds are, collectively, highly productive systems, supporting very high invertebrate biomass due to the abundance of a few key species and providing roosting, nesting, and foraging habitat for large numbers of waterbirds. However, with the exception of the birds that move in and out of the ponds (as discussed below), and some fish and aquatic invertebrates that are drawn into intake ponds, the salt ponds are primarily a closed system, with virtually no export of detritus, nutrients, or energy to the tidal marsh, sloughs, mudflats, or open waters of the Bay. Furthermore, much of the biomass produced by these ponds is unavailable to birds or fish due to water depths (for shorebirds) and salinities (for fish) that preclude these vertebrates' use of most of the invertebrates in the deeper, higher-salinity ponds.

The ecology of the plant and invertebrate communities that provide the basis for community structure and abundance of vertebrates using salt ponds has been described by several researchers (Anderson 1970; Carpelan 1957; Lonzarich 1989). Plant and invertebrate communities in these ponds vary primarily depending on the salinity of the pond. "Intake ponds", into which water is transferred directly from the Bay, are close to the salinity of the Bay and are therefore the lowest-salinity ponds in the salt production process. These ponds, which generally have salinities below 40 ppt, support high abundance of macroscopic green algae (particularly *Rhizoclonium* spp. and *Enteromorpha* spp.), microscopic algae and diatoms, and occasionally the vascular plant wigeon grass (*Ruppia maritima*). Benthic invertebrate density and diversity tend to be relatively high in these lower-salinity ponds, with numerous nematodes, polychaete worms, rotifers, arthropods, and crustaceans (most notably *Corophium* spp.). At least 12 species of fish occur in the lower-salinity intake ponds, where they feed on an abundant supply of benthic and pelagic invertebrate prey. The topsmelt (*Atherinops affinis*), yellowfin goby (*Acanthogobius flavimanus*), longjaw mudsucker (*Gillichthys mirabilis*), rainwater killifish (*Lucania parva*), and staghorn sculpin (*Leptocottus armatus*) are among the most common fish within these ponds. Because most of these fish cannot tolerate salinity >70-80 ppt (Carpelan 1957; Lonzarich 1989), piscivorous birds in salt ponds generally forage only in the lower salinity intake ponds. Dabbling ducks are also usually present in highest concentrations in the lower salinity ponds, where they take both invertebrates and aquatic vegetation.

The plankton, invertebrate, and vertebrate communities in salt ponds become less complex, being dominated by fewer species, as salinity increases. Macroscopic algae is replaced by unicellular algae, such as *Stichococcus bacilaris*, in the higher salinity ponds. Copepods generally dominate low and medium-salinity ponds. The brine shrimp *Artemia franciscana* is the predominant invertebrate in the high salinity ponds, having an optimal salinity range of 70-175 ppt (2-5 times the salinity of seawater). Within South Bay salt ponds, this species produces an estimated eight generations/year, and biomass production by brine shrimp has been estimated at 56 lbs/ac/year in some Alviso salt ponds (Carpelan 1957). The reticulate water boatman (*Trichocorixa reticulata*) is also found in mid-salinity ponds, and brine flies are also tolerant of medium and high-salinities, reaching very high densities in some ponds. Even as adults, water boatmen are primarily aquatic, but adult brine flies can be seen in dense swarms on the edges of high-salinity ponds from late spring through fall. These three species provide an abundant food source for shorebirds, gulls, swallows, and other birds where water depths are conducive to efficient foraging on these invertebrates.

Salt ponds in the San Francisco Bay area provide habitat for more than one million waterbirds each year, including large percentages of the populations of some shorebird, duck, and tern species (Accurso 1992; Harrington and Perry 1995; Page and others 1999; Stenzel and Page 1988; Takekawa and others 2001). With its extensive mudflats, remnant salt marsh, and salt ponds, the South Bay in particular supports very high diversity and abundance of waterbirds (Harvey and others 1992; Takekawa and others 2000;

Warnock 2004b). Bird use of the salt ponds varies considerably among species. Some species, such as the Wilson's Phalarope (*Phalaropus tricolor*), Red-necked Phalarope (*Phalaropus lobatus*), Eared Grebe (*Podiceps nigricollis*), and the federally threatened Western Snowy Plover (*Charadrius n. nivosus*), occur in the South Bay most abundantly in salt ponds. In contrast, a number of other bird species use other habitats extensively as well, and most shorebirds occur in salt ponds primarily during high tide when their preferred intertidal foraging habitats are inundated. Use of individual salt ponds by foraging birds is influenced primarily by water depth and salinity, which mediate food availability. Because most shorebirds forage on moist sediment or in water <4 cm in depth (occasionally up to 10-15 cm deep in the case of large shorebirds) (Isola and others 2000), they are confined to shallow water and margins of islands or levees for foraging. Dabbling ducks are also limited to shallow waters, generally preferring water depths from 10 to 30 cm (Page 2001 in Life Science 2004), while diving ducks generally prefer water at least 30 cm (and up to several meters) deep (Life Science 2004). Salinity mediates the availability or abundance of prey in these ponds – piscivorous species find food only in the low-salinity ponds, while species that forage on brine flies, water boatmen, and brine shrimp in the higher-salinity ponds can benefit from the considerable biomass of these invertebrates in areas where water depths are suitable for foraging. At any given time, only a relatively small portion of the salt pond complexes provide suitable conditions (*e.g*., moist soil or shallow water) for foraging by shorebirds.

Numerous waterbirds use the salt ponds and their associated islands and levees primarily for roosting, either at night or during high tide when their preferred foraging habitats are submerged. Large mixed-species flocks of shorebirds, gulls, terns, cormorants, pelicans, herons, and other birds are often seen roosting or loafing on levees, in shallow water, or on exposed mud in the ponds. A few species, including the Black-necked Stilt (*Himantopus mexicanus*), American Avocet (*Recurvirostra americana*), Western Snowy Plover, Caspian Tern (*Sterna caspia*), Forster's Tern, Black Skimmer (*Rhynchops niger*), California Gull (*Larus californicus*), and Double-crested Cormorant nest on islands or levees within the ponds, particularly those that are not accessible by mammalian predators, or in the case of the Western Snowy Plover and California Gull, on barren salt flats on the bottoms of dried ponds.

The highest-salinity ponds support little, if any, wildlife. Above a salinity of 200 ppt, even brine shrimp cannot survive, and thus there is no prey to support predatory wildlife. Although birds may occasionally roost in these hypersaline ponds, the high salinity may have adverse effects on the birds, such as impairing the waterproofing of their feathers (Rubega and Robinson 1997), and little use is made of such ponds by wildlife (Takekawa and others 2000).

Adjacent Upland/Edge Habitats. A wide variety of upland land uses and habitat types occur on the landward side of the bayland habitats described above (*e.g*., tidal sloughs, tidal marsh, and salt ponds) in the study area. These land uses include residential, commercial, and industrial areas, landfills (both closed and active), parks, freshwater riparian habitats, agricultural lands (including cropland and limited pasture), ruderal areas, and non-native grassland. Thus, a wide variety of wildlife species occurs in these edge habitats. Due to the intense disturbance of much of this adjacent area, with most areas lacking an obvious transitional zone between the aquatic bayland habitats and adjacent habitats, most of the wildlife species found in these peripheral areas are common species adapted to urban or ruderal habitats. Reptiles such as the western fence lizard (*Sceloporus occidentialis*), gopher snake (*Pituophis melanoleucus*), and southern alligator lizard (*Elgaria multicaranata*), and mammals such as the house mouse (*Mus musculus*), California vole (*Microtus californicus*), western harvest mouse (*Reithrodontomys megalotis*), California ground squirrel (*Spermophilus beecheyi*), black-tailed jack rabbit (*Lepus californicus*), cottontail (*Sylvilagus audubonii*), brush rabbit (*S. bachmani*), valley pocket gopher (*Thomomys bottae*), and striped skunk (*Mephitis mephitis*), all occur in the upland transitional areas along the edge of the Bay. A small, isolated population of western pond turtles (*Clemmys marmorata*) is present in brackish habitats near the Sunnyvale WPCP and Moffett Field, and California tiger salamanders (*Ambystoma californiense)* occur in vernal pool habitats in the Warm Springs area.

In most areas, the bird species that occur in the peripheral habitats are also common, widespread species. These include permanent residents such as the Anna's Hummingbird (*Calypte anna*), Mourning Dove (*Zenaida macroura*), Black Phoebe (*Sayornis nigricans*), Northern Mockingbird (*Mimus polyglottos*), Bushtit (*Psaltriparus minimus*), California Towhee (*Pipilo crissalis*), Red-winged Blackbird (*Agelaius phoeniceus*), Brewer's Blackbird (*Euphagus cyanocephalus*), House Finch (*Carpodacus mexicanus*), Lesser Goldfinch (*Carduelis psaltria*), summer residents such as the Barn Swallow (*Hirundo rustica*) and Cliff Swallow (*Petrochelidon pyrrhonota*), transients (some of which breed at higher elevations in the Bay Area), including the Orange-crowned Warbler (*Vermivora celata*) and Swainson's Thrush (*Catharus ustulatus*), and winter residents such as the Hermit Thrush (*Catharus guttatus*), White-crowned Sparrow (*Zonotrichia leucophrys*), Golden-crowned Sparrow (*Zonotrichia atricapilla*), Yellow-rumped Warbler (*Dendroica coronata*), and American Pipit (*Anthus rubescens*). Burrowing Owls (*Athene cunicularia*) are also present in ruderal habitats and non-native grasslands in scattered areas surrounding the South Bay salt ponds and marshes. Ruderal habitats, which are particularly extensive on former landfills (*e.g*., Bayfront Park, and in Sunnyvale and Alviso), and grasslands, agricultural lands, and pastures in the Mountain View, Alviso, Fremont, and Newark areas provide foraging habitat for large numbers of diurnal raptors, such as Red-tailed Hawks (*Buteo jamaicensis*), Northern Harriers (*Circus cyaneus*), White-tailed Kites (*Elanus caeruleus*), and American Kestrels (*Falco sparverius*). Vegetated levees and other ruderal habitat provide nesting habitat for ducks and Canada Geese (*Branta canadensis*) as well. The extent of the upland fields that once probably provided extensive alternate foraging habitat for shorebirds has been reduced considerably by development. Nevertheless, shorebirds such as Killdeer (*Charadrius vociferus*), Long-billed Curlews (*Numenius americanus*), and Dunlin (*Calidris alpina*) occasionally forage in more extensive upland fields in the Alviso, Fremont, and Newark areas during the wet season, and Greater Yellowlegs (*Tringa melanoleuca*) and Least Sandpipers (*Calidris minutilla*) may forage around ponded water in such fields in winter.

The Newby Island landfill north of Coyote Creek near Alviso and the Tri-Cities Recycling and Disposal Facility located in Fremont provide food for thousands of breeding California Gulls in the South Bay and for tens of thousands of wintering gulls of several species. High winter counts include 20,000 Herring Gulls (*Larus argentatus*; among 29,000 gulls total) on 24 February 1998 and 24,000 Herring Gulls (among 33,000 total) on 22 December 1998 at the Newby Island Landfill (Santa Clara County Bird Data Unpublished). Tens of thousands of California Gulls regularly forage at this landfill year-round. Virtually all of the gulls foraging at these landfills roost on the Bay or salt ponds/levees at night. Black-crowned Night-Herons (*Nycticorax nycticorax*), American Crows (*Corvus brachyrhynchos*), Common Ravens (*Corvus corax*), and Turkey Vultures (*Cathartes aura*) forage on refuse at these landfills as well.

Other Adjacent Waterbird Habitats. In addition to landfills (used by gulls) and agricultural fields (used by gulls and some shorebirds during winter and migration), several other land-use types surrounding baylands in the South Bay, including water treatment plants, nontidal freshwater, brackish, and salt marshes, and managed ponds and lakes, provide habitat for numerous waterbird species that are more commonly associated with the Bay. Nontidal ponds and lakes, such as Shoreline Lake in Mountain View, near Sunnyvale Baylands Park, and at Coyote Hills Regional Park, are used by numerous ducks, gulls, terns, herons, egrets, and other waterbirds. Counts of 1200 Double-crested Cormorants on 16 November 1996 and 382 Surf Scoters on 3 January 2003 at Shoreline Lake in Mountain View (Santa Clara County Bird Data Unpublished) exemplify the high densities of birds that may be present at these ponds. Non-tidal freshwater ponds east of the lower Eden Landing ponds are also well used by waterbirds (Krause, pers. comm.).

The Coyote Creek Reach 1A pond along lower Coyote Creek was created and is managed specifically for waterbird use and provides habitat for numerous shorebirds, waterfowl, gulls, terns, and larger waders. This pond was created as mitigation for the loss of a portion of salt pond A-18 for flood control purposes. It is a fresh/brackish pond, being fed by Coyote Creek and having a salinity varying from 3 to 11 ppt (Strong 2003). Regular monitoring by SFBBO of this 16-acre pond recorded 57 species of waterbirds using the pond, the most common of which were dowitchers (averaging >1000 individuals/survey in summer 1995), American Avocets (which averaged >500/survey in summer 2002), Northern Shovelers, and California Gulls (Strong 2003). The mean number of individuals/survey varied among years between 540 and 1,486 birds/survey over all seasons. Additional observations have resulted in counts of up to 180 Pectoral Sandpipers (*Calidris melanotos*; 27 September 1991), 3,500 Western Sandpipers (*Calidris mauri*; 13 July 1997), and 2,065 Wilson's Phalaropes (24 July 1993), as well as large numbers of nesting American Avocets, Black-necked Stilts, and ducks (Santa Clara County Bird Data Unpublished; Steve Rottenborn, pers. obs.).

New Chicago Marsh, a managed, diked salt marsh located south of pond A16 and east of pond A12 in Alviso, provides habitat for the salt marsh harvest mouse, nesting habitat for Black-necked Stilts and American Avocets, and foraging habitats for large numbers of shorebirds during migration and winter. This marsh is used heavily by roosting shorebirds during high tide, and hundreds to thousands of both Red-necked and Wilson's Phalaropes forage in the marsh in late summer and fall. Crittenden Marsh, a small nontidal salt marsh at the north end of Moffett Field, also supports high numbers of waterbirds, including breeding Black-necked Stilts, American Avocets, and waterfowl, foraging ducks and terns, and up to thousands of shorebirds that roost and forage in the shallow water and on exposed mud during high tide (when water levels within the marsh are not too high). Coyote Hills Regional Park supports an extensive freshwater marsh/open water system located east of the Cargill salt ponds in the Newark area. This park provides foraging, nesting, and/or roosting habitat for a variety of ducks, grebes, terns, gulls, herons, egrets, and shorebirds. The Palo Alto Flood Control Basin likewise provides freshwater, brackish, and salt marsh in a managed system that supports numerous waterbirds. The Warm Springs wetlands provide foraging and breeding habitat for waterfowl and shorebirds.

Sludge ponds, oxidation ponds, drying beds, and associated impoundments at the South Bayside System Authority Wastewater Treatment Works in Redwood City, the San Jose-Santa Clara WPCP in Alviso, and the Sunnyvale WPCP support high densities of breeding dabbling ducks, Canada Geese, and Black-necked Stilts, and depending on pond conditions can support very high densities of migrant and wintering waterfowl (particularly Northern Shovelers), shorebirds (including thousands of Wilson's and Red-necked Phalaropes), and gulls, (being particularly important for Bonaparte's Gulls [*Larus philadelphia*]). High counts of selected species at these plants include 4,750 Northern Shovelers (19 Dec 1999), 4,000 Western Sandpipers (10 July 1998), and 81 nests/broods of Black-necked Stilts (2 July 1999) at the San Jose-Santa Clara WPCP and 428 Snowy Egrets (*Egretta thula*; 25 August 1994), 5,500 Northern Shovelers (20 December 1996), 650 Gadwalls (including 25 broods of young; 24 July 1993), 1,950 Canvasbacks (19 December 2000), 2,950 Ruddy Ducks (*Oxyura jamaicensis*; 20 December 1996), 4,000 Red-necked Phalaropes (14 September 1997), and 380 Forster's Terns (21 September 1998) at the Sunnyvale WPCP (Santa Clara County Bird Data Unpublished; Steve Rottenborn, pers. obs.).

In summary, the ecology of South Bay wildlife communities is characterized by:

- high productivity of tidal marshes, with export of organic matter from tidal marshes to tidal sloughs, channels, and mudflats, and to the Bay, supporting high abundance of invertebrates, fish, and birds;
- high productivity of salt ponds, supporting an abundance of invertebrates (particularly in higher-salinity ponds) and high numbers of fish in lower-salinity ponds, but with virtually no export of organic matter to other habitats aside from variable (and at times, very heavy) use of the salt ponds by birds;
- a heavily invaded aquatic invertebrate community dominated by non-native species;
- heavy use of South Bay habitats by waterbirds, including significant proportions of Pacific Coast migratory shorebird populations;
- highly dynamic bird and fish communities, with use of different areas varying several times a day with tide height, and with abundance and community composition varying seasonally depending on migration, precipitation, temperature, salinity, and other factors. In particular, large numbers of shorebirds forage on intertidal mudflats at low tide and use salt ponds and other alternative habitats (*e.g.*, water treatment plant ponds) for roosting and/or foraging, particularly at high tide;
- the presence of rare San Francisco Bay endemics, including the California Clapper Rail and salt marsh harvest mouse, in remnant tidal marsh habitat.
- small, isolated tidal salt-marsh remnants, with very limited escape cover for salt marsh harvest mice, effectively isolating subpopulations of this species.

4.2 Methods

A vast amount of data on wildlife use of the South Bay has been collected by resource agencies such as the USFWS, CDFG, and the U.S. Geological Survey, non-profit organizations and research groups such as PRBO and SFBBO, consultants (working for private landowners, municipalities, and public resource agencies), researchers, and private individuals (*e.g.*, birders). Much of the data on the wildlife species and communities of the South Bay were summarized for the Goals Project (2000). Preparation of this existing conditions document relied primarily on previously collected information rather than fieldwork conducted specifically for the preparation of this document. However, H.T. Harvey & Associates wildlife ecologists are personally very familiar with the wildlife and habitats of the South Bay during all seasons, and reconnaissance-level wildlife surveys by foot and by car were performed in summer and fall 2004 specifically to note current habitat/wildlife conditions, and to assess how the implementation of the ISP has altered (and is expected to alter) those conditions. H.T. Harvey & Associates wildlife ecologists also performed more detailed observations of wildlife at certain locations (*e.g.*, to observe the response of shorebirds to the drawdown of water levels at certain ponds).

4.3 Description of Wildlife Communities in the South Bay

4.3.1 Invertebrates

Invertebrate communities of the South Bay play important roles as consumers (controlling phytoplankton biomass in the Bay) and as a source of prey for fish and birds, and are important in nutrient and contaminant recycling and accumulation of contaminants (Thompson and Shouse 2004). Invertebrate communities vary considerably among different habitats in the South Bay. This section includes a separate description of invertebrates in subtidal/intertidal habitats, tidal marshes, and salt ponds, as well as a discussion of invasive invertebrates and mosquitoes.

Subtidal/Intertidal Invertebrate Communities. Intertidal mudflats contain three main groups of invertebrates: benthic infauna (less mobile invertebrates living in or on the mudflats), epifauna (more mobile species on the mud's surface), and pelagic fauna (highly mobile species living in the water column). Most research has focused on benthic infauna. Because of the instability caused by nearly constant erosion and deposition of sediments, as well as dramatic fluctuations in salinity, benthic infauna is dominated by species that can easily colonize mudflats, many of which are non-native species (Nichols 1979). Within the San Francisco Bay estuary, the South Bay contains by far the highest invertebrate biomass, likely due to greater stability of salinity and sediments, large detritus biomass, and the abundance of several introduced bivalve species (Nichols 1979; Nichols and Pamatmat 1988). The estimated biomass of invertebrates in the South Bay in winter (637 g/0.1m^2) and summer (609 g/0.1m^2) is nearly six times that for the Central Bay, San Pablo Bay, and Suisun Bay combined (115 g/0.1m^2 and 112 g/0.1m^2 in winter and summer, respectively (Meiorin and others 1991; Nichols and Pamatmat 1988). Studying infaunal productivity on mudflats in the South Bay, Nichols (1979) determined rates of annual productivity varying from 53 to 100 g/m^2/year. Although biomass was dominated by two or three common bivalves, the standing crop of invertebrates was abundant throughout the year. Migratory shorebirds were thought to be the primary consumers of invertebrate biomass on South Bay mudflats.

Much of the food for benthic invertebrates on mudflats of the South Bay comes from phytoplankton that settle to the bottom of the water column (Meiorin and others 1991) and diatoms and blue-green algae growing on the surface of the sediment (Nichols and Pamatmat 1988). Both phytoplankton and microalgae blooms occur in the South Bay primarily in spring, in turn supporting large numbers of filter-feeders (Nichols and Pamatmat 1988). The South Bay tidal invertebrate community is dominated primarily by filter/suspension feeders such as shrimp, clams, and mussels that obtain food from phytoplankton and organic debris and bacteria, and deposit feeders, which include worms and some clams that obtain food primarily from organic debris on the surface of the mud.

Several studies of the infaunal invertebrate communities of South Bay mudflats have been conducted. Nichols and Pamatmat (1988) and Nichols and Thompson (Nichols and Thompson 1985a; Nichols and Thompson 1985b) determined that the numerically dominant species on mudflats in the vicinity of both the Alviso and Baumberg Complexes are the gem clam (*Gemma gemma*), the amphipod *Ampelisca abdita*, and the polychaete worm *Streblospio benedicti*. Although less abundant, the Baltic clam (*Macoma balthica/petulam*), soft-shelled clam (*Mya arenaria*), and eastern mud snail (*Illyanassa obsoleta*) "often represent the bulk of benthic invertebrate biomass" (Nichols and Thompson 1985a). All of these dominant species except for the Baltic clam are introduced.

The benthic infaunal community has been studied in the South Bay at three stations on intertidal mudflats near the Palo Alto Water Quality Control Plant since 1974 (Thompson and Shouse 2004). The number of invertebrate species at each of three stations ranged from 10 to 16 and included five bivalves, one cnidarian, seven crustaceans, two gastropods, and 14 polychaetes and oligochaetes. *Gemma*, *Streblospio* and *Ampelisca* dominated the community until the 1980s, but since 1998 *Gemma* has been the overwhelming dominant on the Palo Alto flats. Since trace element concentrations at the plant were reduced in the mid-1980s, this research has noted a substantial decline in metals accumulation in the Baltic clam and an increase in the species' reproductive activity (Hornberger and others 2000).

Sampling nearby areas along lower San Francisquito Creek and the Palo Alto Water Quality Control Plant outfall channel, Cressey (1997) had somewhat different results. He found simple invertebrate communities in these areas, with the most abundant taxa consisting of four annelids (*Neanthes succinea*, *Eteoni lighti*, *Tubificidae* sp., and *Heteromastus filiformis*), three arthropods (*Nippoleucon hinumensis*, *Corophium alienense*, and *Grandidierella japonica*), and two mollusks (the Baltic clam and the Asian clam *Potamocurbula amurensis*); all except the Asian clam were found at all stations in both channels, in a variety of salinities from 1 to 27 ppt. The 1994-96 Benthic Pilot Study of San Francisco Estuary Regional Monitoring Program (1997) found that in muddy estuarine sediments of the South Bay, the most abundant species were *Potamocurbula amurensis*, *Ampelisca abdita*, *Nippoleucon hinumensis*, *Corophium heteroceratum*, *C. alienense*, *Grandidierella japonica*, *Balanus improvisus*, *Tubificidae* sp., *Neanthes succinea*, and *Streblospio benedicti*.

Bivalve mollusks, which represent the majority of the invertebrate biomass of the San Francisco Bay estuary (Nichols 1979), are primarily filter feeders, taking in large quantities of phytoplankton. A variety of clams and mussels, many of which are introduced, occur in the South Bay. Of the native species, the Baltic clam is the only one that is still common in the South Bay. The Baltic clam is the largest-bodied infaunal invertebrate in the South Bay and thus contributes significantly to the biomass of the region. It is eaten by birds (Painter 1966) and bat rays (Thompson and Shouse 2004) and likely by a number of other fish species as well. In the mid-1800s, the eastern oyster (*Crassostrea virginica*) and Pacific oyster (*C. gigas*) were introduced into San Francisco Bay, replacing much of the fishery for the native oyster (*Ostrea lurida*). Until around 1910, extensive oyster beds were located in the South Bay south of Dumbarton Bridge, and off Eden Landing and Redwood City. However, the introduced oysters declined in the early 1900s due in part to reduced Bay water quality; the loss of marshes may have also influenced the decline in oyster populations, as much of the oysters' food is detritus that is derived from tidal marshes (Harvey and others 1977) . A native oyster bed was present in Salt Pond A-9 in Alviso until the 1970s (Laine, pers. comm.).

Thompson (1999), studying the spatial and temporal distribution of bivalves in the South Bay (primarily between the San Mateo and Dumbarton Bridges but with some stations scattered throughout the far South Bay, from 1991 to 1995), found that bivalves mostly disappeared from shallower areas in winter and spring; they declined in, but did not disappear from, deeper areas in winter. Recruitment varied among years, but was more likely to be limited in higher-elevation mudflats in some years than in deeper mudflats closer to channels, possibly due to predation by shorebirds and bat rays. Thompson and Shouse (2004) hypothesized that recruitment of bivalves onto South Bay mudflats where they are available to birds is dependent on the abundance of adult bivalves in deeper water and circulation patterns that transport larvae from either deeper water or from North Bay areas.

Tidal invertebrates in South Bay estuarine habitats must either be able to tolerate daily and seasonal changes in salinity (*e.g.*, benthic invertebrates) or be mobile enough to follow preferred salinities. During particularly wet years, species intolerant of fresher water (e.g., *Mya arenaria*, *Corophium acherusicum*, *Ampelisca abdita*, and *Streblospio benedicti*) virtually disappear from portions of the upper San Pablo Bay and shallow areas of the Bay. During a 2-year drought, these same species colonized Suisun Bay (which is usually too fresh for these species) in numbers (Nichols and Thompson 1985a). Similarly, Hopkins (1987) noted that several intertidal invertebrate species disappeared during an unusually wet winter but had re-established the following year under normal conditions; two of his four intertidal study sites were near Palo Alto and Hayward. In contrast, limited observational data following unplanned breaches of Napa ponds 2a and 3, with releases of water having salinity of 50 and >60 ppt into South Slough, revealed no extensive losses of benthic invertebrates, suggesting that this elevated salinity did not have a significant impact on benthics.

The epifaunal invertebrate community in the South Bay is dominated by several species of shrimps and crabs. Two native caridean shrimps, the California bay shrimp (*Crangon franciscorum*) and blacktail bay shrimp (*C. nigricauda*), are common in tidal sloughs and in the Bay itself. The California bay shrimp supports the only commercial fishery remaining in the South Bay aside from the limited harvest of brine shrimp that occurs in salt ponds (as discussed below). Two to four boats are involved in shrimping in the South Bay each year, catching approximately 75,000 pounds valued between $154K and $312K per year (Hansen 2003), although shrimping activity and success have declined in recent decades (Laine, pers. comm.). Most shrimping activity occurs between the Dumbarton Bridge and Calaveras Point, with limited activity above Calaveras Point in Coyote Creek (Hansen 2003).

According to Hatfield (1985), adult California bay shrimp spawn in the ocean in March and April. The planktonic larvae are carried into the San Francisco Bay by tides, and by currents into the Suisun and South Bays. Juvenile bay shrimp arrive in the South Bay in May, and use shallow waters having lower salinities as nurseries. These juveniles migrate up sloughs to brackish water, seeking out waters with salinities of 3-19 ppt, preferring 10-15 ppt (Baxter and others 1999). Thus, they use the Guadalupe, Alviso, and Coyote Slough systems, and likely other South Bay tributaries as well, for feeding and growth through the summer. As they mature, the shrimp migrate to deeper, more saline bay waters until they migrate out of the Bay to spawn in the ocean in winter (Baxter and others 1999; Kinnetic Laboratories 1987). California bay shrimp are present in the South Bay year-round, but they are most abundant in September-October and least abundant in March-April (Hansen 2003). Bay shrimp are sensitive to changes in salinity and water quality, and may abandon sloughs in the far South Bay for deeper, more saline waters during periods of high freshwater runoff. Effluent from wastewater treatment plants may have altered the distribution of bay shrimp as well, as this species has declined in abundance in the far South Bay in recent decades (Laine, pers. comm.).

Crabs of South Bay tidal habitats include the yellow shore crab (*Hemigrapsus oregonensis*), lined shore crab (*Pachygrapsus crassipes*), Dungeness crab (*Cancer magister*), brown rock crab (*Cancer antennarius*), red rock crab (*Cancer productus*), and several introduced species, including the xanthid crab (*Rothropanopeus harrisii*), Chinese mitten crab (*Eriocheir sinensis*), and European green crab (*Carcinus maenas*) (Josselyn and San Francisco State Univ. 1983). Most of these species forage both in tidal sloughs and on mudflats and deeper waters of the South Bay. Although Dungeness crabs, and particularly larger individuals, occur much more commonly in the north and central Bay, this species was historically more common in the South Bay (i.e., into the 1970s) (Laine, pers. comm.). The *Cancer* crabs do not support a fishery within the South Bay, but use of South Bay marshes by juveniles of these species, and detrital export to the Central Bay from South Bay marshes, may help to support the economically important ocean fishery for these crabs. Crabs tagged as juveniles in the Bay have been caught by commercial fishermen in the ocean (Harvey and others 1977). Furthermore, Dungeness crabs in the Bay mature nearly twice as fast as populations outside the Bay, presumably because of higher Bay water temperatures but possibly also due to the high productivity of the estuary (Life Science 2004). Early larval stages of the Dungeness crab are currently limited primarily to the Central Bay, but later planktonic larvae and juveniles may be found throughout the Bay (Life Science 2004).

The California Department of Fish and Game has conducted a fishery survey for shrimp and crabs within the San Francisco Bay since 1980, with monthly surveys in deeper subtidal areas and some beach seine sampling (CDFG data Life Science 2004). These surveys include data from three open-water stations (Stations 102, 101, and 140) located near the San Mateo and Dumbarton Bridges, and two beach seine stations (171 and 172) also located in the South Bay. Between 1980 and 2001, Dungeness crabs comprised 52.6%, 43.8%, and 73.3% of crabs caught at Stations 101, 102, and 140. Chinese mitten crabs comprised 42.1%, 12.5%, and 18.8% of crabs at these stations. Graceful rock crabs (*Cancer gracilis*) and brown rock crabs collectively comprised 18.8% of the total catch at Station 102 but <3% of the crab catch at the other two stations. California bay shrimp comprised 79.5%, 58.8%, and 78.7% of shrimp captures at Stations 101, 102, and 140, while blacktail bay shrimp comprised 12.8%, 34.2%, and 14.0% of captures. Other shrimp species, including blackspotted bay shrimp (*Crangon nigromaculata*), oriental shrimp (*Palaemon macrodactylus*), stout coastal shrimp (*Heptacarpus brevirostris*), miniature spinyhead (*Mesocrangon munitella*), ridgetail prawn (*Exopalaemon carinicauda*), and visored shrimp (*Betasus longidactylus*), were all represented but were much less abundant in the South Bay.

Tidal Marsh Invertebrate Communities. The invertebrates of the vegetated portions of tidal salt and brackish marshes, which include benthic infauna, epifauna, and terrestrial species, have not received as much study as those of intertidal habitats, in part because much of the invertebrate biomass within tidal marshes occurs within the intertidal and subtidal zones of sloughs and smaller marsh channels. However, tidal salt marsh invertebrates perform a variety of important ecological services, as discussed by Maffei (2000b).

Within tidal salt marshes in the South Bay, common invertebrates include the ribbed mussel (*Ischadium demissum*), the Baltic clam, the mud snail (*Illyanassa obsoleta*), and the yellow shore crab (*Hemigrapsus oregonensis*) (Niesen and Lyke 1981). The introduced ribbed mussel is common within the lower zone of tidal marshes (among Pacific cordgrass), and the Baltic clam may occur up into the cordgrass zone as well (Josselyn and San Francisco State Univ. 1983; Vassallo 1969). The native hornsnail *Cerithidea californica* formerly occurred in pickleweed marshes and on mudflats throughout much of the Bay, but it has been displaced from much of its former habitat and range by the introduced mud snail, and it is now restricted to high salt pans in the South Bay (Race 1981). The mud snail is abundant in intertidal habitats and sloughs. The marsh snails *Assiminea californica* and *Ovatella myosotis* inhabit dense pickleweed marshes (Fowler 1977). Several amphipod species, including *Anisogammarus confervicolus*, *Orchestria traskiana*, *Hyale plumulosa*, and *Grandidierella japonica*, occur within the ground litter in pickleweed-dominated marshes (Josselyn and San Francisco State Univ. 1983). The amphipod *Traskorchestia traskiana* is abundant in at least some pickleweed marshes of the San Francisco Bay (Obrebski and others 2000). This detritivore tolerates salinities up to 50 ppt (Koch 1989), and is one of the only invertebrates known to consume pickleweed (Page 1997).

Terrestrial invertebrate assemblages of salt marshes are dominated by a variety of insects and spiders. Diptera (true flies) are a major component of South Bay cordgrass/pickleweed marshes, while the orders Homoptera (plant hoppers and aphids) and Lepidoptera (butterflies and moths) are also well represented (Lane 1969). Reticulate water boatmen, brine flies, chironomid midges, and other species dominate open-water areas such as marsh ponds within the tidal marsh (Barnby and others 1985; Maffei 2000b).

Detritus from macrophytic vegetation in the tidal marsh is an important component of the food web of the tidal marsh itself, as Teal (1962) demonstrated in Atlantic tidal salt marshes. Cameron (1972) determined that half of the detritus produced in San Pablo Bay marshes was exported out of the marsh, where it serves as an extremely important source of nutrients and carbon for the aquatic components of the Bay ecosystem (Harvey and others 1977; Warwick and Price 1975).

Salt Pond Invertebrate Communities. Invertebrate communities in South Bay salt ponds have been most extensively studied by Carpelan (1957), Anderson (1970), Swarth and others (1982), and Lonzarich and Smith (1997). Carpelan (1957), studied the floral and faunal communities in six Alviso salt ponds ranging in salinity from a mean of 27.5 ppt in the intake ponds to 94 ppt in the highest-salinity pond. Only one vascular plant species, wigeon grass, was found to be present, and this occurred only in one of the lower-salinity ponds for a brief period in mid-summer. Thus, the flora of the salt ponds is dominated by the macroscopic green algae *Rhizoclonium* and *Enteromorpha* in the lower-salinity ponds and by unicellular algae, particularly *Stichococcus bacilaris*, in higher-salinity ponds.

Salt pond studies have documented that the species richness of invertebrates decreases, while the biomass increases (to a point), with increasing salinity, primarily because of the increase in brine shrimp with increasing salinity (Anderson 1970; Britton and Johnson 1987; Carpelan 1957; Lonzarich 1989; Swarth and others 1982; Williams and others 1990). In the lower-salinity ponds, numerous nematodes occur in decaying organic matter and mud. The most prevalent worm in the lower-salinity ponds is the polychaete *Polydora ligni*. This polychaete serves as prey for fish, and for the nemertinean *Tubulanus sexlineatus*, which is common in decomposing algae in the lowest-salinity ponds. Carpelan (1957) found few mollusks within the salt ponds. The introduced mud snail, which was abundant on the adjacent tidal mudflats, was found in scattered areas, although in its limited areas of distribution it was the dominant benthic species. Anderson (1970) reported that mud snails did not survive long in the Newark-area ponds he studied, and that although the ribbed mussel and native oyster were present in the adjacent slough, they did not become established in the intake ponds. A number of other non-arthropod species of varying abundance, including roundworms, rotifers, protozoans, and coelenterates, occur throughout the salt ponds (Anderson 1970; Carpelan 1957).

A survey of benthic invertebrates in Alviso salt ponds by Lonzarich (1989) found three mollusks (*Gemma gemma*, *Ilyanassa obsoleta*, and *Tryonia imitator*), two annelids (*Nereis succinea* and *Tubificoides* sp.), and six crustaceans (*Anisogammarus confervicolus*, *Crangon* sp., *Hemigrapsus oregonensis*, *Ostracoda* sp., *Palaemon macrodactylus*, and *Sphaeroma quoyana*) in ponds that seasonally reached salinities of 40 ppt, but not in higher-salinity ponds. Only the annelid *Polydora ligni* and the crustaceans *Artemia franciscana*, *Balanus* sp., *Copepoda* sp., and *Corophium* sp. tolerated salinities in the ponds that averaged 22-84 ppt.

Studying North Bay salt ponds, Takekawa and others (2004) recorded 20 zooplankton taxa, with more taxa in lower-salinity ponds and highest abundance at mid-salinities. Copepods and brine shrimp comprised 66.1% and 28.2% of all zooplankton sampled; copepods dominated low and mid-salinity ponds (23-48 ppt), while brine shrimp dominated higher-salinity ponds (170 ppt). Brine flies were also common in higher-salinity ponds. Total zooplankton abundance was highest in spring and early summer, with biomass several orders of magnitude higher in a pond having a salinity of 170 ppt than in lower-salinity ponds due to the abundance of brine shrimp. The diversity of macroinvertebrates was also higher in lower-salinity ponds (23 ppt), which contained 50-55 taxa (only 3-4 at high densities, including the polychaete *Heteromastus*, the bivalve *Gemma*, and the amphipods *Corophium* and *Ericthonius*). Mid-salinity ponds (48 ppt) contained 25 taxa dominated by the polychaetes *Polydora*, *Capitella*, and *Streblospio*, by *Corophium*, and by water boatmen, while a high-salinity pond (170 ppt) contained 12 taxa dominated by brine shrimp and brine flies.

Arthropods comprise the dominant, and ecologically most important, group of invertebrates inhabiting salt ponds in the South Bay. The brine shrimp (*Artemia franciscana*) is the predominant animal in higher-salinity ponds. Although it can occur in salinities near that of seawater (Persoone and Sorgeloos 1980), the brine shrimp’s aquatic predators (*e.g.*, insects such as water boatmen) are more abundant in less saline water (Wurtsbaugh 1992), allowing brine shrimp to reach high densities only in their optimal hypersaline environments (70 to 170 ppt) (Carpelan 1957). Herbst (2001) found water boatmen to be most abundant in lower-salinity ponds while brine shrimp were most abundant in moderate to high salinity salt ponds in the Mojave Desert. Brine shrimp are absent from crystallizer ponds with salinities exceeding 200 ppt (Larsson 2000). Historically, brine shrimp occurred in the San Francisco Bay area in salt pans and ponds with hypersaline conditions. They still occur in these natural features within tidal salt marshes in the South Bay, in addition to salt ponds.

Carpelan (1957) estimated that brine shrimp in the Alviso salt ponds produced up to eight generations/year, with winter eggs having delayed hatching. Larsson (2000) reported that females produce an average of 10 broods during their 50-75 day lifespan in the lab, although under natural conditions 3-4 broods may be more likely. Productivity of brine shrimp in the highest-salinity pond in Carpelan's study area was estimated at 56 lbs/ac/year. Brine shrimp are so abundant in some ponds that they have supported a small commercial industry, primarily as food for aquarium fish. According to Thomas Laine (pers. comm.), these shrimping operations can regularly obtain 10,000-13,000 lbs. of shrimp per day, with two people once collecting 27,000 lbs. in a day in South Bay ponds, and a 42-day operation netting 500,000 lbs. of brine shrimp in South Bay salt ponds. Brine shrimp are still harvested in Newark salt ponds, where they fetch $0.55/lb. (Laine, pers. comm.).

Two insect groups are also important components of the South Bay invertebrate fauna due to numerical abundance and importance to foraging birds. Adult reticulate water boatmen inhabit salt ponds year-round. Carpelan (1957) found that egg-laying occurs in spring, summer, and fall, with the main hatch in spring; many nymphs are observed in April and May. Water boatmen have been reported to occur in water ranging from brackish to 170 ppt (Carpelan 1957; Cox 1969; Jang 1977), and Carpelan (1957) found it in Alviso salt ponds with salinities from 23 to 153 ppt. However, it occurs and reproduces in greatest abundance in ponds with salinities between 35 and 80 ppt (Maffei 2000c). A number of species of brine flies occur within the San Francisco Bay area; the most common species within the SBSP study area are *Ephydra millbrae*, *E. cinerea*, and *Lipochaeta slossonae*, which occur in variable numbers in natural salt pans and marsh ponds, and in artificial salt ponds and crystallizers (Carpelan 1957; Maffei 2000b). *E. millbrae* has been reported to occur in pools with salinity concentrations up to 42 ppt (Jones 1906), while *E. cinerea* and *Lipochaeta slossonae* occur in saline and hypersaline environments, with *Lipochaeta* found commonly in crystallizers (Maffei 2000a). Even as adults, water boatmen are primarily aquatic, although they can fly. In the South Bay, adult brine flies become common by early March and can be seen in dense swarms on the edges of high-salinity ponds from April through September (Swarth and others 1982).

The biomass of brine shrimp in South Bay salt ponds may be four times that of water boatmen (Swarth and others 1982), and brine shrimp have been found to be a numerically important component of the diet of the Western Sandpiper, Wilson's and Red-necked Phalaropes, and other waterbirds (Anderson 1970; Colwell and J.R. Jehl 1994; Hamilton 1975; Harvey and others 1992; 1988; Jehl 1988). Despite the high biomass of brine shrimp in salt ponds, the nutritive value of brine shrimp to foraging shorebirds may be limited, as Rubega and Inouye (1994) found that Red-necked Phalaropes could not survive foraging on brine shrimp alone. As a result, brine flies (both adults and larvae) and reticulate water boatmen are also very important to shorebirds that forage in mid- to high-salinity South Bay salt ponds. Amphipods, most notably *Corophium* spp., are numerous in South Bay salt ponds as well (Carpelan 1957), serving as additional prey items important to shorebirds and fish.

Invasive Invertebrates of the South Bay. According to Cohen and Carlton (2003), the San Francisco Estuary is the most invaded aquatic ecosystem in North America. This study is the most recent and most inclusive compilation of information on aquatic invasive species in the San Francisco Estuary. Previous lists and/or descriptions of introduced aquatic species include works on fish fauna by Moyle (1976) and McGinnis (1984), freshwater mollusks by Hanna (1966) and Taylor (1981), marine mollusks by Nichols and others (1986), and introduced marine and estuarine invertebrates by Carlton (Carlton 1975; Carlton 1979a; Carlton 1979b; Carlton and others 1990). Collectively, these non-native species have significant impacts on the San Francisco Bay estuary through aggressive predation, highly efficient filter feeding, and competition, which, when magnified by the great abundance of some of these species, has the potential to change (or already has changed) the trophic structure and dynamics of the Bay ecosystem (Josselyn and others 2004).

Cohen and Carlton (2003) note that at least 212 species, 69% of which are invertebrates, have been introduced to the Bay and Delta since 1850. The most important include a number of clams, many of which were introduced into the Bay via releases of ballast water (Cohen and Carlton 1995), such as the introduced Asian species of *Venerupis* and *Musculista,* and the Atlantic clam *Gemma.* With the exception of the Baltic clam, the numerically dominant mollusks of the South Bay are all non-native species (Nichols and Pamatmat 1988). Collectively, these introduced clam species are capable of filtering the entire volume of the South Bay daily, in addition to having dramatic impacts on the Bay's phytoplankton populations. Cohen and Carlton (2003) suggest that the phytoplankton populations of the northern reaches of the San Francisco Bay may be "continuously and permanently controlled by introduced clams".

The Asian clam *Potamocorbula amurensis*, the most abundant clam in the San Francisco Bay, was introduced via ballast water around 1986 (Cohen 1998). Since then, this filter feeder has impacted phytoplankton populations in the North Bay (Alpine and Cloern 1992), preventing summer phytoplankton blooms since its introduction and altering the trophic structure of the North Bay. Although similar large-scale impacts on the South Bay have not yet been detected, the species is present in the South Bay. This clam was found by a CDFG study to be the most important prey of scoters in Suisun Bay (Harvey and others 1982). The gem clam (*Gemma gemma*) occurs throughout the South Bay, in both deep subtidal and high intertidal habitats. It occurs in lower-salinity salt ponds as well. This clam is eaten by a variety of shorebirds (Recher 1966) and waterfowl (Painter 1966), and thus benefits some native wildlife species. The Atlantic ribbed marsh mussel (*Arcuatula demissa*) was introduced in the late 1800s, and is now common throughout much of the Bay. Although it is apparently "a major food source" for the Clapper Rail, rails have been known to drown after getting their beaks or toes caught in the open valves of the mussel (Takekawa 1993). The soft-shell clam (*Mya arenaria*) was introduced for commercial purposes, and maintained an important fishery in the Bay in the late 1800s and early 1900s (Skinner 1962). Although it is still present in the Bay, most individuals are small (Thompson and Shouse 2004). It is an important prey item for bat rays, flounder, and in the Suisun Bay, Canvasbacks (Harvey and others 1982). Thompson (1999) found that it disappeared rapidly from areas where it recruits, suggesting that it is preyed upon heavily by these fish, and possibly by birds and other invertebrates.

A carnivorous opisthobranch, *Philine auriformis*, invaded the South Bay in 1982, and has been noted in abundance in bottom trawls by the Marine Sciences Institute (Thompson and Shouse 2004). This species, which has been found most frequently in deeper water, preys on bivalves. The polychaete worm *Streblospio benedicti* was first detected in the Bay in 1932. This species readily colonizes the Bay in both deep and shallow intertidal habitats, and is consistently one of the dominant species on South Bay mudflats.

The dominant crustaceans of the South Bay are all introduced as well. The tube-dwelling amphipod *Ampelisca abdita* was first detected in the Bay in the 1950s. Since then, it has increased in abundance, and can achieve very dense beds at a variety of depths. This species was a dominant species on Palo Alto mudflats until the 1990s, when abundance declined (though it has remained common) (Thompson and Shouse 2004). The other dominant crustaceans in the South Bay include several burrowing amphipods, including *Grandidierella japonica* and several non-native *Corophium* species. Both of these genera tolerate poor water quality, and readily colonize available habitat throughout the South Bay. These crustaceans are important prey species for shorebirds on intertidal mudflats.

The European green crab (*Carcinus maenas*) became established in the San Francisco Bay in 1989-1990. This opportunistic omnivore eats a variety of plant and animal matter, including bivalves and shore crabs, and has the potential to impact native species considerably (Josselyn and others 2004). After its invasion of Bodega Bay in 1993, a 90-95% decline in the abundance of native bivalves and grapsid shore crabs was observed (Grosholz and others 2000).

Two non-native species could physically impact South Bay marshes, levees, streambanks, and other structures. The Australian-New Zealand boring isopod (*Sphaeroma quoyanum*) burrows into mud banks and levees throughout the Bay, potentially weakening these features and making them prone to erosion (Talley and others 2001). Another burrowing species that may cause the same problem is the Chinese mitten crab (*Eriocheir sinensis*), which has been known to accelerate bank erosions in Germany. First detected in the Bay in 1992, the mitten crab has undergone rapid population increases throughout the Bay and its tributaries. This catadramous species migrates upstream (in virtually all of the Bay's tributaries) year-round, peaking in spring. Downstream migration to saltwater (approximately 25 ppt) breeding areas occurs primarily August-January, with a peak in September-October (Veldhuizen and Stanish 1999). The Chinese mitten crab is common in the South Bay. Halat (1996) has reported that the burrows of this crab reach densities of 30 burrows/m^2 along San Francisquito Creek. Halat did not report any bank erosion even at this density of mitten crab borrows but suggested that if bank erosion does occur it is likely to occur along steep clay banks in tidally influenced alluvial controlled reaches of the Bay. Thompson and Shouse (2004) noted abundant Chinese mitten crab burrows in a salt marsh bank in Palo Alto, possibly due to its proximity to San Francisquito Creek, and speculated that the erosion of the salt marsh bank observed since the mitten crab's invasion in the early 1990s may have been caused by the crab's burrowing. Surveys by the Marine Science Institute recorded burrow densities as high as 6.2/m^2 in December 1995 and 8.9/m^2 in March 2000 along Alviso Slough, values approximately 3 times and 4.5 times, respectively, the next highest density for a South Bay area surveyed.

Mosquitoes. An extensive body of literature exists on the mosquitoes associated with the tidal and seasonal wetlands of the South San Francisco Bay region, as summarized by Bohart and Washino (1978), Durso (1996), and Maffei (2000d; 2000e; 2000f; 2000g; 2000h). More than 20 species of mosquitoes occur in the San Francisco Bay area, but five species, the summer salt marsh mosquito (*Aedes dorsalis*), winter salt marsh mosquito (*Aedes squamiger*), Washino's mosquito (*Aedes washinoi*), western encephalitis mosquito (*Culex tarsalis*), and winter marsh mosquito (*Culiseta inornata*), are routinely controlled by the mosquito and vector control agencies within each of the counties of South San Francisco Bay. Within the SBSP project area, the Alameda County Mosquito Abatement District, Santa Clara Vector Control District, and San Mateo County Mosquito Abatement District are responsible for managing the populations of mosquitoes for their respective communities.

The ecology of these mosquitoes, including preferred habitats, salinity tolerances, reproductive rates, flight characteristics, adult hosts and vector/nuisance potential were summarized in detail for the Goals Project's Baylands Ecosystem Species and Community Profiles (Maffei 2000d; 2000e; 2000f; 2000g; 2000h). Adult females feed on blood, the hosts varying depending on the species but including mammals, birds, reptiles, and amphibians. Adult males feed on plant juices, while larvae generally feed on particulate matter, unicellular algae, and other microorganisms. Larvae serve as prey for a variety of aquatic organisms, shorebirds, and waterfowl, and adults may be fed on by other insects and birds such as swallows. The rate of larval development is often a function of water temperature and food availability. Larval survivorship is typically low, with most losses attributable to predation.

The summer salt marsh mosquito is widespread throughout most of the United States and southern Canada, and is found in Europe and Asia as well (Carpenter and LaCasse 1955; Darsie and Ward 1981). In California, it inhabits coastal salt marshes and brackish marshes of the Sacramento/San Joaquin River Delta (Bohart and Washino 1978). In the San Francisco Bay area, this species occurs primarily in "temporarily flooded tidal marsh pans, heavily vegetated ditches and brackish seasonal wetlands", while adults occur in open habitats such as grasslands, salt marsh, and woodland edges (Maffei 2000d). The summer salt marsh mosquito lays its eggs on mud at the edges of tidal pools or brackish seasonal wetlands, with larvae often occupying the same pools occupied by the tidal pool brine fly (*Ephydra millbrae*) and reticulate water boatman (Maffei 2000d). Eggs may hatch in the spring, but they can remain viable for years, and subsequent hatching can occur when the larval habitat is reflooded. Although survivorship may be highest in water having a salinity near seawater (Washino and Jensen 1990), larvae have successfully completed development at the Great Salt Lake in water with salinities as high as 120 ppt (Rees and Nielsen 1947). Up to 12 broods and eight generations were found to occur during a single breeding season in Marin County (Telford 1958). Adults are highly mobile, aggressive, day-biting mosquitoes that may be able to disperse more than 30 miles (Rees and Nielsen 1947).

The winter salt marsh mosquito occurs along the Pacific Coast from Sonoma County south to Baja California, including much of the area around the immediate South and North San Francisco Bays (Maffei 2000h). Tidal and diked pickleweed marshes with salt marsh pools diluted by rains provide the preferred habitat of this species. This species has not been found in freshwater marshes, instead occurring in brackish and salt marshes having salt concentrations from 1.2 to 35 ppt, with optimal conditions for larval development at salinities of 5-15 ppt. Egg-laying occurs in spring on plants and on mud close to the edges of marsh pools. The eggs lie dormant until fall rains inundate them, although hatching as early as late September has been noted due to water diversion into a marsh. Some eggs do not hatch until later re-floodings. Most adults emerge from salt marsh pools in late February and March and disperse widely into surrounding areas, sometimes dispersing as far as 15 miles or more from larval areas. Feeding occurs from March through June, with biting occurring during daytime and early dusk.

Washino's mosquito occurs from Oregon south to Santa Barbara, California, including the entire San Francisco Bay area (Maffei 2000e). In the Bay area, shallow pools and fresh to slightly brackish sites in uplands near salt marshes or in riparian areas, often dominated by willow, cottonwood, or blackberry, provide this species' preferred habitat. Females deposit eggs in mud along the receding water line of larval habitat. The eggs hatch when these pools are reflooded the following winter. Adults emerge from the larval depressions in late winter and early spring, and are present into June. Females are day-biting mosquitoes, and may travel up to 1.5 miles from their larval habitat along artificial canals (Maffei 2000e).

The western encephalitis mosquito is widespread in a variety of habitats and locations in western North America, with larvae occurring in most freshwater habitats (Maffei 2000f). Typical larval habitat includes poorly drained fields and pastures, rice fields, marshes, ponds, and seeps, although most artificial waterbodies in urban areas provide potential habitat for this species as well. The species has been found to occur in salt marsh pools with salt concentrations up to 10 ppt (Telford 1958). Adults may be present year-round but enter facultative diapause in winter. Females lay eggs in groups directly into the water. Adult females usually feed at night. This species seems to be able to disperse readily with wind, and dispersal distances of 20-25 miles are suspected for some Sacramento Valley populations (Bailey and others 1965). The western encephalitis mosquito is the main vector of western equine encephalitis and St. Louis encephalitis in most of the western United States (Maffei 2000f), and is a vector of avian malaria.

The winter marsh mosquito occurs in a wide range of habitats throughout much of western North America. Larval habitat includes a variety of pools, ponds, marshes, and other water bodies, in salinities ranging from 8 to 26 ppt (Maffei 2000g; Telford 1958). Adults are present from fall through spring, entering facultative diapause in summer. Females lay groups of eggs directly on the water. San Francisco Bay populations tend to remain within 2 miles of their larval source, although dispersal up to 14 miles is known (Clarke 1943). Larvae of the summer salt marsh mosquito, winter salt marsh mosquito, and winter marsh mosquito are often found in the same locations (Maffei 2000h). Mosquito species occurring in the major habitats in the SBSP project area are listed in Table 16 below.

Table 16 – Mosquito Species Found in Marsh Habitats in the SBSP Project Area.

Habitat	Mosquito Species
Open salt pond with vigorous wave action	none
Fully tidal salt marsh: Higher ground with pools or borrow channels that do not flush	*Aedes squamiger* (winter), *Aedes melanimon* (fall), *Aedes dorsalis* (summer), *Aedes taeniorhynchus* (summer), *Culiseta inornata* (winter)
Muted tidal salt marsh: Pools and channels that do not flush vigorously	*Aedes squamiger* (winter), *Aedes melanimon* (fall), *Aedes dorsalis* (summer), *Aedes taeniorhynchus* (summer), *Culiseta inornata* (winter)

Habitat	Mosquito Species
Seasonal wetland: Brackish to nearly fresh water pools with vegetated margins	*Aedes squamiger* (winter), *Aedes melanimon* (fall), *Aedes dorsalis* (summer), *Aedes taeniorhynchus* (summer), *Aedes washinoi* (winter fresh water), *Culex tarsalis* (spring, summer), *Culex erythrothorax* (summer in tules), *Culex pipiens* (foul fresh water), *Culiseta incidens* (spring, fall fresh water), *Culiseta inornata* (winter)
Vernal pools, upland fresh water marsh	*Aedes washinoi* (winter), *Culex tarsalis* (spring, summer), *Culex erythrothorax* (summer in tules), *Culex pipiens* (foul fresh water), *Culiseta incidens* (spring, fall fresh water), *Culiseta inornata* (winter)

Marshes that lack vigorous tidal flow can provide suitable mosquito breeding habitat. Salt marshes at the southern end of the San Fransisco Bay produce a single seasonal brood of the winter salt marsh mosquito and multiple broods of the summer salt marsh mosquito each season. Because both of these mosquito species can fly considerable distances and are aggressive biters, control of mosquitos at the source (*i.e.*, in salt marshes) is necessary to reduce the inconvenience to humans in the South Bay.

Detailed records are maintained by the local mosquito and vector control districts concerning major mosquito breeding areas, population densities, and control techniques and materials. In Santa Clara County, areas with known or potential mosquito problems include Coyote Reach 1A, New Chicago Marsh, Sunnyvale Baylands Park, the Moffett Field Flood Control Basin, Mountain View Demonstration Marsh, the Palo Alto Flood Basin (Palo Alto Baylands Park), the Zanker Landfill Marsh, Dow-Corning Marsh, Alviso Marshes, ITT Marsh (near the Palo Alto Water Quality Control Plant), the Palo Alto Municipal Airport, and the Palo Alto Municipal Golf Course (Strickman 2005). In San Mateo County, Bair Island produces large numbers of mosquitos. In the Alameda County portion of the SBSP project area, south of the San Mateo Bridge, sites that can produce large numbers of mosquitoes if not treated include the Perry Duck Club, Alameda Creek Marshes, Union City Marshes, Coyote Hills Marshes, Mayhew's Landing, and the upper ends of major sloughs (Mowry, Newark, Plummer, Albrae, and Mud Sloughs). Fully tidal marshes such as Hook Island (Palo Alto), Triangle Marsh (Coyote Creek), and Greco Island, do not produce significant numbers of mosquitoes.

Mosquito control techniques employed by these agencies emphasize minimization and disruption of suitable habitat, and control of larvae through chemical and biological means, as opposed to spraying of adults. Control techniques most often include source reduction, source prevention, larviciding, use of mosquito fish (*Gambusia affinis*) as larval predators, and monitoring of mosquito populations and vector-borne diseases (Alameda County Mosquito Abatement District 1999). Larvicides employed by the San Mateo County Mosquito Abatement District include "Golden Bear 11 11" (a short-lived petroleum distillate that is applied to the surface of the water and causes mosquito larvae to drown), methoprene (a juvenile growth hormone that specifically targets mosquito larvae and prevents their maturation), *Bacillus thuringensis israelis* (a bacteria that is toxic to mosquito larvae), and *Bacillus sphaericus* spores and toxin (for *Culex* species) (http://www.smcmad.org/preventative_approach.htm).

In salt marshes, attempts to control mosquito populations by ditching have resulted in marsh degradation. Ditching is not necessary to reduce mosquito populations in tidal marshes. Rather, functional tidal marshes do not provide high-quality habitat for the most troublesome mosquito species in the Bay area, and maintenance and restoration of natural tidal flushing in these marshes is effective at limiting mosquito populations while sustaining the natural hydrology of the marsh (San Francisco Bay Joint Venture 2004).

Mosquitos serve as vectors for several diseases that pose health concerns for humans and domestic animals. The western encephalitis mosquito is a vector of avian malaria and the main vector of western equine encephalitis and St. Louis encephalitis in the western United States (Maffei 2000f). Anopheles mosquitos carry the organism that causes malaria. The West Nile virus is a mosquito-borne disease that has been found in parts of Asia, Eastern Europe, Africa and the Middle East. First detected in the U.S. in 1999 in New York City, West Nile virus has since spread through most of the U.S. West Nile Virus is typically spread from an infected mosquito, usually in the genus *Culex*, to a bird that then disperses or migrates, spreading the virus after being bitten by other mosquitos. Most people and domestic animals that become infected with the virus have few or no symptoms, but in rare cases they can become seriously ill. As of December 22, 2004, 819 human infections from 23 counties in California had been detected in 2004, with 25 West Nile virus-related fatalities to date in California, in Los Angeles, Kern, Orange, Riverside, San Bernardino, and Tehama counties (http://westnile.ca.gov/latest_activity.htm). In 2004, 536 infections of horses from 32 counties in California were reported, along with 3,218 dead birds that tested positive for the virus (most of which were corvids).

4.3.2 Fishes

Fishes play very important ecological roles in the South Bay system. Information on South Bay fish communities is limited, likely due to the lack of a commercial fin-fishing industry in this part of the Bay. However, a dataset from the CDFG and several other studies provide information on fishes of the South Bay's tidal habitats, while several studies have identified the fish present in South Bay salt ponds (Anderson 1970; Carpelan 1957; Lonzarich 1989; U.S. Geological Survey Unpublished Preliminary Data). Information on key species is also available in the Goals Project's Baylands Ecosystem Species and Community Profiles (Goals Project 2000).

Fish Communities of Tidal Habitats. More than 100 species of fish have been recorded in the tidal waters of the South Bay (Laine, pers. comm.). The California Department of Fish and Game has conducted a fishery survey within the San Francisco Bay since 1980, with monthly surveys in deeper subtidal areas and some beach seine sampling (CDFG data in Life Science 2004). These surveys include data from three open-water stations (Stations 102, 101, and 140) located near the San Mateo and Dumbarton Bridges, and two beach seine stations (171 and 172) that are also located in the South Bay. Three sampling methods were used in the open-water stations: the otter trawl (which was towed on the bottom for five minutes against the current, then retrieved), midwater trawl (which was towed with the current for 12 minutes then retrieved obliquely), and plankton net (which was towed on the bottom for 5 minutes then retrieved obliquely).

A total of 65 fish species were captured at Stations 102, 101, and 140 during CDFG's surveys between 1980 and 2002, with 51 species captured by the otter trawl, 48 species by the midwater trawl, and 27 by the plankton net. Table 17 summarizes the most abundant fish species captured during these surveys.

Numerically, the dominant fish were the northern anchovy (*Engraulis mordax*), shiner perch (*Cymatogaster aggregata*), longfin smelt (*Spirinchus thaleichthys*), white croaker (*Genyonemus lineatus*), Pacific staghorn sculpin, bay goby (*Lepidogobius lepidus*), plainfin midshipman (*Porichthys notatus*), English sole (*Parophrys vetulus*), cheekspot goby (*Ilypnus gilberti*), and Pacific herring (*Clupea pallasi*). The dominant fish captured at the beach seine stations were topsmelt (37.3%), arrow goby (*Clevelandia ios*, 22.6%), yellowfin goby (16.9%), jacksmelt (*Atherinopsis californiensis*, 16.2%), and Pacific staghorn sculpin (3.3%), with 22 other species representing <2% of the catch at Station 171, and topsmelt (54.4%), jacksmelt (23.4%), Pacific herring (9.7%), Pacific staghorn sculpin (3.0%), and northern anchovy (2.0%), with 28 other species representing <2% of the catch at Station 172.

Kinnetics (1987) collected fish from two locations in Coyote Creek and one location in Guadalupe Slough between 1982 and 1985. The dominant species collected from these sloughs included the staghorn sculpin, northern anchovy, starry flounder (*Platichthys stellatus*), shiner perch, yellowfin goby, threadfin shad (*Dorosma petenense*), and longfin smelt. Fish sampling in the nearby open waters of the Bay revealed species composition similar to that in the sloughs, with white croaker and striped bass (*Morone saxatilis*) also occurring as dominants. Sampling fish in lower San Francisquito Creek and the Palo Alto Water Quality Control Plant outfall channel, Cressey (1997) recorded the northern anchovy, topsmelt, yellowfin goby, staghorn sculpin, and threespine stickleback (*Gasterosteus aculeatus*).

Surveys of South Bay tidal sloughs by (U.S. Geological Survey Unpublished Preliminary Data) in June and September 2004 recorded a total of 10 fish species in Alviso Slough, Coyote Creek, Stevens Creek, Alameda Creek, and at Coyote Hills. Northern anchovies and topsmelt were by far the most abundant species caught; the American shad (*Alosa sapidissima*), bat ray, leopard shark, striped bass, staghorn sculpin, shiner surfperch, and yellowfin goby were also recorded.

Many of the fish recorded in the South Bay, including the bat ray (*Myliobatus californica*), leopard shark (*Triakis semifasciata*), northern anchovy, gobies, and many others, occur in tidal channels within marshes, in sloughs, and/or on mudflats at high tide when they are inundated. Thus, these tidal channels and mudflats are productive foraging habitats for estuarine fish in this system (Harvey 1988).

The use of the South Bay (*i.e.*, for breeding, foraging, or both), and the spatial and temporal distribution of different estuarine fish in the South Bay, vary widely among species. A number of species breed in the region. The South Bay is particularly important to the leopard shark. Pupping (live birth) in the San Francisco Bay occurs almost exclusively in the South Bay (CDFG Bay Trawl data cited in McGowan(2000a)). This species appears to be most abundant in the areas on either side of the Dumbarton Bridge, where they forage on shallow mud and sand flats (Compagno 1984). Leopard sharks occur in the Bay year-round, although individuals may move in and out of the Bay (McGowan 2000b). Northern anchovies are known to spawn in the South Bay, including areas south of the Dumbarton Bridge (McGowan 1986). Spawning occurs in marsh channels; larvae forage over shallow flats after hatching (McGowan 2000b). Adults generally leave the Bay for the open ocean in fall, but some late-spawned juveniles may remain in the Bay throughout the winter. Jacksmelt likely spawn in the South Bay as well. In the San Francisco Bay, spawning occurs from October to early August (Wang 1986), when adults

Table 17 – Summary of the most abundant fish species captured during California Department of Fish and Game South Bay fishery surveys, 1980-2002. Data are from Stations 101, 102, and 140 between the San Mateo and Dumbarton Bridges.

Species	Station 101			Station 102			Station 140		
	Otter Trawl	Midwater Trawl	Plankton Net	Otter Trawl	Midwater Trawl	Plankton Net	Otter Trawl	Midwater Trawl	Plankton Net
Northern Anchovy[1]	34.8	93.5	85.5	24.6	92.8	82.2	7.7	87.7	36.7
Shiner Perch	19.2			17.1			34.7	2.3	
Longfin Smelt	13.9								
White Croaker	9.8			3.5			4.4	3.2	
Pacific Staghorn Sculpin	4.5						7.0		
Bay Goby	4.3			19.1			8.3		
Plainfin Midshipman	3.1						7.9		
English Sole				12.0			7.4		
Cheekspot Goby				5.7					
Speckled Sanddab				4.0			2.1		
Pacific Herring			5.7	3.5		10.3			2.3
California Tonguefish							3.9		
White Seaperch							3.0		
Brown Smoothhound							2.4		
Topsmelt					2.2				
Jacksmelt					2.0				
Walleye Surfperch								2.1	
Arrow/Cheekspot Goby			2.8						21.1
Yellowfin Goby			2.3						
Goby Type II			2.2			2.0			3.8
Unidentified Fish									34.1
Total Species Richness	42	36	22	46	42	24	48	42	27
Other Species (Percent)	10.4	6.5	1.5	10.5	3.0	5.5	11.2	4.7	2.0

[1] Only species comprising at least 2.0% of the catch for a given sampling method at a given station are included. Data are the percentage of the total number of fish caught that were composed of each species.

move inshore from marine habitats and lay eggs on aquatic vegetation and other substrates. Apparently preferring more saline waters, the jacksmelt is most common in the Central and South Bays during years of high freshwater flows from the Delta (CDFG 1987 in Saiki (2000b)).

Adult topsmelt enter shallow sloughs and mudflats to spawn in late spring and summer, and spawning has been observed in the South Bay near the Dumbarton Bridge (Wang 1986). Eggs are laid on submerged vegetation. The South Bay seems to be this species' center of abundance in the San Francisco Bay, and the mudflats and sloughs in the South Bay are used for spawning and feeding, and as nursery areas for juveniles (Saiki 2000c). The Pacific staghorn sculpin is most abundant in the Central and North Bays, but in some years it occurs commonly in the South Bay as well (CDFG 1987 in Tasto (2000b)). This sculpin spawns from November to March in shallow subtidal to intertidal water, and the young gradually shift their foraging areas from shallow intertidal habitats to deeper subtidal habitats as they mature (Tasto 2000b). The arrow goby occurs on shallow intertidal flats and in salt-marsh channels throughout much of the South Bay, where it is often commensal with burrowing invertebrates (Hieb 2000a). This species breeds primarily in spring and early summer, with peak larval occurrence from April through July. The bay goby occurs in somewhat deeper-water habitats than the arrow goby, and is also a common breeding species in the South Bay (Hieb 2000b). The longjaw mudsucker resides on mudflats and in tidal channels and sloughs. Marshes with complex channels provide the highest-quality habitat, although this species also breeds in lower-salinity salt ponds (Hieb 2000c). The longjaw mudsucker spawns from November through June in the South Bay, constructing burrows for breeding.

Other species forage in the South Bay but are not known to breed here. Pacific Herring are present in the North Bay from November through March, when spawning occurs; larvae and juveniles occur more widely, during which time they occur in the South Bay (though abundance decreases southward). Most individuals depart the Bay by August (Tasto 2000a). Longfin smelt spawn in fresh water in the upper end of Suisun Bay and in the Delta, occurring in the South Bay year-round as pre-spawning adults and yearling juveniles (Wernette 2000). Striped bass were introduced into the San Francisco Bay estuary in 1879, and are now the most important sport fish in the San Francisco Bay estuary, bringing in approximately $45 million per year into the local economies of the Estuary (Sommer 2000). Adults congregate in the San Pablo and Suisun Bays in fall and move into the Delta to spawn primarily in the Sacramento/San Joaquin Rivers in May and June. Striped bass in the South Bay are likely subadult fish foraging widely in the Bay, as this species is not known to breed in the South Bay. The California halibut (*Paralichthys californicus*) forages to some extent in the South Bay, but is not known to breed anywhere inside San Francisco Bay (Saiki 2000a). Juvenile starry flounders (*Patichthys stellatus*) occur fairly commonly in South Bay sloughs, tidal marsh channels, and mudflats, although this species is not known to breed in the Bay (Kline 2000).

Central California Coast ESU steelhead (*Oncorhynchus mykiss*) occur in estuarine habitats of the South Bay, primarily from late December through early April (during the adults' upstream migration) and from February through May (during the downstream migration of adults and juveniles). Chinook salmon, Central Valley Fall-Run ESU, are present in tidal habitats of the South Bay primarily from late August through October (during the adults' upstream migration) and during the downstream migration of juveniles. Juvenile migration on the Guadalupe River and Coyote Creek has been documented by the

SCVWD from February through June (B. Dyer, pers. comm.). Relatively few data are available regarding use of South Bay marshes by salmonids, due to the difficulty of sampling small fish in this habitat. Steelhead were not captured by the CDFG during its South Bay surveys, and Chinook salmon were captured only in very low numbers. These species are discussed in detail in the Special-Status Wildlife Species section below (Section 5.5).

The diets of South Bay fish vary widely (Goals Project 2000; Harvey and others 1977). Herring, anchovies, perch, and a variety of other fish and shrimp species provide prey for striped bass. The American shad feeds on copepods, larval fish, and *Corophium*. Northern anchovies are filter feeders that capture zooplankton and phytoplankton. Gobies prey on small fish and crustaceans. Jacksmelt eat a variety of copepods, insects, and polychaetes. Longfin smelt feed on zooplankton, shrimp, and copepods. Chinook salmon (*Oncorhynchus tshawytscha*) take insects, shrimp, amphipods, and isopods. The Pacific sardine (*Sardinops sagax*) is a filter and particulate feeder. The bat ray feeds on benthic mollusks, polychaete worms, and crustaceans. Leopard sharks eat a variety of crabs, shrimp, and small fish.

The history of the fisheries in the San Francisco Bay area, based on commercial catch data, was well described by Skinner (1962), but information specific to the South Bay in that text is very limited. According to Thomas Laine (pers. comm.), saltwater fish have declined in abundance in the far South Bay since historic times, with an apparent decline being particularly noticeable in the Alviso area since the 1970s. Although no commercial fishery for fin-fishes has existed in the Alviso area, this area was important for recreational fishing, particularly for sturgeon and striped bass, when the boat ramp at the Alviso marina was operational, and fishing derbies for sturgeon in the 1970s attracted as many as 700 entrants (Laine, pers. comm.). Large sturgeon and striped bass are still caught in the South Bay, but public boating access is limited to boat launches at the Refuge headquarters entrance in Newark and in the Redwood City area (except for the few boats currently moored along Alviso Slough).

Salt Pond Fish Communities. Fish community composition and abundance within the salt ponds of the South Bay are primarily a function of salinity, with more diverse communities and greater abundance in lower-salinity ponds, and generally no fish surviving salinities greater than 100 ppt. Carpelan (1957) found that in the Alviso salt ponds he studied, the primary fish species were topsmelt and threespine stickleback. Stickleback, primarily a fresh-water species, occurred in low-salinity ponds, where they were often noted in clear water above macrophytic green algae. Topsmelt were the most abundant fish species, occurring in ponds with salinities up to 55 ppt. These fish feed in the salt ponds primarily on copepods. The longjaw mudsucker and the Pacific staghorn sculpin also occurred in the lower salinity Alviso ponds, but in lower abundance.

Lonzarich and Smith (1997) more recently studied fish assemblages in Alviso ponds A9 through A12, finding topsmelt, threespine stickleback, and longjaw mudsucker to be common in low to mid-salinity ponds (35-90 ppt). Adult topsmelt occurred in ponds with salinities up to 90 ppt, and juvenile topsmelt occurred in ponds up to 75 ppt. Rainwater killifish (*Luciana parva*) and yellowfin gobies were also resident in most ponds studied. Nine additional fish species recorded in salt ponds by Lonzarich and Smith (1997), including staghorn sculpin, leopard shark (*Triakas semifasciata*), and northern anchovy, were apparently seasonal transients from adjacent Bay waters. Surveys in Eden Landing and Alviso salt ponds by USGS (Unpublished Preliminary Data) recorded 13 fish species in salt ponds; these results are similar to those of Lonzarich and Smith (1997), with longjaw mudsucker, rainwater killifish, topsmelt, and yellowfin goby being the most abundant fish, although very few sticklebacks were caught by USGS.

In decommissioned North Bay salt ponds, Takekawa and others (2004) recorded 16 fish species, with much greater fish abundance and biomass in lower-salinity (averaging 23 ppt) than in mid-salinity (48 ppt) ponds, and none in a high-salinity pond (170 ppt). In lower-salinity ponds, American shad, striped bass, and striped mullet (*Mugil cephalus*) dominated gill net captures; Pacific staghorn sculpins, yellowfin gobies, inland silversides (*Menidia beryllina*), and striped bass dominated bag seines. In mid-salinity ponds, striped bass, longjaw mudsuckers, and yellowfin gobies were caught in gill nets, and longjaw mudsuckers, Shimofuri gobies (*Tridentiger bifasciatus*), and inland silversides were caught in bag seines.

4.3.3 Reptiles and Amphibians

Use of the SBSP project area by reptiles is rather limited, and consequently, there has been little study of the use of South Bay marshes and salt pond areas by reptiles. The western fence lizard (*Sceloporus occidentialis*), a ubiquitous lizard in California, occurs in a variety of habitats, including salt pond levees with some vegetation. Other reptile species that occur within the project area include garter snakes (*Thamnophis* couchi, *T. elegans*, and *T. sirtalis*), gopher snakes (*Pituophis melanoleucus*), and southern alligator lizards (*Elgaria multicaranata*), all of which occur along edges of well vegetated levees, particularly in the vicinity of upland areas. A small, isolated population of western pond turtles (*Clemmys marmorata*) occurs in brackish habitats near the Sunnyvale WPCP and Moffett Field (see Special-Status Wildlife Species in Section 5.5).

Due to the paucity of freshwater habitats within the immediate SBSP project area, amphibian use of the project area is even more limited. Where freshwater occurs along the inland margins of the project area, the Pacific treefrog (*Hyla regilla*), bullfrog (*Rana catesbeiana*), and western toad (*Bufo boreas*) are present. California tiger salamanders (*Ambystoma californiense)* occur in vernal pool habitats in the Warm Springs area, primarily on San Francisco Bay NWR lands, adjacent to the SBSP project area and the Newark salt ponds.

4.3.4 Mammals

Relatively few species of mammals occur in the SBSP project area owing to the intense disturbance and habitat conversion that has occurred within the area. Within the SBSP study area, most research attention on mammals has focused on the ecology of special-status salt marsh associated species (*i.e.*, the salt marsh harvest mouse and salt marsh wandering shrew, along with other small mammals using salt marshes), the use of South Bay waters and tidal habitats by the Pacific harbor seal, and the presence and impacts of non-native mammals.

Salt marsh harvest mice and salt marsh wandering shrews occur in the project area primarily in pickleweed-dominated salt marshes. Harbor seals, the only marine mammals that regularly occur in the

South Bay, forage in Bay waters and sloughs and breed and loaf on the edges of tidal marshes and mudflats. Because these three species are discussed in detail in the Special-Status Wildlife Species section (Section 5.5), they are not discussed further in this section.

Trapping studies for the salt marsh harvest mouse in the South Bay have revealed much about the status of other small mammals in marsh habitats of the region. House mice (*Mus musculus*) and California voles are common in diked and tidal salt marshes, particularly in the pickleweed-dominated high marsh and the peripheral halophyte zone, where the western harvest mouse (*Reithrodontomys megalotis*) also occurs in the high marsh. Deer mice (*Peromyscus maniculatus*), shrews, and rats are also recorded in these marshes during salt marsh harvest mouse trapping studies. Table 18 below lists the results of a small sample of such studies to indicate the relative abundance (relative to trapping effort and among species) of these species in South Bay marshes (Environmental Science Associates 1991; H. T. Harvey & Associates 1988; 1989; 1990e; 1991b; Harvey and Stanley Associates 1985; 1986; Muench 1985; Shellhammer and others 1988; Wondolleck and others 1972).

Aside from the introduced house mouse, which occurs commonly in a variety of habitats in the South Bay, the most abundant mammal trapped during the studies listed in Table 18 was the California vole. This species is a common inhabitat of grasslands, ruderal habitats, and wetlands around the South Bay, and is a "keystone" species in grasslands due to its importance as a prey species to mammals and raptors (Pearson 1985) and the significant effect this species may have on vegetation during populations peaks (Lidicker 1989; Lidicker 2000). Studies of populations in upland areas have demonstrated dramatic fluctuations in abundance, and when it is particularly abundant, the California vole may have adverse effects on other small mammals. For example, western harvest mice are impacted strongly, presumably via competitive interactions, during vole "outbreaks", and it is possible that high densities of voles may have the same negative impacts on salt marsh harvest mice, as has been suggested by Geissel and others (1988).

Several species of bats, such as the Mexican free-tailed bat (*Tadarida brasiliensis*), forage over the salt ponds and marshes of the South Bay. Native mammals such as the California vole, western harvest mouse, deer mouse, Botta's pocket gopher (*Thomomys bottae*), California ground squirrel, black-tailed jack rabbit, Audubon's cottontail, brush rabbit, striped skunk (*Mephitis mephitis*), and long-tailed weasel (*Mustela frenata*) occur on salt pond levees, at the margins of marshes, and in upland ruderal and grassland habitats around the periphery of the SBSP project area.

Several non-native mammal species occur in the South Bay, including the red fox (*Vulpes vulpes regalis*), Norway rat (*Rattus norvegicus*), roof rat (*Rattus rattus*), feral cat (*Felis felis*), and Virginia opossum (*Didelphis virginiana*). These species have the potential to impact populations of California Clapper Rails and other native species in the South Bay considerably. The red fox was first reported in the South San Francisco Bay area in 1986 (Foerster and Takekawa 1991), and it has since increased and expanded to become established throughout the Bay area. It dens in a variety of habitats, including salt pond levees (Foerster and Takekawa 1991).

Table 18 – Relative abundance of small mammals captured during selected salt marsh harvest mouse trapping studies in the South Bay.

Site and Habitat	Year(s)	Trap Nights	Species*							Reference
			Salt Marsh Harvest Mouse	Western Harvest Mouse	House Mouse	Deer Mouse	California Vole	Shrew spp.	Black / Norway Rat	
1990 Bay Road, East Palo Alto (tidal salt marsh)	1990-91	1,000	20		3	1	3		3	Environmental Science Associates 1991
Dumbarton Marsh (tidal salt marsh)	1990-91	1,000	18		8	1	16	1		Environmental Science Associates 1991
Palo Alto Baylands (salt marsh)	1972	2,058	196		74		39	3		Wondolleck and others 1972
Western Alameda and Northeastern Santa Clara Counties (diked marsh)	1983-86	12,800	140	45	717	54	478	10	3	Shellhammer and others 1988
Western Alameda County (tidal salt marsh)	1983-86	1,200	13	7	72		129	2		Shellhammer and others 1988
Lower Calabazas Creek at Hwy. 237, Alviso (fresh/brackish tidal marsh)	1988	1,000		3	46					H.T. Harvey & Associates 1988
Coyote Creek Flood Control Project (ruderal/alkali habitat)	1990	1,000	7	4 (harvest mouse sp.)	21	2	1			H.T. Harvey & Associates 1990c
Mayhews Landing (mixed grassland, diked marsh, fresh/brackish marsh)	1988-89	3,120	36		101		7			H.T. Harvey & Associates 1989
Warm Spring International Industrial Park (diked pickleweed marsh)	1985	900	1		36					Harvey and Stanley Associates 1985
Warm Springs II/Fremont Airport (diked pickleweed/grassland)	1985	2,400	27		≤ 154		1			Harvey and Stanley Associates 1986
Triangle Marsh (tidal salt marsh) and New Chicago Marsh (diked salt marsh)	1985	776	1	1	161		6	1		Muench 1985
Triangle Marsh (tidal salt marsh)	1990	500	10		8	3	18			H.T. Harvey & Associates 1991c

Site and Habitat	Year(s)	Trap Nights	Species*							Reference
			Salt Marsh Harvest Mouse	Western Harvest Mouse	House Mouse	Deer Mouse	California Vole	Shrew spp.	Black / Norway Rat	
Calaveras Point Marsh (tidal salt marsh)	1990	400	22				1			H.T. Harvey & Associates 1991c
Warm Springs Marsh (tidal brackish marsh)	1990	500			35	3	57			H.T. Harvey & Associates 1991c

* In these studies, species other than salt marsh harvest mice were not uniquely marked for identification, and hence the numbers listed for species other than the salt marsh harvest mouse include an unknown number of recaptures. However, the house mouse and California vole were still found to be the most abundance species in many marshes.

Clapper Rail predation by both red foxes and feral cats has been directly documented in the South Bay by the tracking of radio-marked rails that were depredated in 1991 and 1992 (Albertson 1995). In addition, the remains of Clapper Rails were found at a fox den in a tidal marsh on the refuge (Harding and others 1998), and at the entrance to a den in the outboard levee along salt pond A9 (Steve Rottenborn, pers. obs.). Norway rats are thought to be one of the main predators of California Clapper Rail eggs (Foerster and others 1990; Harvey 1988), and raccoons have also been known to prey on California Clapper Rail eggs (Foerster and others 1990). In addition to impacts to Clapper Rails, red fox predation on nests of the federally threatened Western Snowy Plover has been recorded, and fox predation has resulted in the abandonment of important colonies of Caspian Terns (at Mowry and Bair Island) and herons (at Bair Island) in the South Bay in 1991 (Strong 2004a).

The feral cat is fairly common in upland habitats around the South Bay (Foerster and Takekawa 1991; Takekawa 1993), whereas the Norway rat and roof rat occur in most habitat types in the SBSP project area. Both rats are known nest predators of California Clapper Rails, and up to one-third of Clapper Rail eggs in the South Bay may be depredated by Norway rats (BDOC Unpublished; Josselyn and others 2004). Rats have depredated California Gull nests in the South Bay as well (Jones 1986).

In 1991, the San Francisco Bay NWR implemented a predator management plan directed at the removal of red foxes, raccoons (*Procyon lotor*), striped skunks, and feral cats to protect the federally listed California Clapper Rail and Western Snowy Plover (Harding and others 1998). From spring 1991 to fall 1996, the average number of individuals removed from NWR lands per year included 90 red foxes, 27 feral cats, 26 striped skunks, and 2 raccoons. In addition, 38 non-native opossums and 25 native gray foxes (*Urocyon cinereoargenteus*) were captured and released. The numbers of red foxes trapped were consistent from 1991 to 1996, but trapping rates declined because more traps were used in successive years. Successful trapping required 46 traps/fox in 1991-92 and 83 traps/fox in 1995-96, suggesting that the trapping program was successful in reducing fox populations. More than half of the cats and skunks trapped were in the Warm Springs/Fremont area. In 2003, the CDFG implemented a predator-control program at the Eden Landing Ecological Reserve to reduce predation on listed species (John Krause, pers. comm.).

4.3.5 Birds

The birds of the South Bay have been studied more than any other wildlife group. This focused attention results from the high diversity of birds in the region, the presence of several San Francisco Bay-area endemics and state and federally listed species, the plasticity demonstrated by a number of species in adapting to the anthropogenic changes (including salt pond development) that have occurred in the South Bay, and the intensity of interest in the birdlife of the region by professional and amateur ornithologists.

Overview. The San Francisco Bay area is extremely important to breeding birds and, particularly, to migratory waterbirds in the Pacific Flyway. The Bay provides important foraging and roosting habitat for more than a million waterbirds each year, supporting large proportions of the populations of some shorebird and duck species (Accurso 1992; Harrington and Perry 1995; Page and others 1999; Stenzel and others 1989; Stenzel and Page 1988; Takekawa and others 2001). With its extensive mudflats, remnant salt marsh, and salt ponds, the South Bay in particular supports very high diversity and abundance of waterbirds (Harvey and others 1992; Takekawa and others 2000; Warnock 2004b). More than 250 bird species occur in the greater South Bay area with some regularity, and many of these are common inhabitants of the SBSP project area and its immediate vicinity. More than 75 species of waterbirds use the salt ponds, tidal marshes, mudflats, subtidal habitats, and surrounding managed marshes, water treatment plants, and managed ponds regularly, with more than 50 species more occurring rarely and/or in low numbers. Species richness in the South Bay system is generally highest in fall and lowest in summer and winter, while waterbird abundance is highest in spring and winter (Strong 2003; Takekawa and others 2001; Takekawa and others 2004). In Bay-wide surveys, Bollman and others (1970) found waterbird abundance to be lowest in summer, increasing rapidly in early September and peaking in December.

The high waterbird diversity in the South Bay is a function of the diversity of wetland and aquatic habitats in the region, while high bird abundance is a function of the high productivity of the South Bay estuary and, secondarily, of alternative habitats such as salt ponds. Despite the extensive loss and degradation of the South Bay's tidal marsh, and the invasion of the South Bay benthic invertebrate community by non-native species, this system is still extremely productive. The remnant tidal marshes not only provide habitat for marsh obligates such as the California Clapper Rail, they also play important roles as sources of nutrients and carbon for the aquatic system, resulting in high abundance of invertebrates on the mudflats and shallow subtidal areas (Warwick and Price 1975), and ultimately high fish populations. These invertebrates and fish in turn serve as prey to the myriad shorebirds, waterfowl, herons, egrets, gulls, terns, grebes, and other waterbirds that use the South Bay.

Salt ponds and other "alternative" habitats (such as artificial ponds and lakes, water treatment plant settling and oxidation ponds, muted and managed marshes, and managed ponds) also provide important habitat for waterbirds in the South Bay (Hanson and Kopec 1994; Harvey and others 1992; Stralberg and others 2003; Takekawa and others 2000; Takekawa and others 2001; Warnock 2004b). Though salt ponds are more or less closed systems, providing little input of carbon or nutrients to the estuary itself, the concentration of superabundant invertebrate prey in salt ponds, provision of alternate foraging habitat during high tide, provision of roosting sites, and concentration of fish in lower-salinity ponds results in suitable foraging conditions for a variety of waterbirds. For some species, such as the Wilson's Phalarope, Red-necked Phalarope, Black-necked Stilt, American Avocet, Western Snowy Plover, Bonaparte's Gull, American White Pelican, and breeding gulls and terns, these ponds provide higher-quality nesting and/or foraging habitat than the existing tidal marshes or intertidal habitats. A number of other species use salt ponds primarily when their preferred intertidal habitats are inundated, or when high densities may cause some birds to forage in less optimal areas (Warnock and Takekawa 1995). For such species, the question of whether salt ponds and other alternate habitats are required for foraging, or whether they are required primarily for high-tide roost sites, varies among species, and possibly among seasons (*i.e.*, being more important for foraging when densities are high). Alternate habitats such as salt ponds and levees are required for high-tide roosting sites, refugia from strong winds, and foraging sites during prolonged winter storms, when winds, rain, and high water may limit foraging efficiency and limit the availability of intertidal foraging areas (Davidson and Evans 1986; Evans 1976; Pienkowski 1981).

Although birds may be very abundant in salt ponds during high tide, most bird activity is concentrated in small areas within the larger salt pond complexes. For example, Stralberg and others (2003) reported that 90% of the small shorebirds and dabbling ducks in their South Bay study area were recorded in six of 22 ponds under study, while 90% of the larger shorebirds were recorded in 10 of 22 ponds. This concentration is a result of the dispersion of suitable foraging habitat and prey availability, which may be concentrated in relatively few ponds having suitable water depths and salinities. It has been reported that salt ponds close to the edge of the Bay have greater bird use than those farther from the Bay, and that many shorebirds use mudflats and salt ponds in close proximity to one another (Warnock and Takekawa 1996), thus reducing commuting distances between low-tide intertidal foraging habitat and high-tide refugia within the ponds for birds that use both habitats. Studies of color-marked or radio-tagged shorebirds in the South Bay indicate that many individuals have high site fidelity and small home ranges, often using the same roosting and foraging sites consistently (Kelly and Cogswell 1979; Warnock and Takekawa 1996). Wintering Western Sandpipers in the South Bay were found to have a mean home range size of 22 km^2, and the mean distance between feeding and roosting areas was 2.2 ± 0.1 km, although some birds moved around quite a bit, particularly within pond complexes. Warnock and Takekawa (1996) found less movement from one side of the Bay to the other. While the ponds supporting the greatest use do tend to be closer to the Bay (U.S. Geological Survey Unpublished Preliminary Data), and many birds may repeatedly use the same small areas, waterbirds in some areas are known to repeatedly travel longer distances (*e.g.*, thousands of shorebirds regularly commuting more than 4 miles between intertidal foraging areas and high-tide roosting areas near the NWR headquarters in Newark; (Morris 2004)). The sudden appearance of large numbers of shorebirds when salt ponds were drained during ISP implementation (Krause, pers. comm.; H. T. Harvey & Associates Unpublished), or of large numbers of piscivores at prey fish “blooms” (Steve Rottenborn, pers. obs.), is also indicative of these birds’ potential for significant local movement to exploit favorable foraging conditions.

A few studies have compared the use of salt ponds with the use of other available habitats (*e.g.*, tidal marsh, mudflats, and subtidal areas) in the South Bay. Within salt ponds and nearby mudflats near Coyote Hills, Swarth and others (1982) found higher bird species richness in low-salinity ponds than in higher-salinity ponds or mudflats, although relatively few species used the salt ponds at low tide. In contrast, Takekawa and others (2001) found species richness and diversity in the North Bay to be higher in natural baylands (*i.e.*, tidal marsh and mudflats) than in salt ponds during all seasons, while overall bird density was higher in salt ponds than in baylands in winter and spring (and overall was twice as high in salt ponds than in baylands). During Bay-wide surveys, Bollman and others (1970) found that salt ponds supported densities of waterbirds (57-73 birds/ac) 2-3 times higher than mudflats (29-30 birds/ac) and open water (15-18 birds/ac). At any given time, the proportion of a salt pond or mudflat in use by foraging birds may be relatively small, as birds often concentrate in areas providing the most suitable conditions, complicating the comparison of densities among these habitat types. Studies of shorebird use of different South Bay habitats during high tide, coordinated by SFBBO, are summarized under “Shorebirds” below (Hanson and Kopec 1994).

Stralberg and others (2003), comparing use of salt ponds with a limited sampling of tidal marshes (though not including tidal mudflats in the comparison), found that salt ponds had significantly higher species richness than tidal marshes, with a mean of 47 species/pond. However, salt ponds supported high densities of relatively few species, with only occasional use by many of the species contributing to the high species richness in the ponds; in contrast, tidal marsh was used at lower densities by many species. Warnock and others (2002) confirmed this finding, reporting that 10 species (out of 75 recorded) comprised >85% of all birds recorded in 22 salt ponds in the South Bay. Thus, tidal marsh provides habitat for more species more consistently; salt pond use by most species is more limited or irregular, but may be very important (to large numbers of individuals of at least some species) at times. Within salt ponds, species richness decreases with salinity, though many species use a wide range of salinities. Of the 50 most common species in salt ponds, the core salinity range for 34 included low-salinity (20-60 ppt) ponds, with 18 found only in this range; mid-salinity (60-120 ppt) ponds were within the core salinity range for 31 species. No species were restricted only to high-salinity ponds (Stralberg and others 2003).

Stralberg and others (2003)found waterbird species richness and diversity in tidal marshes negatively associated with the proportion of salt ponds in the surrounding landscape and positively associated with the proportion of surrounding mudflat and marsh. Within marshes, waterbird diversity was higher in marshes with more large channels, and the densities of ducks, larids, and shorebirds increased with increasing amounts of open water within the marsh; waders and other piscivores increased with larger channels in marsh.

The use of individual salt ponds, and foraging locations within those salt ponds, by foraging waterbirds is determined primarily by prey availability, which is mainly a function of salinity and water depth. Warnock and others (2002) reported bird diversity in South Bay salt ponds to be highest at mid-salinity ponds (±126 ppt), while bird density on salt ponds peaks at higher salinities (±140 ppt). Due to variations in bill and leg length, foraging behavior (*i.e*., swimming, wading, or diving), and prey preferences, different waterbird species are able to, or prefer to, forage in water of different depths (Isola and others 2000). Thus, ponds with more topographic heterogeneity, such as islands and uneven bottoms, are important in providing habitat for a greater diversity of foraging guilds by providing a range of foraging depths (Anderson 1970; Takekawa and others 2004; Velasquez 1993; Warnock 2004b).

The most recent and comprehensive dataset on bird use of the South Bay salt ponds themselves is currently being compiled by USGS, which has been conducting monthly bird surveys at 53 ponds in the South Bay Salt Ponds complexes (USGS, unpubl. preliminary data; Appendix B). Surveys have been conducted since January 2002 in some of the Alviso Complex ponds (and at all Alviso ponds since January 2003), since October 2002 at all Eden Landing Complex ponds, and since November 2002 at all Ravenswood Complex ponds. Preliminary results of these surveys through September 2004 are presented in Appendix B; these surveys are ongoing. Because management of the salt ponds included in this study may have differed from prior management in anticipation of the purchase of these ponds (and/or their mineral rights) from Cargill (Takekawa, pers. comm.) and because these surveys overlap the implementation of ISP management in some ponds, these data cannot be clearly related to pre-ISP or to ISP conditions, making it difficult to ascribe mechanisms to the patterns observed. Nevertheless, this dataset is useful in characterizing the general temporal and spatial distributions of birds in the South Bay salt ponds at the present time.

As of September 2004, the surveys by USGS had recorded 73 species of waterbirds in the Alviso Complex. Excluding Ponds A19-A23 (since these ponds were not surveyed as many times as the remaining ponds), the number of species/pond ranged from a low of 29 species in the mostly dry Pond A6 to 58 in Pond A9. Ponds A1, A5, A7, A10, and AB2 supported 50-56 species each, while ponds with the lowest species richness included A6, A12, A13, A15, and A17. Because more surveys were conducted in the Alviso Complex, species richness cannot be directly compared between these ponds and those in the Eden Landing and Ravenswood Complexes using these preliminary data. A total of 70 species of waterbirds were recorded in the Eden Landing Complex and 52 species in the much smaller Ravenswood Complex. Species richness/pond varied from 27 (Pond E2C) to 52 (Pond E10) in Eden Landing, with Ponds E2 and E4 supporting 50 species, and a number of ponds with much lower species richness. In Ravenswood, all ponds (excluding the very small RS2) supported 20-27 species except for R1, which supported 49 species of waterbirds. Although it is likely not possible to determine the mechanisms responsible for these patterns, since ISP conditions were implemented during the study period in some ponds, those ponds having high species richness tended to be large ponds with high topographic variability that included both shallow and deep water, thus providing foraging habitat for a number of foraging guilds. Low-diversity ponds tended to be deep-water ponds with little topographic heterogeneity or ponds that contained little water during the year.

Ponds supporting high waterbird abundance in the Alviso Complex were Ponds A5 (due largely to high Western Sandpiper abundance, and high abundance of other species), A6 (due to the large California Gull colony in this pond), and A9 (due to high abundance of many species, particularly ducks); Ponds A12, A13, A15, A16, A17, and AB1 supported the lowest bird abundance. In the Eden Landing Complex, Ponds E8A and E9 supported particularly high waterbird abundance due primarily to high abundance of Western Sandpipers and Dunlin, while Ponds E2C, E5, E5C, E6B, E6C, and E11 supported relatively low bird abundance. Ravenswood Ponds R1 and RSF2 supported high bird abundance primarily due to the large numbers of Western Sandpipers and Dunlin, while the remaining ponds supported much lower abundance (U.S. Geological Survey Unpublished Preliminary Data).

Birds in the South Bay overlap considerably in habitat preference and resource use, but general groups of species can be distinguished based on their physical adaptations, habitat associations, foraging behavior, dietary requirements and prey, the ways in which they use SBSP habitats (e.g., for nesting, foraging, or roosting), and their temporal occurrence in the study area. For the purposes of describing the existing conditions of the bird community in the South Bay, six general groups of species have been identified: shorebirds; waterfowl (ducks and geese); large waders (herons, egrets, and ibis) and other piscivores (fish-eating grebes, cormorants, and pelicans); larids (gulls and terns); “other waterbirds” (Eared Grebes, coots, and rails); and “landbirds” (including raptors and passerines). Each of these groups is discussed in detail below.

Shorebirds. Perhaps no other group of birds using the South San Francisco Bay has been better studied than shorebirds, which include plovers, sandpipers, stilts, avocets, and phalaropes, and perhaps no other group relies more heavily on the South Bay. Comprehensive shorebird surveys of the Pacific Coast of the U.S., summarized by Page and others (1999), have documented that the San Francisco Bay supports 41-97% (mean 67%) of estimated totals for key species for the entire West Coast in fall, 38-90% (mean

55.7%) in winter, and 24-86% (mean 52.3%) in spring. No other site on the West Coast of the U.S. supports a mean greater than 8% in any season. For 11 shorebird species, the San Francisco Bay supports >50% of the individuals recorded in all U.S. Pacific Coast wetlands in at least one season. The percentage of the total West Coast population of individual shorebird species that occurs in San Francisco Bay in fall, winter, and spring, respectively, include numbers as high as 62%, 59%, and 56% for Black-bellied Plovers (*Pluvialis squatarola*); 59%, 68%, and 54% for Western Sandpipers; 67%, 39%, and 73% for Least Sandpipers; 78%, 90%, and 58% for Black-necked Stilts; 97%, 88%, and 86% for American Avocets; and 69%, 59%, and 57% for Willets (*Catoptrophorus semipalmatus*). The San Francisco Bay supports an average of more than 40% of the West Coast populations over these three seasons for Semipalmated Plover (*Charadrius semipalmatus*), Red Knot (*Calidris canutus*), dowitchers (*Limnodromus* spp.), Long-billed Curlews (*Numenius americanus*), and Marbled Godwits (*Limosa fedoa*) as well. The San Francisco Bay likely supports more than one million shorebirds in spring and hundreds of thousands in the fall and winter (Stenzel and others 1989). As a result of these numbers, the San Francisco/San Pablo Bay area has been designated as a site of hemispheric importance by the Western Hemisphere Shorebird Reserve Network (Harrington and Perry 1995), and the Don Edwards San Francisco Bay NWR has been designated a Globally Important Bird Area by the American Bird Conservancy (2004).

The South Bay is the most important part of the larger San Francisco Bay from the perspective of use by breeding, migrant, and wintering shorebirds. Of 838,000 shorebirds counted during a Bay-wide survey 16-18 April 1988, 70% were recorded south of the San Mateo Bridge, with the highest concentration at low tide occurring on the broad intertidal flats on the east side of the Bay between the San Mateo and Dumbarton bridges (Stenzel and Page 1988). Mudflats and salt ponds on the east side of the Bay between these two bridges supported approximately 305,000 shorebirds during this survey, compared to 62,000 on the west side of the Bay between the bridges and 224,000 south of the Dumbarton Bridge. Of nearly 379,000 shorebirds counted during another Bay-wide survey 9-12 September 1988, 75% were recorded south of the San Mateo Bridge; within this area, 128,000 shorebirds were south of the Dumbarton Bridge, compared to 25,000 on the west shore and 77,000 on the east shore between the Dumbarton and San Mateo Bridges (Stenzel and others 1989). The wintering shorebird population in the South Bay was estimated by Harvey and others (1988) to exceed 200,000.

Most of the shorebirds that use the South Bay do so only for foraging and roosting but do not breed here. Only four shorebird species breed within the baylands habitats of the South Bay, while 20 species regularly use the South Bay for foraging and roosting as nonbreeders, and 19 additional shorebird species occur only as rare visitors to the area. Most individuals of most shorebird species in the South Bay forage primarily on intertidal mudflats when these flats are available at low tide. These individuals then seek high-tide refugia in salt ponds, on levees, in other alternative habitats in the area (*e.g*., water treatment plants, managed ponds, and muted or managed marshes), and to a limited extent in tidal marsh; here, most individuals of the larger shorebird species simply roost until the tide recedes again, while some individuals of the smaller shorebird species forage in their high-tide habitats. A few shorebird species remain in these alternative habitats throughout the tidal cycle, using salt ponds, water treatment plants, and managed ponds and marshes for foraging regardless of tide height.

Shorebird abundance in the South Bay is highest in spring and winter. For most species, the spring migration is rapid and compressed to a relatively brief period from early April to mid-May (Recher 1966; Stenzel and Page 1989), resulting in large numbers of individuals using the South Bay simultaneously. In contrast, the fall migration is more protracted for most species, as different sexes and age classes migrate in fall at different times. Shorebird abundance is lowest during summer, when only breeding individuals of four species and low numbers of non-breeders of other species are present. However, the "summer" period for shorebirds is very short in the South Bay – late spring migrants may move through the area as late as late May or early June, and the first fall migrants (usually Wilson's Phalaropes) begin to arrive in mid-June, with the first southbound arrivals of a number of other species appearing by late June and early July. Fall migration then continues through October.

Breeding. Prior to conversion of tidal marshes to salt ponds in the San Francisco Bay area in the mid 1800s, only one shorebird species, the Killdeer (*Charadrius vociferus*) likely bred in the South Bay. This species breeds on open ground in a variety of habitats, and open sand, gravel, or soil suitable for breeding was likely present historically. However, the creation of salt ponds in the South Bay has enhanced breeding habitat for several species. The Western Snowy Plover, which nests on salt flats and islands within salt ponds, likely did not breed in the South Bay prior to late 1800s; although salinas were present in the tidal salt marsh, they were not extensive and may not have been large enough to support breeding by this species (Goals Project 1999). This species was first recorded breeding in salt ponds in 1918 (Harvey and others 1992), and today, Snowy Plovers nest on levees, islands, and salt flats throughout the South Bay salt ponds, occurring in highest concentrations in the Eden Landing area. This species is discussed in greater detail below in the Special-Status Wildlife Species section (Section 5.5).

The American Avocet and Black-necked Stilt also did not breed in the San Francisco Bay area prior to the creation of salt ponds. These species were first recorded breeding in Bay-area salt ponds in 1926 and 1927, respectively (Gill 1977; Harvey and others 1992). Since then, their populations have increased considerably, with avocet population estimates of 1,800 pairs in 1971 (Gill 1977) and 540 pairs in 1981 (Rigney and Rigney 1981), and stilt population estimates of 400-500 pairs in 1971 (Gill 1977) and 600-650 pairs in 1981 (Rigney and Rigney 1981). More recently, a breeding-season survey of the South Bay by Rintoul and others (2003) counted 1,184 Black-necked Stilts and 2,765 American Avocets, with the number of breeding pairs estimated at 135-590 for stilts and 440-1380 for avocets. No other coastal site along the Pacific Coast supports such high abundance of these two species (Rintoul and others 2003).

Both stilts and avocets nest at scattered locations throughout the SBSP project area, although Rintoul and others (2003) noted particularly large concentrations of both species in the East Bay (from the vicinity of Highway 84 at the east end of the Dumbarton Bridge north through the Eden Landing ponds) and in New Chicago Marsh in Alviso, with another concentration of avocets in the Warm Springs area along the upper edges of the salt ponds and marshes (Figure 11). Rintoul and others (2003) noted an increase in the importance of the Eden Landing area for nesting stilts and avocets since 1981 (Rigney and Rigney 1981). It is not clear whether their surveys covered the San Jose/Santa Clara WPCP, where on 10 May 1997, more than 30 stilt nests were found scattered over the sludge ponds during an informal survey (Steve Rottenborn, pers. obs.).

Rintoul and others (2003) found 21% of 137 Black-necked Stilt nests in marshes and 69% around salt ponds; of 409 American Avocet nests, 3% were in marshes and 93% were around salt ponds. Stilts used salt ponds and marshes in proportion to availability, while avocets favored salt ponds. Within marshes, stilts tended to use more heavily vegetated areas than avocets. Both species used similar habitats for brooding young (mostly salt ponds, with lesser numbers in marshes). Less than 20% of nests found were on levees; most were on islands, as reported by others (Gill 1973; Harvey and others 1988; Rigney and Rigney 1981; Robinson and others 1997; Robinson and others 1999; Swarth and others 1982). Both species commonly nest among nesting Forster's Terns on islands.

Feeding. As noted previously, the South Bay is the single most important area on the west coast, south of Alaska, for use by migrant and wintering shorebirds. Surveys have documented more than 590,000 shorebirds present simultaneously 16-18 April 1988 (Stenzel and Page 1988) and 230,000 present 9-12 September 1988 (Stenzel and others 1989) in the South Bay. Because these were only "snap-shot" surveys, and thus capture only a fraction of the shorebirds that use the South Bay as migratory stopover or staging areas, the actual number of birds that use the South Bay for foraging during migration is much higher. The San Francisco Bay is the northernmost location used by large numbers of shorebirds in winter on the West Coast (Warnock 2004a), and wintering shorebird numbers in the South Bay were estimated by Harvey and others (1988) to exceed 200,000.

Shorebirds tend to forage in habitats, at times, under conditions, and on prey that provide high foraging efficiency while balancing predation risk and other adverse factors (Goss-Custard 1970; Goss-Custard 1979; Goss-Custard and others 1977; Van de Kam and others 2004). Shorebirds tend to concentrate foraging activity where suitable prey is most dense (Skagen and Oman 1996) and/or where such prey is most available (*i.e.*, where the birds can reach and obtain food), although they may alter their behavior (*e.g.*, foraging duration or foraging locations) based on competition from other shorebirds or energetic needs. For example, Western Sandpipers in the South Bay make more use of salt ponds during spring than during other seasons (Warnock and Takekawa 1996), possibly because high spring shorebird densities force some birds to spread out from preferred intertidal mudflats and forage more heavily in less optimal habitats. In winter, shorebirds may spend more time foraging and less time roosting due to decreased daylength, more rapid energy loss due to cool temperatures, and adverse effects of low temperature on food availability and foraging efficiency (Goss-Custard and others 1977; Heppleston 1971; Kelly and Cogswell 1979; Van de Kam and others 2004).

Most shorebird species in the South Bay are "mudflat specialists", foraging primarily on intertidal mudflats when these flats are available at low tide (Anderson 1970; Kelly and Cogswell 1979; Recher 1966; Stralberg and others 2003; Swarth and others 1982; Warnock and others 2002; Warnock and others 1995). These birds move to mudflats as they uncover on an ebbing tide, often concentrating at the edge of the receding tideline. Near the waterline, worms, crustaceans, and bivalves occur close to the surface, whereas these prey species recede deeper into the mud as the water level drops. Near the waterline, microhabitat use often varies among species based on bill and leg length; Semipalmated and Black-bellied Plovers feed on recently exposed mud, small sandpipers such as Western and Least Sandpipers forage on recently uncovered mud and shallow water, mid-sized birds such as Dunlin, Red Knots, Long-billed

Dowitchers, and Short-billed Dowitchers forage in slightly deeper water, and larger shorebirds such as Willets, Long-billed Curlews, and Marbled Godwits probe in deeper water.

Some authors have reported that the greatest concentrations of shorebirds occur at the receding tideline (Recher and Recher 1969; Stenzel and Page 1988; Storer 1951). Gerstenberg (1979) reported that shorebirds forage along the tideline until it reaches its ebb, then spread out over the tidal flats (especially when bird abundance is high), although he also noted that shorebirds may concentrate along the waterline on both the receding and incoming tide. All of these scenarios have been observed in the South Bay, where shorebirds may be observed foraging along the receding and incoming waterline, and often spread out over the flats as well (Steve Rottenborn, pers. obs.). It is likely that shorebirds use more of the tidal flats when densities are higher, as competition for space and food resources requires the birds to spread out over the flats more.

After the mudflat specialists have finished foraging on the mudflats, they may roost temporarily on the upper mudflats before leaving as the tide rises, or fly directly to alternate sites to roost or, to varying degrees, forage during high tide. Although sites such as water treatment plants, managed ponds (*e.g.*, the Coyote Creek Reach 1A pond), managed/muted tidal marshes, and wet fields are used (heavily at times) by mudflat specialists during high tide, most shorebirds move to the salt ponds. Surveys of South Bay high-tide roosting and foraging sites, coordinated by SFBBO between October 1992 and May 1993, documented 51% of shorebirds using salt ponds at high tide, with 10% on levees around and within salt ponds and other habitats, 10% in tidal marsh, 12% in diked marsh, and up to 4% in inactive salt ponds, uplands, freshwater ponds (including sewage treatment ponds), tidal islands, and salt pans (Hanson and Kopec 1994).

The use of salt ponds for foraging by mudflat specialists varies considerably among species, and for some species, it varies among individuals, seasons, and possibly age classes. Of the mudflat specialist species, most of the individuals observed in salt ponds at high tide are roosting rather than foraging. For example, over all surveys and all shorebird species recorded during SFBBO's 1992-1993 study, roosting comprised 68% of activity at these high-tide areas, while foraging comprised 26% of shorebird activity (Hanson and Kopec 1994). The percentage of birds in a given location that were foraging at high tide varied considerably among surveys; for example, <1% of more than 24,400 shorebirds in Pond R1 on 22 March 1993 were foraging, whereas 70% of the 6,200+ birds (of similar species composition) in the same pond on 3 May 1993 were foraging at high tide. At times, nearly all birds in a given location were observed foraging at high tide, with foraging activity being particularly high in spring.

Long-billed Curlews, Marbled Godwits, and Black-bellied Plovers roost in salt ponds but do not use them heavily for foraging (Warnock and others 2002). Black-bellied Plovers, Willets, and dowitchers make somewhat greater use of salt ponds for foraging, but still do not forage in salt ponds to a great extent. Most Western Sandpipers and Dunlin use salt ponds primarily for roosting, but forage on moist mud and in shallow water to a greater extent. A greater proportion of Least Sandpipers seems to use salt ponds for foraging than is observed in other mudflat specialists (Steve Rottenborn, pers. obs.).

Telemetry studies by Warnock and Takekawa (1995; 1996) determined that Western Sandpipers made greater use of salt pond levees and shallows for foraging during spring, when densities in the South Bay were higher, than during winter. These results suggest that birds depositing fat prior to spring migration may need to spend more time foraging (and thus forage in salt ponds during high tide), and that at higher densities (such as occur during spring migration), more birds are relegated to less preferred habitats, such as salt ponds. Some individuals of other mudflat specialists, particularly Least Sandpipers, Dunlin, and Semipalmated Plovers, may also take advantage of suitable foraging conditions within salt ponds and remain in these ponds throughout the tidal cycle; even within salt ponds, these birds forage primarily at low tide, with most individuals roosting at high tide (Hanson and Kopec 1994; Warnock and others 2002).

The mild microclimate of the South Bay may help to explain its high bird use during winter (Warnock and Takekawa 1996). Nevertheless, alternate foraging sites may be particularly important for mudflat specialists during the wet season. High winter tides, combined with sustained strong winds and/or flooding, may reduce the extent to which intertidal mudflats are uncovered, temporarily limiting the availability of these preferred foraging habitats (Storer 1951). Flooding may also wash silt onto mudflats, reducing prey availability or foraging efficiency (Gerstenberg 1979; Warnock and Takekawa 1996). Studies have demonstrated that Dunlin in coastal areas may move inland to forage after heavy rains (Warnock and others 1995).

Several species of shorebirds make little or no use of intertidal mudflats, instead preferring the "alternate" habitats for foraging regardless of tide height (Harvey and others 1988; Stenzel and Page 1988; Storer 1951; Swarth and others 1982; Warnock and others 2002). American Avocets forage in shallow pools and wet mud on mudflats, and occasionally in deeper water near the tideline (Hamilton 1975; Storer 1951; Warnock and others 2002), and Snowy Plovers may use mudflats for foraging as well, but these species are most abundant in the South Bay in salt ponds. Black-necked Stilts and Wilson's and Red-necked Phalaropes also occur in the South Bay primarily in salt ponds, rarely foraging in tidal habitats. Greater Yellowlegs and Lesser Yellowlegs (*Tringa flavipes*) forage in a variety of nontidal habitats in the South Bay, including salt ponds, and occur less frequently on tidal mudflats. While these seven "pond specialists" may occur by the hundreds or thousands in alternate habitats other than salt ponds, the salt ponds support the vast majority of the South Bay's populations of these species.

Within the salt ponds, water depth and salinity influence the distribution of foraging shorebirds. The abundant invertebrates of the mid- and high salinity ponds (60-200 ppt), namely brine shrimp, brine flies, and reticulate water boatmen, are important food sources for shorebirds (Larsson 2000; Maffei 2000b; Stralberg and others 2003; Warnock and others 2002), but their availability to shorebirds is limited by water depth. Most shorebirds forage in water less than 10-15 cm deep, with depths below 4 cm being preferred by smaller species such as the Western Sandpiper, Least Sandpiper, and Dunlin (Isola and others 2000; Safran and others 1997). Thus, only the moist soils along the edges of salt ponds, and moist soil or very shallow water within the ponds, provide suitable foraging habitat for these wading species.

The extent of shorebird foraging habitat present within the salt ponds varies considerably among ponds and seasons, but at any given time a relatively small proportion of the salt pond complexes provides suitable conditions (*e.g*., moist soil or shallow water <10 cm deep) for foraging by most shorebirds. Deeper ponds without shallowly sloping sides provide foraging habitat only in a very narrow zone along their immediate periphery. For example, a 12”-wide strip of moist-soil and shallow-water foraging habitat around the edges of ponds A2W, E1, and E2 (which represent the ponds that lack shallowly sloping sides and are usually flooded) would comprise only ±0.1% of the area of these ponds (or approximately 1.3 acres out of a total of 1,287 acres in these three ponds).

Calculating the area of suitable foraging habitat for shorebirds over entire pond complexes and across seasons is problematic. Water depth in seasonal ponds may vary considerably among years, seasons, and even months or weeks depending on precipitation levels and temperature. Even in ponds where water levels are managed more actively, the lack of data on microtopography of the pond bottoms and the vagaries of management make it difficult to predict the extent of areas providing water <10 cm deep, and floating mats of algae in late summer and fall may provide foraging habitat for birds in ponds >10 cm deep. Furthermore, extensive dry flats with thick salt crusts provide only marginal foraging habitat for shorebirds, as prey densities may be low away from the moist-soil and ponded areas. Over all three complexes, rough estimates suggest that at any one time, less 15% of the total salt pond area provides foraging habitat for most shorebirds under ISP management during winter and early spring (when ponds contain the most water), and less than 25% of the salt pond area provides suitable foraging habitat during late summer and fall (when ponds are driest).

In contrast, phalaropes, and American Avocets to a lesser extent, can forage while swimming. Thus, these birds are able to use the entire surface area of a pond, taking advantage of prey near the surface of the water. Phalaropes can draw invertebrates from deeper water upward in the water column by spinning on the water’s surface. However, much of the invertebrate biomass of the mid- and high-salinity salt ponds may still occur at depths greater than those that can be used by these shorebirds (Laine, pers. comm.). Although brine shrimp comprise most of the biomass of the invertebrates within these high-salinity ponds, the nutritive value of brine shrimp to foraging shorebirds may be limited, as Rubega and Inouye (1994) found that Red-necked Phalaropes could not survive foraging on brine shrimp alone. Brine flies (both adults and larvae), and water boatmen to a lesser extent, are thus very important to shorebirds that forage in South Bay salt ponds (Anderson 1970).

Most vegetated tidal marsh receives little use by foraging shorebirds because of the height and/or density of marsh vegetation. However, more open areas within the marsh are used for foraging by some species. Willets forage in the vegetated portions of tidal marshes (Gerstenberg 1979; Kelly and Cogswell 1979; Long and Ralph 2001), particularly when these areas are flooded during very high tides but occasionally even during low tide (Kelly and Cogswell 1979). Long-billed Curlews, Marbled Godwits, Least Sandpipers, and other species occasionally forage in vegetated tidal marsh areas as well, usually in more sparsely vegetated areas but occasionally in dense (but short) pickleweed. Large numbers forage on intertidal flats along the larger sloughs within marshes when the flats are exposed, but most shorebirds avoid areas with dense, tall vegetation, and therefore do not forage in most of the marsh plain. These birds will forage, sometimes abundantly, in shallow marsh ponds and pans within the high marsh, and in areas where bare mud and shallow water is interspersed with short pickleweed vegetation. Stralberg and others (Stralberg and others 2003) reported that the proportion of small shorebirds foraging (rather than roosting) was higher in tidal marsh than in salt ponds. Thousands of individuals of a variety of species use New Chicago Marsh, a managed marsh (*i.e.*, not considered a tidal marsh) in Alviso, for foraging at both low and high tide, as this marsh provides extensive shallow-water marsh pond/pan habitat interspersed with low pickleweed. However, most such areas that formerly occurred within South Bay tidal marshes have been destroyed by fill and diking, and at this time, high marsh habitat within fully tidal marshes is of limited importance for foraging shorebirds in the South Bay.

Birds are often classified by their foraging methods and habitats, which are largely a reflection of their physical adaptations for foraging and their preferred prey, into foraging groups or "guilds". As indicated in the USGS bird data from South Bay salt ponds (Appendix B), shorebirds in the South Bay are generally grouped into three foraging guilds – shallow probers, deep probers, and sweepers.

"Shallow probers" are species that pick prey off the surface of the water or sediment (generally after locating the prey visually), or that probe at shallow depths within mud or moist sand to locate prey tactilely. The more common shallow probers in the South Bay include the Killdeer, Black-bellied Plover, Semipalmated Plover, Snowy Plover, Red Knot, Dunlin, Least Sandpiper, and Western Sandpiper. This guild represents the majority of the migrant and wintering shorebirds in the South Bay, with hundreds of thousands of Western Sandpipers, tens of thousands of Least Sandpipers and Dunlin, thousands of Black-bellied Plovers and Semipalmated Plovers, and hundreds of Snowy Plovers and Red Knots using the South Bay at times (Harvey and others 1992; Stenzel and others 1989; Stenzel and Page 1988). Warnock and Bishop (1998) have identified the San Francisco Bay as a major staging area for the Western Sandpiper because individuals are present for longer periods of time and presumably put on more fat than in the "stopover" areas that are used, but are less important, elsewhere along the central California coast. The Western Sandpiper is by far the most abundant shorebird species present in the South Bay.

"Deep probers" include species generally having larger bodies and longer legs and bills than the shallow probers. These species, which probe more deeply into moist sediment and burrows for prey and do less picking of items from the surface (except for yellowlegs), include Short-billed Dowitchers (*Limnodromus griseus*), Long-billed Dowitchers, Long-billed Curlews, Marbled Godwits, Whimbrels (*Numenius phaeopus*), and Willets. Though not nearly as abundant in the South Bay as the shallow probers, this guild is still represented by tens of thousands of dowitchers, 10,000+ Willets and Marbled Godwits, and hundreds of Long-billed Curlews, Whimbrels, and Greater and Lesser Yellowlegs during migration and winter (Harvey and others 1992; Stenzel and others 1989; Stenzel and Page 1988). The salt pond surveys by USGS identified the highest abundance of both shallow and deep probers (the vast majority of which were likely roosting, rather than foraging, in these ponds) in Alviso Ponds A5 and A7, Eden Landing Ponds E8A and E9, and Ravenswood Ponds R1 and RSF2 (U.S. Geological Survey Unpublished Preliminary Data). This USGS Data is summarized in Appendix B.

"Sweepers" include the American Avocet, Black-necked Stilt, Wilson's Pharalope, and Red-necked Phalarope. All of these species forage by picking visually identified prey from the soil surface or water column, but avocets also forage by sweeping their bills from side to side through water and mud, tactilely detecting prey. Phalaropes may create a vortex by spinning in the water and drawing prey to the surface. In the South Bay, breeding populations of American Avocets and Black-necked Stilts are augmented in winter, when up to 24,500 avocets and 11,500 stilts are present (Harvey and others 1988). High counts of phalaropes in the South Bay include counts of 37,462 Wilson's Phalaropes on 6 August 1984 and 19,000 Red-necked Phalaropes on 18 August 1981 (Harvey and others 1992), with combined phalarope counts of as many as 70,000 individuals (Harvey and others 1988). Both species are much less common in spring than in late summer and fall in the South Bay. Due to the presence of the South Bay salt ponds, the San Francisco Bay is one of five major staging areas for adult Wilson's Phalaropes prior to their non-stop migration to South America (Colwell and J.R. Jehl 1994). The salt pond surveys by USGS identified the highest abundance of sweepers in Alviso Ponds A1, A5, A7, A8, A9, A14, A16, and AB2, Eden Landing Ponds E1C, E3C, E4C, E8A and E14, and Ravenswood Pond R1 (U.S. Geological Survey Unpublished Preliminary Data). This USGS Data is summarized in Appendix B.

Shorebirds in the South Bay eat a wide variety of invertebrates, and occasionally small fish. Brine shrimp, brine flies, and reticulate water boatmen probably comprise the bulk of the prey taken in salt ponds, although *Corophium* spp., annelids, polychaetes, and other invertebrates are known to be taken in salt ponds as well (Anderson 1970). *Corophium* spp., polychaetes, bivalves, and snails likely comprise the bulk of the prey taken on mudflats (Harvey and others 1992; Recher 1966; Swarth and others 1982). Shorebirds are very flexible and opportunistic in their diets, with considerable dietary overlap among species and foraging guilds (Skagen and Oman 1996). They often take prey in accordance with availability, concentrating where prey is most dense (Goss-Custard 1970; Goss-Custard 1977; Goss-Custard 1979). Thus, the hydrologic regimes and ecosystem processes that maintain abundant invertebrate populations are more important than the specific invertebrate taxa available. As a result, shorebirds are still abundant in the South Bay, and still show a preference for foraging on intertidal mudflats, despite the widespread and pervasive invasions of the South Bay benthic invertebrate community by nonnative species.

Roosting. Shorebirds generally roost, resting and preening, when they are not foraging. Many mudflat specialists roost on the upper flats after initially foraging on the receding tide, then fly to alternate habitats to roost as the mudflats flood. In the South Bay, the most commonly used high-tide roosts for both pond specialists and mudflat specialists are shallows and bare sediment within salt ponds, levees surrounding and (especially) between salt ponds, and islands and artificial structures such as boardwalks within these ponds (Warnock and others 2002). Surveys coordinated by SFBBO in 1992 and 1993 (Hanson and Kopec 1994) found that 28% of all birds were in shallow water of salt ponds at high tide (most roosting), with an additional 23% on islands within salt ponds and another 10% on levees around a variety of habitats, including salt ponds. Islands within salt ponds were found to be used primarily for roosting, whereas shallow water within salt ponds was used by similar numbers for foraging and roosting. Levees were used for roosting more in spring than in winter, and infrequently in fall.

Although some shorebirds forage at high tide within salt ponds, most birds, including both pond specialists and mudflat specialists, roost during high tide (Hanson and Kopec 1994; Warnock and others 2002). Major high tide shorebird roosts in the South Bay, based on the unpublished preliminary USGS bird survey data and SFBBO's 1992-1993 study (Hanson and Kopec 1994), are indicated on Figure 12, which also depicts the sites of major Western Sandpiper roosts in the South Bay identified by Warnock and Takekawa (1995). In addition to these sites, large shorebird roosts occur just north of the study area, on the north side of Highway 92 in Hayward.

Shallowly flooded marsh ponds, marsh pans, managed marshes, managed ponds, and water treatment plant drying ponds are also used for roosting, and American Avocets, Willets, Long-billed Curlews, Marbled Godwits, Dunlin, and dowitchers roost to some extent in tidal marshes with short vegetation (PRBO Conservation Science 2004; Storer 1951). Diked and tidal marshes along the Foster City/Redwood Shores shoreline provide roosting sites for large numbers of birds at times, particularly larger species such as Willets, Marbled Godwits, and Black-bellied Plovers (Hanson and Kopec 1994).

Due to their proximity to foraging habitat, protection from predators, and protection from wind and wave action, some high-tide roosts are used consistently, and studies of color-marked or radio-tagged shorebirds in the South Bay indicate that many individuals use the same roosting sites consistently (Kelly and Cogswell 1979; Warnock and Takekawa 1995). Other shorebird roosts, however, may be more ephemeral or inconsistently used (Colwell and others 2003). For foraging shorebirds, site fidelity is tied to consistently suitable conditions at certain locations (*e.g.*, certain ponds that consistently provide shallow foraging habitat for shorebirds) rather than the locations themselves. While the same is likely true of shorebird roost sites, fidelity to a roost site is less easily explained given the abundant, widespread nature of ostensibly suitable roosting habitat on salt pond levees throughout the South Bay.

Waterfowl. Historical accounts of waterfowl numbers in the San Francisco Bay area attest to the abundance of ducks and, to a lesser extent, geese using the Bay area during migration and winter; for example, more than 300,000 ducks were sold in San Francisco markets during the 1911-1912 waterfowl season (Skinner 1962). The South Bay undoubtedly supported large wintering waterfowl populations, as reported by Skinner (1962) for the Alvarado area and the Santa Clara Valley, and the town of Drawbridge near Alviso "became a resort solely for duck hunters arriving from San Francisco by regular trains in the 1880s" (Harvey and others 1992). The loss of 90% of the Bay's wetlands, along with hunting pressures, contamination, and other factors led to a decline in waterfowl populations, although this decline is not well documented for the South Bay. Currently, the South Bay supports fairly large migrant and wintering populations of ducks, with several breeding species as well.

More than 32 species of waterfowl use the baylands and immediately adjacent habitats of the South Bay. Of these, eight species breed regularly (with populations augmented considerably during the nonbreeding season), nine additional species occur regularly during migration and winter, and at least 15 more occur irregularly and/or in very low numbers in the baylands as nonbreeders. Harvey and others (1988) reported that wintering waterfowl in the South Bay (south of the San Mateo Bridge) in 1981 exceeded 75,000 individuals, with more ducks on salt ponds than in the Bay, especially from January through April. Surveys in 1987-1990 revealed approximately 57,000 dabbling ducks (ducks that feed without submerging their entire bodies) and 220,000 diving ducks (Goals Project 1999) in the Bay area. The South Bay salt ponds were found to support up to 76,000 wintering waterfowl, representing more than one-quarter of the Bay's waterfowl population, including 89% of the Bay's Northern Shovelers, 67% of the Ruddy Ducks, half of the Buffleheads, and 17% of the Canvasbacks wintering in the Bay (Accurso 1992; Takekawa and others 2000).

Breeding. Though not nearly as important to nesting waterfowl in the Bay Area as the Suisun Bay (Goals Project 1999; Harvey and others 1992), the baylands habitats of the South Bay support eight regularly nesting waterfowl species: the Mallard, Gadwall, and Canada Goose (breeding populations of which are introduced) are fairly common breeders, while the Cinnamon Teal, Northern Pintail (*Anas acuta*), Ruddy Duck, Lesser Scaup, and Northern Shoveler breed in smaller numbers. Several other species, including the Green-winged Teal (*Anas crecca*), Blue-winged Teal (*Anas discors*), Canvasback (*Aythya valisineria*), and Redhead (*Aythya americana*), have been recorded breeding only a few times in the study area (Santa Clara County Bird Data Unpublished).

Few data exist on breeding population estimates for these waterfowl species in the South Bay. The most comprehensive survey and population estimate for this area was by Gill (1977). During the 1971 breeding season, he found 21 nests or broods of the Northern Pintail, 19 of the Gadwall, eight of the Mallard, five of the Ruddy Duck, four of the Cinnamon Teal, and one of the Northern Shoveler in the South Bay. Based on his observations, Gill estimated breeding populations of these species at 50-100 pairs of pintails, 100-150 pairs each of Gadwalls and Mallards, 50-100 pairs of Ruddy Ducks, 75-100 pairs of Cinnamon Teal, and 1-5 pairs of shovelers in the South Bay. Based on breeding bird atlas work and other observations by birders, current populations of these species likely exceed Gill's 1971 estimates. For example, 650 Gadwalls (including 25 broods of young) on 24 July 1993 at the Sunnyvale WPCP (Steve Rottenborn, pers. obs.) attest to much higher breeding abundance than was estimated by Gill. In addition, the Lesser Scaup has become a regular breeder (albeit in low numbers, likely 10-20 pairs or more) in the South Bay since Gill's studies (Santa Clara County Bird Data Unpublished).

None of the 41 nesting attempts observed by Gill in salt marsh were successful, leading him to postulate that breeding populations in the South Bay were limited by the availability of freshwater habitats. The nesting microhabitats of these waterfowl within the South Bay are poorly known since nests are usually well hidden, and most breeding is detected by the observation of adults with broods of precocial young. Nesting by most of these species likely occurs in dense herbaceous vegetation in the upper tidal marsh, managed wetlands, upland transition areas, ruderal vegetation on levees, and upland areas surrounding ponds, sloughs, and ditches, such as weedy lots and fields. In contrast, the Ruddy Duck builds its nests in emergent vegetation in freshwater marshes and the marshy borders of freshwater ponds and ditches.

Important breeding areas for waterfowl in the South Bay combine freshwater or brackish seasonal wetlands with extensive grassy or ruderal vegetation for nesting and fresh, brackish, or low-salinity ponds and marshes for brooding of young. Such areas occur in the South Bay in the Palo Alto Flood Control Basin and vicinity, the Moffett Field/Crittenden Marsh area, the Sunnyvale and San Jose-Santa Clara WPCPs, the Sunnyvale Baylands, the Coyote Creek Reach 1A waterbird pond, the Warm Springs wetlands, the seasonal wetlands landward of the salt ponds and tidal marshes in the Fremont/Newark area, and Coyote Hills Regional Park.

Foraging and Roosting. The South Bay is an important foraging area for migrant and wintering waterfowl. All of the breeding species are present in much greater abundance during the nonbreeding season than during summer, and they are joined by other species that occur in the South Bay solely as nonbreeders. Duck abundance in the South Bay increases in August and September as migrants, particularly Northern Shovelers, arrive in salt ponds and marshes. Numbers of other dabbling ducks and several species of diving ducks increase through the fall and into winter, and remain high into March (Santa Clara County Bird Data Unpublished; U.S. Geological Survey Unpublished Preliminary Data).

Dabbling ducks forage in a variety of habitats in the South Bay, including mudflats, shallow subtidal habitats, tidal sloughs and marsh channels, marsh ponds, managed and muted tidal marsh, seasonal wetlands, managed ponds, and water treatment plants. In these areas, dabbling ducks feed on a variety of aquatic plants and invertebrates. Because these species do not typically dive for food, dabbling ducks usually forage in water less than 30 cm deep (Page 2001). Within salt ponds, salinity is also important for these birds. The plants on which many dabbling ducks feed cannot tolerate high salinities, and thus dabbling duck abundance tends to be highest on lower salinity ponds (20-63 ppt) ponds, with few in ponds >154 ppt (Accurso 1992).

The most abundant dabbling ducks wintering in the South Bay are the Northern Shoveler, American Wigeon (*Anas americana*), Northern Pintail, Mallard, and Gadwall (U.S. Geological Survey Unpublished Preliminary Data). Shovelers are both abundant and flexible in habitat use in the South Bay, although they do not use tidal habitats frequently (Swarth and others 1982). The Northern Shoveler was the third most abundant species recorded at the Coyote Creek Reach 1A waterbird pond during monitoring from 1992 to 2003, comprising 81% of the waterfowl recorded there (Strong 2003), and counts of 4,750 (19 Dec 1999) at the San Jose-Santa Clara WPCP and 5,500 (20 December 1996) at the Sunnyvale WPCP have been recorded (Santa Clara County Bird Data Unpublished). Swarth and others (1982) found shovelers to be much more abundant on salt ponds than in tidal habitats, with 16,500 shovelers counted on two salt ponds during a census in early November. In contrast, these observers found American Wigeon, Canvasback, scaup, and Surf Scoters to be much more abundant on the Bay than in salt ponds. Ruddy Ducks and Northern Pintails were common in both habitats.

Diving ducks comprise the most abundant wintering waterfowl in the South Bay. Common species include the Lesser Scaup, Greater Scaup (*Aythya marila*), Ruddy Duck, Canvasback, Bufflehead (*Bucephala albeola*), Surf Scoter (*Melanitta perspicillata*), Common Goldeneye (*Bucephala clangula*), and Red-breasted Merganser (*Mergus serrator*). These species may “tip up” for food in shallow water, but more frequently dive completely underwater to obtain food. Bivalves, including large numbers of Baltic clams, are a favored food item for diving ducks such as scaup, Canvasbacks, and Surf Scoters, and Canvasbacks often congregate over bivalve beds (Miles 2000b; Takekawa and Marn 2000; White and others 1988). Ruddy Ducks forage on aquatic vegetation (such as wigeon grass), which grows primarily in lower-salinity ponds, and invertebrates, including mollusks and water boatmen (Anderson 1970; Miles 2000a). Brine fly larvae/puparie are important to Lesser Scaup foraging on South Bay salt ponds (Anderson 1970).

Diving ducks are common in the open waters of the Bay, where large flocks of Lesser and Greater Scaup, Canvasbacks, and other species often congregate to roost. Although diving ducks may forage in water up to 10 m deep (Miles 2000b), these birds forage primarily in water only a few meters deep (John Takekawa, pers. comm.), and therefore much of the Bay is not available to (or does not provide high-quality foraging conditions for) these birds for foraging, and foraging flocks of diving ducks tend to congregate over shoals and over intertidal flats when they are inundated at high tide. Diving ducks are also common on salt ponds, in larger sloughs, on the artificial lagoons in the Foster City/Redwood Shores area, and on some artificial lakes, such as Shoreline Lake in Mountain View.

Surveys conducted between October 1987 and March 1988 found that scaup comprised 41%, scoters 21%, Northern Shovelers 11%, Ruddy Ducks 9% and Canvasbacks 6% of all waterfowl on the open waters of the Bay (Takekawa and others 1988). A large percentage (up to 25% or more) of the Bay's wintering populations of scaup and Surf Scoters occur in the South Bay, but most forage on the Bay itself, whereas Buffleheads and Ruddy Ducks forage more extensively in salt ponds (Takekawa and others 1988). Conducting winter censuses (November 2000 – February 2001) of the Bay south of the Bay Bridge, Ford and others (2002) estimated more than 168,000 scoters, 164,000 scaup, and 53,000 ducks of other species on the open waters of the Bay. Although the center of abundance moved around somewhat among surveys, the greatest concentrations of scoters were north of the San Mateo Bridge, while several centers of abundance for scaup included areas between the Dumbarton and San Mateo Bridges and south of the Dumbarton Bridge.

Although total numbers of waterfowl are higher on the Bay than in salt ponds in the South Bay, lower-salinity salt ponds (20-63 ppt) of moderate size (50-175 ha) support the highest densities of waterfowl in the study area (Siegel and Bachand 2002). Ponds A9 and A10 in Alviso, and the Sunnyvale WPCP ponds, have been identified as being particularly important to Northern Pintail populations in the South Bay (Casazza and Miller 2000).

Results of the salt pond surveys by USGS (U.S. Geological Survey Unpublished Preliminary Data) indicate that in the Alviso Complex, Ponds A1, A2E, A2W, A5, A7, A9, and AB2 support high numbers of dabbling ducks, with the higher salinity Ponds A12, A13, and A19-A23 supporting few dabblers (Appendix B). Ponds A1, A2W, A9, and A10 support large numbers of diving ducks, primarily Ruddy Ducks and scaup, with fewer Buffleheads and Canvasbacks. Ponds in the Eden Landing Complex supporting large numbers of dabblers include Ponds E3C, E4C, and E10, while Ponds E1, E2, E4, E7, E9, E10, and E14 support the greatest abundance of diving ducks. Few dabbling ducks were recorded in any of the Ravenswood ponds, although Ponds R2 and R4 support modest numbers of diving ducks.

On decommissioned salt ponds in the North Bay, Takekawa and others (2004) found that diving benthivores, primarily diving ducks, dominated the bird community on the salt ponds. Diving duck densities were four times higher in salt ponds than in the natural baylands in winter and spring, as contrasted with dabbling ducks, which were consistently higher in baylands habitats than in salt ponds. In South Bay salt ponds, dabbling ducks tend to dominate the salt pond bird communities, with Northern Shovelers accounting for 41-46% of all birds in ponds at low tide (Warnock and others 2002). Ruddy Ducks are the next most abundant duck wintering on South Bay salt ponds (primarily on low-salinity ponds), with up to 19,000 recorded on these ponds (Accurso 1992). In contrast to shorebirds, the vast majority of which use salt ponds primarily at high tide, duck numbers on South Bay salt ponds are similar at high and low tides (Warnock and others 2002).

Stralberg and others (2003) found that dabbling duck species richness in the South Bay tended to be higher in marshes than in salt ponds, and that dabbling ducks were more abundant in marshes at low tide, while diving ducks were more abundant at high tide. Dabbling ducks reached peak densities in salt ponds in fall and early winter, while diving ducks peaked in early spring. Dabbling duck densities tended to be higher in salt ponds with more natural upland, less tidal marsh, and less development surrounding the pond, while diving ducks tended to be higher in ponds closer to the Bay. Ninety percent of the dabbling ducks recorded during this study were recorded in just six of 22 ponds, while 90% of the diving ducks were recorded in nine ponds, indicating that the majority of ponds support few ducks.

Diving ducks, and many dabbling ducks, often roost while swimming in the open waters of the Bay, on sloughs, and in salt ponds. Dabbling ducks, and diving ducks to a lesser extent, also roost on the edges of mudflats and marshes, on islands and levees within ponds, and on mud and shallow water within the bottoms of salt ponds.

Large waders and other piscivores. This category includes a diverse group of approximately 20 species of piscivorous (*i.e*., fish-eating) waterbirds that occur in the South Bay, including Pied-billed Grebes (*Podilymbus podiceps*), Western Grebes (*Aechmophorus occidentalis*), Clark's Grebes (*Aechmophorus clarkii*), loons (which are uncommon to rare visitors), Double-crested Cormorants, American White Pelicans, Brown Pelicans (*Pelecanus occidentalis*), and large waders (*i.e*., herons, egrets, and ibis). Several other species, including gulls, terns, mergansers, and Belted Kingfishers (*Ceryle alcyon*) also forage for fish in the SBSP project area but are treated in other categories.

While a number of piscivores breed in the South Bay, numbers of most of these species are highest during the nonbreeding season. Western and Clark's Grebes do not nest in the baylands of the South Bay but may occur in the area, particularly on salt ponds and in the open Bay, year-round (being most abundant in winter). Brown Pelicans typically occur in San Francisco Bay as post-breeding dispersants during summer and fall (Ainley 2000a). American White Pelicans are most abundant from June through December.

Breeding. Several piscivorous species in this category nest in the South Bay. Pied-billed Grebes nest in freshwater wetlands, building floating nests of vegetation, in scattered areas surrounding the salt ponds and tidal wetlands in the project area. Double-crested Cormorants nest on electrical transmission towers at several locations in the project area, and on the levee between Ponds A9 and A10 in Alviso (see Figure 14); this species and the White-faced Ibis (*Plegadis chihi*) are discussed in greater detail in the Special-Status Wildlife Species section below (Section 5.5).

Herons and egrets nest in the SBSP project area as well (Figure 13). Historically, the largest heronry in the South Bay was at Bair Island. Here, Great Blue Herons were noted nesting as early as 1902 (Carriger and Pemberton 1908), and up to 49 pairs of Great Blue Herons (*Ardea herodias*), 75 pairs of Great Egrets (*Ardea alba*), 1,000 pairs of Snowy Egrets, and 684 pairs of Black-crowned Night-Herons nested in coyote brush, on transmission towers, and on the ground until 1991, when this site was abandoned following red fox predation (Harvey and others 1992; Ryan and Parkin 1998a).

Another sizeable colony of waders was detected at Mallard Slough in Alviso in the mid 1970s (Harvey and others 1992). This colony steadily increased in size, peaking at over 800 nests, through the 1990s. Ten nesting pairs of Great Egrets were discovered in 1977, increasing to 30 pairs in 1990, when an estimated 266 pairs of Snowy Egrets and 115 pairs of Black-crowned Night-Herons were present. Up to nine pairs of Cattle Egrets (*Bubulcus ibis*) and one or more pairs of Little Blue Herons (*Egretta caerulea*) and White-faced Ibis also nested in the Mallard Slough colony in the early 1990s. However, this colony was abandoned for unknown reasons in 1999. That year, a small colony of Great Egrets, containing up to 30 adults and eight nests, became established nearby along lower Coyote Creek near the Reach 1A waterbird pond. Twelve Great Egret nests were found here in 2000, and seven pairs of Great Blue Herons nested at this location in 2001 (Santa Clara County Bird Data Unpublished). However, this colony has since been abandoned.

Since 1998, small heron rookies have appeared on islands in inland reservoirs in the South Bay (*e.g*., Lake Cunningham, Almaden Lake, and Vasona Reservoir), and several other small colonies have appeared in the immediate SBSP project area. Currently, heron rookeries in the vicinity of the Alviso Complex in the South Bay include a colony of Snowy Egrets and Black-crowned Night-Herons at the Palo Alto Baylands duck pond; small numbers of Great Blue Herons nesting on transmission towers in Ponds A2W, A2E, A3N, and A19 (and on a duck blind in Pond A2E); Great Egrets, Snowy Egrets, and Black-crowned Night-Herons nesting in California bulrush at the west end of the Coyote Creek Lagoon near Newby Island (first noted in 2000); and Great Egrets, Snowy Egrets, Black-crowned Night-Herons, and Little Blue Herons in Guadalupe Slough between ponds A4 and A5 (Santa Clara County Bird Data Unpublished; Strong 2004a). Heronries in the Eden Landing vicinity include Black-crowned Night-Herons and Great Blue Herons on telephone poles and old wooden structures in Ponds E13/E14, and Great Blue Herons nesting on an old clubhouse in Pond E6B. In the northwest portion of the South Bay, between the Ravenswood Complex and the San Mateo Bridge, a small colony of Snowy Egrets (up to 100 nests), Black-crowned Night-Herons (up to 50 nests), and Great Egrets (up to 13 nests) has existed in trees around the South Bayside System Authority Wastewater Treatment Works in Redwood City since 1992, and a small colony of the same species became re-established on outer Bair Island in 2004; Great Blue Herons are nesting on transmission towers near Redwood Creek on outer Bair Island (Ryan and Parkin 1998a; Strong 2004a). Green Herons (*Butorides virescens*) nest at low densities in scattered locations throughout the South Bay, including mixed-species heronries but also as isolated pairs or in small monospecific groups on duck blinds, along sloughs, and in trees and brush.

<u>*Foraging and Roosting*</u>. The piscivorous birds of the South Bay forage in a variety of habitats and locations where prey fish are available. The low-salinity salt ponds that support fish, tidal sloughs and channels, edges of intertidal mudflats, nontidal ponds and channels, and artificial lakes such as Shoreline Lake provide the highest-quality foraging areas, and large “frenzies” of feeding activity may be observed at these locations, presumably when conditions result in large fish concentrations. Brown Pelicans usually plunge-dive for fish and therefore require water several feet deep, but American White Pelicans and cormorants swim while feeding and can thus feed in shallower water. Although Double-crested Cormorants, Western and Clark’s Grebes, and Brown Pelicans forage to varying degrees within the open waters of the Bay, American White Pelicans apparently do not, instead preferring nontidal waterbodies (Cogswell 2000:Harvey, 1988 #150; Harvey and others 1988). Large wading birds are constrained by

water depth, and are usually seen foraging from the edges of a body of water or wading within the shallows. Pied-billed Grebes and most of the herons and egrets often forage along freshwater streams and in smaller ponds in the South Bay, and Great Blue Herons and Great Egrets occasionally forage for small mammals in upland fields and ruderal areas.

The larger piscivores move around the South Bay in search of suitable foraging conditions, allowing them to exploit particularly large concentrations of fish. Cormorants and pelicans exhibit movements between foraging areas at inland reservoirs and the South Bay, although most foraging likely occurs within the baylands habitats (Steve Rottenborn, pers. obs.). Piscivore density tends to be lower in salt ponds at low tide than at high tide, as some birds move to intertidal flats to forage (*e.g*., herons and egrets) or roost (*e.g*., pelicans) at low tide (Stralberg and others 2003).

Within salt ponds, the fish commonly taken by piscivores include the mudsucker, topsmelt, sculpin, and stickleback (Cogswell 2000; Harvey and others 1988). These fish are usually found in water having salt concentrations up to 70-80 ppt, and most cannot tolerate salinity >40 ppt (Carpelan 1957; Lonzarich 1989). As a result, most piscivore use of salt ponds is concentrated in ponds with lower salinities (Anderson 1970; Swarth and others 1982).

Swarth and others (1982) reported that loons and Western and Clark's Grebes were much more abundant on the Bay than in the salt ponds west of the Coyote Hills (Swarth and others 1982), noting that piscivorous species were more common in the Alviso ponds than in the Coyote Hills ponds. Approximately 94% of the pelicans and Double-crested Cormorants recorded by Swarth and others (1982) were in low-salinity ponds, though most of the cormorants used these ponds only for roosting (primarily on wooden pilings and platforms within the ponds). Although cormorants may take advantage of local concentrations of fish within salt ponds, most apparently feed in the Bay (Ainley 2000b; Anderson 1970). Herons and egrets forage primarily in sloughs and marshes, with only some birds moving to salt ponds at high tide (Anderson 1970; Swarth and others 1982). However, where temporary concentrations of fish were present (generally in low-salinity ponds in fall), these waders occurred in large concentrations. Takekawa and others (2001) reported that piscivores were more abundant in natural baylands than in salt ponds in the North Bay during all seasons, while Stralberg and others (2003) determined that the species richness of large waders tended to be higher in the tidal salt marsh than in salt ponds, although piscivore abundance was higher in salt ponds.

Aerial surveys of the South Bay salt ponds have recorded counts of up to 3,147 (on 6 August 1984) American White Pelicans using these ponds (Harvey and others 1992). These surveys only found white pelicans using ponds with salinities between 25 and 90 ppt, with the highest densities in ponds with low salinities (25-30 ppt). Harvey and others (1992) suggested that the conversion of tidal marsh to salt ponds has benefited white pelicans, and that populations of nonbreeders in the Bay have increased as a result of the provision of sheltered foraging areas that concentrate fish and undisturbed levees for roosting.

Surveys of the South Bay salt ponds by USGS (U.S. Geological Survey Unpublished Preliminary Data) indicate that species richness of piscivores is more or less constant throughout the year, though abundance is highest in late summer and fall due to the presence of high numbers of herons, egrets, and American

White Pelicans foraging in salt ponds at this time (Appendix B). Within the Alviso Pond Complex, piscivore abundance is highest in Ponds A1, A2W, A3W, A5, A7, A9, A10, and AB2 and very low in Pond B6 (which contains little water) and the high-salinity ponds A19-A23. At Eden Landing, Ponds E1, E2, E4, E7, and E10 support large numbers of piscivores, with a number of high-salinity and/or drier ponds supporting low abundance. In the Ravenswood Complex, R1 supports large numbers of piscivores, but few individuals occur in the high-salinity conditions of the other ponds.

Grebes and loons roost entirely on the water, and other swimming piscivores (e.g., pelicans and cormorants) may form floating roosts as well. However, most roosting by pelicans and cormorants occurs on salt pond levees (particularly interior levees between ponds), islands, and artificial structures such as boardwalks. Cormorants often roost in flocks on transmission towers as well. Herons and egrets roost on salt pond levees and in dense marsh vegetation along tidal sloughs.

Larids. Although larids (i.e., birds in the family Laridae, such as gulls, terns, and skimmers) have always used the South Bay for foraging during winter and migration, the use of this area has undoubtedly increased as a result of salt pond creation and, for gulls, the provision of food at landfills, and several species have begun nesting in the South Bay over the last century as a result. Currently, larid populations in the Bay are highest in winter due to the presence of tens of thousands of (if not 100,000+) wintering gulls. However, terns are generally more abundant in the South Bay during the breeding season. Information on special-status larids in the South Bay, including the California Gull, California Least Tern, and Black Skimmer, can be found in the Special-Status Wildlife Species section below (Section 5.5).

Breeding. In the early 1900s, the Caspian Tern was the only larid known to nest in the San Francisco Bay area, with a colony of more than 100 pairs nests present as early as 1916 in marshes near the east end of the Dumbarton Bridge (Grinnell and Miller 1944; Grinnell and Wythe 1927). This colony was reported to occur on a dike between salt ponds as of 1952 (Sibley 1952). As this colony grew to a size of 200 pairs, it split into two colonies in the Newark/Eden Landing area, and a third colony became established on salt pond levees near Mowry Slough in the late 1960s. By 1981, a colony of 1,000 pairs was present on Bair Island as well, with approximately 2,350 nesting birds present in the South Bay (Rigney and Rigney 1981). However, predation and disturbance by red foxes caused the abandonment of both the Mowry and Bair Island colonies in 1990 and 1991. Subsequently, Caspian Terns nested in small numbers at Bair Island in 1993 and 1994 (Harding and others 1998). Since 1990, breeding within the SBSP study area has also occurred in Pond A7 (breeding 1997-2004, peaking at 195 individuals in 2001 but with only 41 in 2004); Ponds A9/A10 (70 individuals present in 1992 only); Pond E10 (1998-2004, peaking at 158 birds in 1999 but with only 46 in 2004); Ponds 1A/2A south of the Alameda Flood Control Channel (up to 60 from 1993 to 2000); and Pond R1, where 2-4 individuals have nested 1997-2004 (Figure 13) (Strong 2004a). All nesting in the South Bay currently occurs on isolated portions of levees and islands with little or no vegetation within salt ponds. Although South Bay populations have declined precipitously since the early 1980s, the establishment of a large colony on Brooks Island in the North Bay has allowed Bay-area populations to remain fairly constant, with approximately 2,300 individuals breeding in the Bay area in 2003 (Strong 2004a).

Forster's Terns were not reported to be nesting in the San Francisco Bay area as of 1944 (Grinnell and Miller 1944), but a colony containing approximately 100 nests was discovered near the east end of the San Mateo Bridge in 1948 (Sibley 1952). Another colony was detected near the east end of the Dumbarton Bridge in 1952, and since then, Forster's Tern colonies have appeared at scattered locations throughout the South Bay, with populations peaking at 4,386 birds in 1992. However, local populations of Forster's Terns have declined significantly since 1984, and a 2003 estimate of the Bay-wide population stands at 2,450 individuals (Strong 2004a). In 2003, the 1,958 Forster's Terns thought to be nesting in the South Bay represented 80% of the total San Francisco Bay population, and represented nearly 25% of the Pacific Coast population and 10% of the North American population estimated in 2001 (McNicholl and others 2001; Strong and others 2004a).

Since 1990, Forster's Tern colonies have been recorded in the SBSP project area at the following locations (Figure 13): Charleston Slough and the Palo Alto Flood Control Basin; Alviso Ponds A1, A5, A6, A7, A8, A9/A10, A16, A17, A18, and B2; Eden Landing Ponds E6B, E8A, E9, E10, E11, and E13/14; Ravenswood Ponds R1 and R2; Coyote Hills Pond 2A; Dumbarton Ponds N1 and N3; Mowry Ponds M4/5; and outer Bair Island (Strong 2004a). These colonies are located on small islands having little or no vegetation (and no tall vegetation) within salt ponds, tidal flats (at Charleston Slough), and managed marsh (Palo Alto Flood Control Basin), with small numbers on duck blinds.

Predation by red foxes, and by avian predators such as California Gulls and Common Ravens, may be impacting tern populations to some extent. In addition, encroachment on Forster's Tern nesting sites by an ever-increasing California Gull breeding population in the South Bay has taken its toll on nesting terns; for example, islands in Alviso Pond AB2 that were formerly used by nesting Forster's Terns have been largely, or entirely, taken over by nesting gulls (Strong 2004a). Because nesting on islands is so important to Forster's Terns and Black Skimmers (and secondarily to the other breeding larids in the South Bay) to deter mammalian predation, population sizes may be limited by available breeding sites.

Least Terns, Black Skimmers, and California Gulls are also recent additions to the breeding avifauna of the South Bay; these species are discussed in detail in the Special-Status Wildlife Species section below (Section 5.5). Western Gulls (*Larus occidentalis*) nest in very low numbers in the South Bay Salt Ponds project area, with 1-3 pairs nesting in Pond A6 and on the levee between Mowry Ponds M4 and M5, both within large California Gull colonies (Strong 2004a). The Western Gull breeds much more commonly near the mouth of the Bay and along the coast.

<u>*Foraging and Roosting*</u>. Terns and skimmers in the South Bay, which include the aforementioned species but also post-breeding Elegant Terns (*Sterna elegans*) and occasionally Common Terns (*Sterna hirundo*), feed primarily on small fish. Foraging occurs commonly within the open waters of the Bay and in low-salinity salt ponds, as well as tidal sloughs and freshwater and brackish channels and ponds. Caspian and Forster's Terns often forage at inland ponds and lakes as well, even during the breeding season. Terns may roost on intertidal mudflats at low tide, whereas at high tide and at night they roost primarily on isolated levees, islands, and exposed mud surrounded by water within shallow ponds.

During the nonbreeding season, nesting populations of Western and California Gulls within the South Bay are augmented not only by nonbreeders of those species (likely including 10,000+ more California Gulls and hundreds to 1,000+ Western Gulls), but also by large numbers of Herring (tens of thousands), Thayer's (*L. thayeri*; thousands), Ring-billed (*L. delawarensis*; thousands to 10,000+), Mew (*L. canus*; thousands), Glaucous-winged (*L. glaucescens*; hundreds to 1,000+), and Bonaparte's (thousands) Gulls. With the exception of the Bonaparte's Gull, which forages primarily on invertebrates in salt ponds and sewage treatment plants, these gulls are opportunistic foragers. They eat a wide variety of animal matter, including invertebrates, fish, small mammals and birds, and carrion, as well as processed food in landfills. Many gulls forage or roost on intertidal mudflats at low tide (Warnock and others 2002).

The Newby Island landfill north of Coyote Creek near Alviso and the Tri-Cities Recycling and Disposal Facility located in Fremont provide food for tens of thousands of wintering gulls, and are likely primarily responsible for the large wintering (and possibly breeding) populations of gulls in the South Bay. Gull abundance is much higher at the far south end of the Bay, in the vicinity of these landfills, than elsewhere in the project area, and particularly large concentrations of roosting birds occur in the Alviso and Fremont salt ponds. For example, the location of Ponds A22 and A23 between these two large landfills makes them a particularly attractive roosting location for gulls in winter. California Gulls forage extensively at landfills in the South Bay, but they (and Mew Gulls to some extent) also forage in large numbers on brine flies and other invertebrates within mid- and high-salinity salt ponds, like the Bonaparte's Gull (Steve Rottenborn, pers. obs.). Up to 10,000 Bonaparte's Gulls forage in the South Bay, primarily on brine shrimp and brine flies in salt ponds having salinities of 90-200 ppt (Harvey and others 1992). The recent surveys of South Bay salt ponds by USGS (U.S. Geological Survey Unpublished Preliminary Data) found Bonaparte's Gull abundance highest on Alviso Pond A8 and Eden Landing Pond E14 (Appendix B).

Most of the gulls in the greater South Bay area roost on the Bay or salt ponds/levees at night and large numbers roost in these areas during the day as well. Thousands of gulls disperse inland from the Bay area during the day to forage at inland landfills, on agricultural fields and seasonal wetlands, on athletic fields, and in urban areas, particularly in winter.

Carpelan (1957) indicated that Forster's Terns are the main predator on topsmelt in South Bay salt ponds, and Anderson (1970) also suggested that the topsmelt was likely the main prey item of Forster's Terns in the South Bay. A study of the diet of breeding Forster's Terns in the South Bay in 1972 (Anonymous Unpublished) found that their diet consisted primarily of fish; many were caught in the Bay, but a large percentage was caught in lower-salinity salt ponds as well. Fish most frequently taken at these ponds included small (<6 cm) Pacific herring (which were often fed to chicks), topsmelt, and anchovies. Observations of adults with prey at four Forster's Tern colonies in the South Bay indicated that threespine stickleback outnumbered all other fish combined by an order of magnitude, with "several thousand" sticklebacks observed as prey. The next five most abundant fish brought to colonies were northern anchovy (90 individuals), topsmelt (82), staghorn sculpin (64), shiner surfperch (50) and dwarf surfperch (*Micometrus minimus*, 45). Ten other fish species, all represented by 27 individuals or fewer, were also used as prey, as well as four individuals of two genera of bay shrimp. Swarth and others (1982) found that most of the Forster's Terns nesting in the Coyote Hills salt ponds foraged in the Bay rather than in the salt ponds during the nesting season.

Gill (1976) recorded 21 species of fish found at the Mowry colony of Caspian Terns during the 1971 breeding season. The eight species comprising more than 2% of the total number of fish recorded were jacksmelt (33%), shiner perch (16%), staghorn sculpin (16%), longjaw mudsucker (9%), Oriental goby (5%), northern anchovy (6%), rainbow trout (4%), and topsmelt (3%). While the vast majority of fish recorded at this colony were estuarine species, seven species were primarily freshwater fish. The observation of Caspian Terns with tagged trout that had been released at Del Valle Reservoir, 25 miles away from the Mowry tern colony, exemplifies this terns' propensity for foraging widely during the breeding season.

Other Waterbirds (Eared Grebes, coots, and rails). The Eared Grebe and South Bay members of the family Rallidae, which includes the American Coot (*Fulica americana*), Common Moorhen (*Gallinula chloropus*), and several species of rails, are combined into a separate group for the purposes of this existing conditions report.

The Eared Grebe is a small diving bird that breeds only occasionally and in small numbers in the South Bay, occurring much more abundantly as a nonbreeding forager from October to April. Eared Grebes nest in California on freshwater wetlands in the Central Valley and Great Basin regions fairly commonly, but in the South Bay, breeding has occurred only in a flooded, diked pickleweed marsh in the Moffett Field/Crittenden Marsh area, where nesting occurred in 1983, 1986, 1993, and 1995 (Cogswell 2000; Santa Clara County Bird Data Unpublished).

Nonbreeding Eared Grebes in the South Bay are closely tied to deeper, higher-salinity salt ponds, where they feed on brine shrimp, brine flies, and reticulate water boatmen (Anderson 1970). Censuses of Eared Grebes on South Bay salt ponds have exceeded 40,000 individuals (Harvey and others 1992), and Cogswell (2000) suggested that the total Bay Area wintering/migrant population could be as high as 50,000 to 100,000 birds. The recent surveys of South Bay salt ponds by USGS (U.S. Geological Survey Unpublished Preliminary Data) found Eared Grebe abundance highest on Alviso Ponds A8 and A11-A17, Eden Landing Ponds E5, E6, E8, and E9, and Ravenswood Pond A4 (Appendix B).

American Coots and, in much lower abundance, Common Moorhens breed in freshwater wetlands, channels, and ponds in and around emergent vegetation in a number of locations throughout the South Bay. These birds are omnivorous, eating a wide variety of plant and animal (particularly invertebrate) material. Coot populations are augmented substantially during winter, when this species occurs by the hundreds or low thousands on lower-salinity salt ponds (Anderson 1970), sewage treatment plant ponds, and other open-water locations.

The status of the California Clapper Rail and California Black Rail in the South Bay is described in detail in the Special-Status Wildlife Species section below (Section 5.5). Two other rails occur regularly in the South Bay. Both the Sora (*Porzana carolina*) and Virginia Rail (*Rallus limicola*) may breed in very small numbers in freshwater wetlands around the South Bay, although they occur much more commonly as nonbreeders from August to May. During the nonbreeding season, these secretive species occur in a wide variety of tidal and nontidal salt, brackish, and freshwater marsh habitats, being most abundant in freshwater and brackish areas. Here, these species forage primarily on invertebrates. Significant depredation of these rails by egrets and herons has been observed during exceptionally high tides in winter, particularly in areas where high tide refugia (such as upland transitional zones in the high marsh or along tidal channels) are lacking.

Landbirds. Numerous landbird species use the upland and riparian habitats immediately surrounding the baylands, but this section focuses on the passerines and raptors using the tidal marsh, salt ponds, and associated habitats. Only a few passerines breed at all commonly in tidal salt, brackish, and freshwater marsh in the South Bay. Within most tidal salt marsh, the only nesting passerines are the Alameda Song Sparrow and Marsh Wren (in the lower marsh dominated by cordgrass and gumplant) and the Savannah Sparrow, which nests in pickleweed and peripheral halophytes in the upper portions of tidal and diked saltmarsh, along vegetated levees, and in adjacent upland transitional zones. South Bay population estimates for these species in 1971 by Gill (1977) included 1,000-1,200 pairs of Marsh Wrens (in cordgrass, but more abundantly in freshwater marshes, especially at Coyote Hills, Alviso and Guadalupe Sloughs, Coyote Creek and Mud Slough, and the Palo Alto Flood Control Basin), 800-1,000 pairs of Savannah Sparrows, and 1,800 pairs of Alameda Song Sparrows. The Saltmarsh Common Yellowthroat may also nest in South Bay salt marshes in small numbers (Ray 1919; Steve Rottenborn, pers. obs.), although it nests primarily in brackish and freshwater marsh; this species, and the Alameda Song Sparrow, are discussed in detail in the Special-Status Wildlife Species section below (Section 5.5). Northern Harriers, and formerly (or rarely) the Short-eared Owl (*Asio flammeus*), also nest within tidal salt marshes in broad vegetated marsh plains; these species are also discussed in the Special-Status Wildlife Species section (Section 5.5).

In addition, the Red-winged Blackbird nests in freshwater marsh in the study area, and scattered small trees and shrubs along salt pond levees and upland edges provide nesting sites for White-tailed Kites, Loggerhead Shrikes, California Towhees, and other species in limited numbers. Barn and Cliff Swallows breeding on artificial structures within and adjacent to the baylands forage commonly for flying insects over marshes and salt ponds in the South Bay.

Transmission towers within the marshes and salt ponds in the South Bay provide nesting sites for Red-tailed Hawks and Common Ravens. Both species may prey on small mammals, rails, waterfowl, and shorebirds in the South Bay, and Common Ravens are particularly notorious predators of eggs and young of a variety of birds. Populations of ravens and American Crows have increased markedly in recent decades throughout the Bay area, feeding heavily at the landfills around the South Bay but also preying on other wildlife species. Few data are available on the impact of ravens and crows on breeding populations of other species, but it is likely that ravens nesting on towers within tidal marshes and salt ponds have at least some impact on populations of California Clapper Rails, Snowy Plovers, and other breeding bird species.

During the nonbreeding season, additional landbirds occur in the baylands, including large numbers of sparrows of several species and several raptors. Short-eared Owls occur regularly in small numbers in the more extensive marshes in winter, foraging on small mammals and birds, and Merlins (*Falco columbarius*), Peregrine Falcons (*Falco peregrinus*), and other raptors forage for waterfowl and shorebirds throughout the South Bay.

4.4 Specific Wildlife Resources

The previous sections, and the Special-Status Wildlife Species section below, summarize the known wildlife use of the South Bay based on previous and, in some cases, ongoing studies. The vast majority of this information is based on data collected prior to ISP implementation since the ISP has been only recently implemented in some salt ponds (and the effects of this implementation on wildlife use have not yet been fully identified) and has not yet been implemented in other ponds. Ongoing studies by USGS and others will help to refine the response of wildlife to implementation of the ISP. In the meantime, wildlife use under ISP conditions can be qualitatively predicted based on the expected ISP management.

Although the purpose of the ISP is to maintain salinities within allowable ranges for discharge into the Bay, the ISP conditions are somewhat flexible (Life Science 2003; Life Science 2004). The ISP allows, and in some cases the mitigation measures specified by the EIR for the ISP require, active pond management for birds, and both the CDFG and USFWS are exploring options for management for certain wildlife species while upholding the salinity requirements of the ISP (Wilcox, pers. comm; Morris, pers. comm.). Adaptive management strategies for the ISP include system-specific alternatives to allow management flexibility. For example, Ponds A2E, A3N, A8, E4, E4C, E5C, E6C, E7, E12, E13, and E14 are proposed to be managed as system and/or seasonal ponds, but could be managed as high-salinity batch ponds. Therefore, for these ponds, bird use under the ISP may vary not only depending on natural variability in pond conditions due to rainfall or drought, but also due to variability in pond management in response to ongoing monitoring.

As noted previously, this existing conditions document is intended to describe the conditions present upon full ISP implementation. Implementation of ISP management has not begun at some ponds (*e.g.*, it is not expected to occur in the Ravenswood Complex for several years, and ISP conditions have not yet been implemented in Alviso Ponds A-19 through A-23); in other ponds, ISP implementation has been too recent (and monitoring not sufficiently intensive) to allow a robust comparison of pre- and post-ISP wildlife use. Some obvious changes in wildlife use have been noted due to changes in water depth and salinity on a pond-by-pond basis (*e.g.*, increased shorebird use of ponds during water drawdown that were formerly deeper) (H. T. Harvey & Associates Unpublished). Continued monitoring of bird use of the salt ponds by USGS, PRBO, SFBBO and others will provide some information on changes in wildlife use due to implementation of the ISP, but data are not yet available to document whether any large-scale changes in wildlife use of the salt ponds, or of the South Bay as a whole, have occurred.

The changes in water depth, salinity, and water management from pre-ISP to ISP conditions are summarized in Appendix A (Life Science 2003), with modifications provided by John Krause of CDFG (pers. comm.). In general, the ISP will result in an increase in the number of low-salinity ponds (<60 ppt) from 22 to 44, and the number of intake ponds will increase from four to 16. Under the ISP, the number of medium-salinity (60-180 ppt) and high salinity (>180 ppt) ponds will be reduced from 24 ponds to three (Alviso ponds A12, A13, and A15), a decrease in acreage of 85% (5,702 ac to 827 ac), although ponds E5 and E6 will be managed as batch ponds to have high salinities in summer and fall (John Krause, pers. comm.). Within the entire South Bay region, the ISP implementation will result in a reduction in the extent of medium/high-salinity ponds from 10,402 ac to 5,527 ac (a 47% decrease). Overall, these changes in salinity and in the number of intake ponds will result in a greatly increased area of ponds capable of supporting fish and macroscopic vegetation, and thus suitable foraging habitat for piscivorous birds and dabbling ducks. Conversely, a reduction in medium and high-salinity ponds may result in a reduction in prey densities for species that forage primarily on the superabundant brine shrimp, brine flies, and reticulate water boatmen in higher-salinity ponds (*e.g.*, Eared Grebes, phalaropes, and Black-necked Stilts). The Western Sandpiper, Least Sandpiper, and Dunlin were found by Stralberg and others (2003) to favor higher-salinity ponds when they occurred in salt ponds (*i.e.*, mostly at high tide). However, a potential decrease in foraging habitat quality within salt ponds under ISP management may be countered by the increase in shallow, low-salinity ponds and seasonal ponds, as these species also take advantage of suitable foraging conditions (*i.e.*, moist sediment or shallow water with abundant invertebrate prey) in low-salinity ponds. Furthermore, these species' primary foraging areas are intertidal mudflats. Thus, the effects of ISP implementation on these species are more difficult to predict. According to the EIR for the ISP, if the results of monthly high-tide bird surveys conducted by USGS or annual spring "window" surveys show significant declines in species associated with higher-salinity ponds, more ponds will be managed as medium or high-salinity batch ponds in an attempt to maintain populations of these species.

Under the ISP, the area of seasonal ponds will increase from 715 to 3,663 ac. Thus, substantially more area will dry out during the summer and early fall than was the case prior to ISP implementation. This change will increase breeding habitat for Snowy Plover. In addition, shallower water levels in spring (as these seasonal ponds are drawing down through evaporation) will likely result in increased availability of foraging habitat for small shorebirds that cannot forage in deeper water (Isola and others 2000), and for dabbling ducks as well. Such ponds may be flooded by baywater (rather than relying on precipitation) in late summer and early fall to provide habitat for fall migrant waterbirds (Wilcox, pers. comm.).

The following three sections highlight the most outstanding wildlife resources and issues associated with each of the three SBSP pond complexes, summarizing the information from the previous and following sections specifically for these pond complexes and their immediate vicinities. Refer to Figures 9 to 14 for the locations of many of the resources discussed below.

4.4.1 Alviso Complex

The most prominent wildlife resources and patterns of wildlife distribution in the Alviso Pond complex and vicinity are as follows:

- Mixed heronries are currently located along Guadalupe Slough and at the west end of the Coyote Creek Lagoon near Newby Island, and small numbers of Great Blue Herons nest on transmission towers in or adjacent to several salt ponds in this complex.
- Breeding concentrations of Black-necked Stilts and American Avocets occur in New Chicago Marsh, in the vicinity of Pond A22, and in the Palo Alto Flood Control Basin, with additional concentrations of avocets at the Warm Springs Marsh and Reach 1A waterbird pond, and of stilts in the San Jose-Santa Clara WPCP. Breeding numbers may increase in the salt ponds as the ISP

is implemented on a broader scale due to drawdown of water in seasonal ponds (possibly increasing the extent of terrestrial breeding locations).

- Moderate numbers of Snowy Plovers breed in Ponds A22 and A23. Snowy Plovers have bred in the past in other ponds in this complex, particularly A8 and A6, although they have not nested in Santa Clara County in several years.
- Large numbers of shorebirds forage on intertidal mudflats ringing the South Bay south of the Dumbarton Bridge during low tide.
- Large numbers of shorebirds roost, and forage to varying degrees, in Ponds A5 and A7, with high numbers also present in Ponds A3N, A6, A9, A14, and A8, and in Crittenden Marsh, at times.
- Several California Gull colonies, including the state's second largest colony in Pond A6, are present.
- Double-crested Cormorants nest on transmission towers in Pond A2W, in the AB1/AB2/A3N area, and in Pond A18, and on the levee between A9 and A10.
- Forster's Terns nest on small islands in a number of locations (primarily in salt ponds), and Black Skimmers nest in the Palo Alto Flood Control Basin and Ponds A1, AB1, AB2, A8, and A16. Caspian Terns nest, or have recently nested, in Pond A7, on the levee between Ponds A9 and A10, and (just outside the complex) on the levee between Mowry Ponds M4 and M5.
- The main post-breeding staging area for Least Terns is located in the Alviso Complex, primarily in the ponds north of Moffett Field but with birds regularly using a number of other ponds in the Alviso Complex for foraging and roosting. Least Terns forage over the Bay off the Alviso salt ponds as well.
- Salt marsh harvest mouse habitat in the Alviso Complex is limited, as most of the marshes are brackish water marshes, areas little used by the mouse, and the salt marsh that does exist has little to no high marsh or escape cover.
- A small population of western pond turtles is present along the northern edge of Moffett Field and the Sunnyvale WPCP.
- Steelhead occur in Stevens Creek, the Guadalupe River, and Coyote Creek.
- Chinook salmon occur in the Guadalupe River and Coyote Creek.
- Clapper Rails occur in a number of locations, although high-quality habitat is limited. The highest numbers are likely in the more extensive marshes tidal salt marshes along Coyote Creek and near Palo Alto, although this species is also present in brackish marshes in the Warm Springs area, along Guadalupe Slough and Alviso Slough, and in smaller marsh remnants along sloughs and the Bay edge.
- Ponds A1, A2E, A2W, A5, A7, A9, and AB2 support high numbers of dabbling ducks, whereas Ponds A1, A2W, A9, and A10 support large numbers of diving ducks.
- Tens of thousands of gulls roost in the Alviso salt ponds and levees, with many foraging at landfills near Milpitas and in Fremont.
- Within the Alviso Pond Complex, piscivorous bird abundance is highest in Ponds A1, A2W, A3W, A5, A7, A9, A10, and AB2.
- Ponds A19, A20, and A21 will be restored to tidal action under the ISP. These ponds will thus initially provide intertidal foraging habitat for shorebirds and other waterbirds at low tide, and tidal foraging habitat for waterfowl at high tide. As sediment accumulates (and the gypsum layer

is buried and/or deteriorates), tidal marsh vegetation will become established, providing breeding and foraging habitat for the California Clapper Rail and other marsh species.

4.4.2 Ravenswood Complex

The most prominent wildlife resources and patterns of wildlife distribution in the Ravenswood Pond complex and vicinity are as follows:

- Moderately large numbers of Snowy Plovers breed and winter in salt ponds throughout the Ravenswood Complex.
- Large numbers of shorebirds forage on mudflats north and east of the Ravenswood Complex at low tide.
- Large numbers of shorebirds roost, and forage to varying degrees, in Ponds R1, R2, and SF2.
- Black Skimmers, Forster's Terns, and Caspian Terns nest on islands in Pond R1.
- Pond R1 is regularly used as a foraging and roosting area by Least Terns during the post-breeding period in late summer. These terns often forage on the Bay off this pond.
- Clapper Rails occur along Ravenswood Slough, but otherwise Clapper Rail habitat is very limited in this complex, being much more extensive on Greco Island to the northwest.
- Salt marsh harvest mouse habitat is very limited in extent and quality (*i.e.*, the tidal marshes are very narrow and have little to no escape cover). Even in more expansive tidal marsh areas nearby, such as at Greco Island, the extent of high marsh habitat and upland transition zones (for refugia during the highest spring tides) is limited enough to constrain habitat quality for the salt marsh harvest mouse.
- In the Ravenswood Complex, R1 supports large numbers of piscivorous birds.

4.4.3 Eden Landing Complex

The most prominent wildlife resources and patterns of wildlife distribution in the Eden Landing Pond complex and vicinity are as follows:

- Black-crowned Night-Herons and Great Blue Herons nest on telephone poles and old wooden structures in Ponds E13/E14, and Great Blue Herons nesting on an old clubhouse in Pond E6B.
- Breeding concentrations of Black-necked Stilts and American Avocets occur in a number of ponds.
- The largest concentration of breeding and wintering Snowy Plovers in the San Francisco Bay area is located in the salt ponds north of Old Alameda Creek within the Eden Landing Complex.
- Large numbers of shorebirds forage on mudflats west of the Eden Landing Complex at low tide.
- Large numbers of shorebirds roost, and forage to varying degrees, in a number of ponds north of Old Alameda Creek, primarily at high tide.
- Steelhead and Chinook salmon occur in the Alameda Creek Flood Control Channel.
- Clapper Rails occur in Whale's Tail Marsh, and along Old Alameda Creek and the Alameda Creek Flood Control Channel.

- Forster's Terns nest, primarily on islands within salt ponds, in a number of ponds in the Eden Landing Complex, and Caspian Terns breed in Ponds E10 and (in Cargill ponds just south of the Eden Landing complex) on the levee between Ponds N1A and N2A. Black Skimmers have nested on Ponds E10 and E4C, and just south of the Eden Landing Complex in Pond N2A.
- Ponds E1, E2, E10, and E11 are regularly used as foraging and roosting areas by Least Terns during the post-breeding period in late summer, and Least Terns forage over the Bay nearby (sometimes immediately outboard of the salt pond levees).
- Salt marsh harvest mouse habitat in the Eden Landing Complex is limited, being most extensive along Whale's Tail Marsh, Old Alameda Creek, and the Alameda Creek Flood Control Channel, and in several areas on the landward side of this complex; smaller habitat units are present in remnant marshes elsewhere in this complex.
- Ponds in the Eden Landing Complex supporting large numbers of dabblers include Ponds E3C, E4C, and E10, whereas Ponds E1, E2, E4, E7, E9, E10, and E14 support the greatest abundance of diving ducks.
- Ponds E1, E2, E4, E7, and E10 support large numbers of piscivorous birds.

4.5 SPECIAL-STATUS WILDLIFE SPECIES

4.5.1 Special-Status Wildlife Species

Special-status animal species that occur in South Bay salt ponds and adjacent habitats are described below. The legal status and likelihood of occurrence of these species are given in Table 19. Expanded descriptions are included for species for which potentially suitable habitat occurs in the study area, or for which the resource agencies have expressed particular concern.

A number of special-status species occur in the project area as visitors, migrants, or foragers but are not known or expected to breed in the immediate project area. Expanded species accounts are not provided for these species. Animals that occasionally occur within the project area and breed in upland habitats in the greater South Bay Area, but occur only in the SBSP project area as uncommon to rare foragers, include the Bald Eagle (*Haliaeetus leucocephalus*), Golden Eagle (*Aquila chrysaetos*), Vaux's Swift (*Chaetura vauxi*), California Yellow Warbler (*Dendroica petechia brewsteri*), Bank Swallow (*Riparia riparia*), and pallid bat (*Antrozous pallidus*). Species that occur in the project area regularly as foragers, but have "special status" only at nesting sites elsewhere in California, include the Common Loon (*Gavia immer*), American White Pelican (*Pelecanus erythrorhynchos*), Cooper's Hawk (*Accipiter cooperii*), Sharp-shinned Hawk (*Accipiter striatus*), Osprey (*Pandion haliaetus*), Barrow's Goldeneye (*Bucephala islandica*), Long-billed Curlew (*Numenius americanus*), and Elegant Tern (*Sterna elegans*).

Expanded species accounts are provided below for key special-status wildlife species. More information on most of these species can be found in the Goals Project Baylands Ecosystem Species and Community Profiles (Goals Project 2000).

Table 19 – Special-status animal species, their status, and potential occurrence in the South Bay Salt Ponds study area.

Name	Status*	Habitat	Potential For Occurrence On Site
Federal or State Threatened or Endangered Species			
Bald Eagle (*Haliaeetus leucocephalus*)	FPD, SE, SP	Occurs mainly along seacoasts, rivers and lakes; nests in tall trees or in cliffs. Feeds mostly on fish.	Occasional visitor, primarily during winter, to the project area. May occasionally forage, but does not nest, in the study area.
American Peregrine Falcon *(Falco peregrinus anatum)*	SE, SP	Forages in many habitats; nests on cliffs and similar human-made structures.	Regular forager (on other birds) in the study area, primarily during migration and winter. Does not breed in the study area.
California Clapper Rail *(Rallus longirostris obsoletus)*	FE, SE, SP	Salt and brackish marsh habitat usually dominated by pickleweed and cordgrass.	Resident in many tidal marshes in the study area.
California Least Tern (*Sterna antillarum browni*)	FE, SE, SP	Nests along the coast on bare or sparsely vegetated flat substrates.	The South Bay is an important post-breeding staging area for Least Terns, although this species does not currently breed within the study area. Forages and roosts in a number of South Bay ponds, especially Alviso ponds in the vicinity of Moffett Field.
California Brown Pelican *(Pelecanus occidentalis californicus)*	FE, SE, SP	Occurs in nearshore marine habitats and coastal bays. Nests on islands in Mexico and southern Calfiornia.	Regular during nonbreeding season (summer and fall) in study area. Roosts on levees in the interiors of pond complexes, forages in salt ponds and Bay.
Salt Marsh Harvest Mouse (*Reithrodontomys r. raviventris*)	FE, SE, SP	Salt marsh habitat dominated by pickleweed.	Occurs in pickleweed marshes within the study area.
Steelhead – California Central Coast ESU (*Oncorhynchus mykiss*)	FT	Cool streams with suitable spawning habitat and conditions allowing migration, as well as marine habitats.	Known to be present in several South Bay creeks (including Coyote, Stevens, San Francisquito, and Alameda Creeks and the Guadalupe River) and associated slough channels within the study area. Suitable spawning habitat is not present in the study area, but this species moves through the area to spawn upstream.
California Black Rail (*Laterallus jamaicensis coturniculus*)	ST, SP	Breeds in fresh, brackish, and tidal salt marsh.	Non-breeding individuals winter in small numbers in tidal marsh within the study area, but the species is not currently known to breed in the South Bay.
Western Snowy Plover (*Charadrius alexandrinus nivosus*)	FT, CSSC	Nests on sandy beaches and salt pan habitats.	Breeds and forages at several sites within the study area. Greatest numbers at Baumberg and Ravenswood ponds. Additional birds occur in the study area during winter.
Bank Swallow (*Riparia riparia*)	ST	Colonial nester on vertical banks or cliffs with fine-textured soils near water.	Observed in the study ara as rare transient. No suitable breeding habitat in the study area.
California Tiger Salamander *(Ambystoma californiense)*	FT, CSSC	Vernal or temporary pools in annual grasslands, or open stages of woodlands.	A population is present on NWR lands in the Fremont/Warm Springs area, though not in the immediate SBSP complexes.
California Species of Special Concern			
Fall-run Chinook Salmon – Central Valley ESU (*Oncorhynchus tshawytscha*)	CSSC	Cool rivers and large streams that reach the ocean and that have shallow, partly shaded pools, riffles, and runs.	Known to be present in several South Bay creeks (including Coyote Creek, Alameda Creek, and the Guadalupe River) and associated slough channels within the study area. Suitable spawning habitat is not present in the study area, but this species moves through the area to spawn upstream.
Western Pond Turtle *(Clemmys marmorata*)	CSSC	Permanent or nearly permanent fresh or brackish water in a variety of habitats.	Uncommon along the inshore side of pond A3W. May occur rarely in freshwater and brackish creeks and sloughs elsewhere in the study area.

Name	Status*	Habitat	Potential For Occurrence On Site
Common Loon *(Gavia immer)*	CSSC (nesting)	Nests in freshwater marshes, winters in coastal marine habitats.	Occasional winter visitor; does not breed in the study area.
American White Pelican (*Pelecanus erythrorhnchos*)	CSSC (nesting)	Forages in freshwater lakes and rivers, nests on islands in lakes.	Common non-breeder, foraging primarily on salt ponds in the study area. Regular visitor from late summer to spring. Not known to breed on site.
Double-crested Cormorant *(Phalacrocorax auritus*)	CSSC (nesting)	Colonial nester on coastal cliffs, offshore islands, electrical transmission towers, and along interior lake margins. Feeds on fish.	Breeds on electrical transmission towers and on levees within the study area, and forages in ponds and other open water habitats in the study area.
White-faced Ibis (*Plegadis chihi*)	CSSC (nesting)	Forages in freshwater marshes, and to a lesser extent, brackish areas.	Occasional visitor in fall and winter. Has bred in heron rookery on Mallard Slough, but no current nesting known.
Barrow's Goldeneye (*Bucephala islandica*)	CSSC (nesting)	Nests in freshwater marshes, winters in coastal marine habitats.	Occasional winter visitor; does not breed in the study area.
Northern Harrier *(Circus cyaneus)*	CSSC (nesting)	Nests and forages in marshes, grasslands, and ruderal habitats.	Breeds in small numbers in marsh in the study area, forages in a variety of habitats.
Sharp-shinned Hawk (*Accipiter striatus*)	CSSC (nesting)	Nests in woodlands, forages in many habitats in winter and migration.	Observed on site as a migrant and winter resident. No breeding habitat in study area.
Cooper's Hawk (*Accipiter cooperii*)	CSSC (nesting)	Nests in woodlands, forages in many habitats in winter and migration.	Observed on site as a migrant and winter resident. Breeds in limited numbers in upland habitats adjacent to the study area, but not within the immediate SBSP complexes.
Osprey (*Pandion haliaetus*)	CSSC (nesting)	Nests in tall trees or cliffs on freshwater lakes and rivers and along seacoast; feeds on fish.	Occasional forager, primarily during the nonbreeding season. No breeding records from the vicinity of the study area.
Golden Eagle (*Aquila chrysaetos*)	CSSC	Breeds on cliffs or in large trees or electrical towers, forages in open areas.	Occasional forager, primarily during the nonbreeding season. No nesting records within the study area.
Merlin (*Falco columbarius*)	CSSC	Uses many habitats in winter and migration.	Regular in low numbers during migration and winter. Does not nest in California.
Long-billed Curlew (*Numenius americanus*)	CSSC (nesting)	Nests on prairies and short-grass fields; forages on mudflats, marshes, pastures, and agricultural fields.	Forages on mudflats and marshes, and roosts on levees, diked marshes, and ponds within the study area as a migrant and winter resident. Does not nest in the study area.
California Gull (*Larus californicus*)	CSSC (nesting)	Nests on lakes inland and, around S. F. Bay, in salt ponds.	Common resident, breeding on several salt ponds in the study area. The colony in Pond A6 is the second largest colony in California. Forages throughout study area.
Black Skimmer (*Rynchops niger)*	CSSC (nesting)	Nests on abandoned levees and islands in salt ponds and marshes.	A few pairs breed and forage in the study area, on islands in salt ponds.
Short-eared Owl (*Asio flammeus*)	CSSC (nesting)	Nests on ground in tall emergent vegetation or grasses, forages over a variety of open habitats.	Uncommon. Has bred in small numbers within the study area, although current breeding status unknown. Most numerous in area in migration and winter.
Western Burrowing Owl *(Athene cunicularia hypugea)*	CSSC	Flat grasslands and ruderal habitats.	Breeds at several upland sites immediately adjacent to the SBSP complexes, may forage within marshes to some extent.

Name	Status*	Habitat	Potential For Occurrence On Site
Vaux's Swift (*Chaetura vauxi*)	CSSC (nesting)	Nests in snags in coastal coniferous forests or, occasionally, in chimneys; forages aerially.	Forages over study area during spring. No nesting habitat within area.
Loggerhead Shrike (*Lanius ludovicianus*)	CSSC (nesting)	Nests in dense shrubs and trees, forages in grasslands, marshes, and ruderal habitats.	Resident in low numbers within the study area.
California Horned Lark (*Eremophila alpestris actia*)	CSSC	Short-grass prairie, annual grasslands, coastal plains, and open fields.	Common in the study area during nonbreeding season. May nest in small numbers on salt pond levees, salt flats, and ruderal habitats within study area.
California Yellow Warbler (*Dendroica petechia brewsteri*)	CSSC (nesting)	Breeds in riparian woodlands, particularly those dominated by willows and cottonwoods.	Observed on site as a migrant. No nesting habitat within the immediate SBSP complexes, but nests in riparian habitat upstream from the Bay.
Saltmarsh Common Yellowthroat (*Geothlypis trichas sinuosa*)	CSSC	Breeds primarily in fresh and brackish marshes in tall grass, tules, willows; uses salt marshes more in winter.	Common resident, breeding in freshwater and brackish marshes (and possibly to a limited extent in salt marshes), and foraging in all three marsh types during the nonbreeding season.
Alameda Song Sparrow (*Melospiza melodia pusillula*)	CSSC	Breeds in salt marsh, primarily in marsh gumplant and cordgrass along channels.	Uncommon resident, breeding and foraging in tidal salt marsh.
Tricolored Blackbird *(Agelaius tricolor)*	CSSC (nesting)	Breeds near freshwater in dense emergent vegetation.	May breed in extensive freshwater marshes around the periphery of the study area, such as at Coyote Hills. Occurs elsewhere in the study area as a nonbreeding forager.
Salt Marsh Wandering Shrew (*Sorex vagrans halicoetes*)	CSSC	Medium high marsh with abundant driftwood and pickleweed.	May occur in salt marshes throughout the study area, although numbers have declined, and current status is unknown.
State Protected Species or CNPS Species			
White-tailed Kite *(Elanus caeruleus)*	SP (nesting)	Nests in tall shrubs and trees, forages in grasslands, marshes, and ruderal habitats.	Common resident; breeds at inland margins of the study site, where suitable nesting habitat occurs.

FE = Federally-listed Endangered
FT = Federally-listed Threatened
FC = Federal Candidate. Sufficient biological information to support a proposal to list the species as Endangered or Threatened
FPD = Federally Proposed for Delisting
SE = State-listed Endangered
ST = State-listed Threatened
CSSC = California Species of Special Concern
SP = State Fully Protected Species
CNPS 1A = Plants presumed extinct in California by California Native Plant Society (CNPS)
CNPS 1B = Plants considered by CNPS to be rare, threatened, or endangered in California, and elsewhere

4.5.2 Federal or State Threatened or Endangered Species

Steelhead (*Oncorhynchus mykiss*), Central California Coast ESU. Federal Listing Status: Threatened; State Listing Status: None. The steelhead is an anadromous form of rainbow trout that migrates upstream from the ocean to spawn. Steelhead in the South Bay usually migrate upstream to spawning areas from late December through early April, with the greatest activity in January through March, when flows are sufficient to allow them to reach suitable habitat in far upstream areas. Spawning occurs between December and June. Steelhead eggs remain in gravel depressions, known as redds, for 1.5 to four months before hatching. After hatching, young of the year steelhead tend to use riffles with cover, while older juveniles use deeper water (such as pools) as rearing habitat, remaining in fresh water for one to four years before migrating to the ocean. This downstream migration of juveniles generally occurs between February and May. After migration, steelhead typically grow rapidly for two to three years before returning to freshwater streams to spawn. Unlike other anadromous salmonids, steelhead do not necessarily die after spawning. Adults may survive and return to the ocean after spawning, coming back to spawn for one or more additional seasons; however, the percentage of adults that return to South Bay streams to spawn more than one season is apparently low (B. Dyer, pers. comm.).

Steelhead usually spawn in gravel substrates in clear, cool, perennial sections of relatively undisturbed streams. Preferred streams typically support dense canopy cover that provides shade, woody debris, and organic matter, and are usually free of rooted or aquatic vegetation. Steelhead usually cannot survive long in pools or streams with water temperatures above 70°F, but they can use warmer habitats if food is available, such as at fast water riffles where fish can feed on drifting insects. Steelhead in some coastal estuaries in central California apparently make extensive use of estuarine habitats for foraging (Bush, pers. comm.), although the extent of the use of estuarine habitats by steelhead in many areas, including the South San Francisco Bay area, is virtually unknown.

Steelhead populations in many areas have declined due to degradation of spawning habitat, introduction of barriers to upstream migration, over-harvesting by recreational fisheries, and reduction in winter flows due to damming and spring flows due to water diversion. Steelhead and other salmonids have been categorized into subpopulations, or Evolutionarily Significant Units (ESUs). In 1997, the National Marine Fisheries Service (NMFS; now NOAA Fisheries) published a final rule to list the Central California Coast ESU of the steelhead as threatened under the FESA. The Central Coast ESU includes all runs from the Russian River in Sonoma County south to Aptos Creek in Santa Cruz County, including all steelhead spawning in streams flowing into San Francisco Bay streams. In 2000, NMFS proposed critical habitat for this and other ESUs as accessible reaches of all rivers within the range of each listed ESU, although this critical habitat designation was vacated (rescinded) in 2002. A recovery plan has not yet been approved for this ESU.

Steelhead are known to occur in several stream systems in the South San Francisco Bay Area (Figure 14), and this species could potentially spawn in virtually any reach of a stream offering suitable spawning habitat and lacking downstream barriers to dispersal. Information on the fine-scale distribution of steelhead in South San Francisco Bay streams is limited, but steelhead are currently known to run in the Coyote Creek, Guadalupe River, Stevens Creek, and San Francisquito Creek watersheds (Foxgrover and others 2004). In addition, ongoing restoration activities in Alameda Creek may lead to a viable spawning population there. Currently, very low numbers of adult steelhead migrate up Alameda Creek annually (Leidy and others 2003). Suitable spawning habitat does not occur within the SBSP restoration project area, but this species moves through sloughs between the Bay and spawning streams (*e.g.*, Coyote Slough, Alviso Slough, and the tidal portions of San Francisquito and Stevens Creeks). Steelhead may use tidal channels in marshes as well, as such channels (particularly in brackish marshes) may provide habitat for juveniles during the process of smoltification (*i.e.*, physiological adaptation to the saltwater environment). The use of larger sloughs within the project area by juvenile salmonids may be limited by the relatively high density of predators, including harbor seals and striped bass (Jerry Smith, pers. comm.).

Chinook Salmon (*Oncorhynchus tshawytscha*), Central Valley Fall Run ESU. Federal Listing Status: None; State Listing Status: Species of Special Concern. Like the steelhead, the Chinook salmon is an anadromous salmonid. Adults of the Central Valley Fall Run ESU migrate from the ocean to spawning streams in late fall and begin spawning in beds of coarse river gravels between October and December. Adults die after spawning. After the eggs hatch, juvenile salmon typically migrate downstream to the Bay or ocean within a few months. Young fish remain in the ocean for several years before returning to freshwater streams and rivers to spawn. Chinook salmon generally spawn in cool waters providing incubation temperatures no warmer than 55^{o} F.

Much more is known regarding the use of estuarine habitats by Chinook salmon than steelhead, and in at least some areas, juvenile Chinook make heavy use of estuarine habitats. Juvenile Chinook salmon may spend a significant amount of time, up to 189 days (Simenstad and others 1982), foraging in estuarine habitats, showing significant growth in some estuaries (MacDonald and others 1987), as they adapt physiologically to higher-salinity environments (Maragni 2000). In at least some areas, tidal marshes are important habitats for Chinook salmon. Fry forage throughout shallower tidal sloughs and channels, even foraging within the marsh during flood tides, while larger smolts forage in larger primary and secondary channels and subtidal habitats (Maragni 2000).

Fall-run Chinook salmon populations have suffered the effects of over-fishing by commercial fisheries, degradation of spawning habitat, added barriers to upstream migration, and reductions in winter flows due to damming. Approximately 40 to 50 percent of the spawning and rearing habitats in Central Valley streams have been lost or degraded. Hatchery-raised fish considerably enhance present populations. Because long-term population trends have been generally stable, NMFS determined that the Central Valley fall- and late fall-run evolutionarily significant unit (ESU) was not a priority for listing as threatened or endangered.

Chinook salmon did not historically spawn in streams flowing into South San Francisco Bay. Since the mid-1980s, however, small numbers of fall-run Chinook salmon have been found in several such streams, including Coyote Creek, Los Gatos Creek, and the Guadalupe River (Leidy and others 2003), and the species has recently been recorded along lower Alameda Creek as well. These fish are of Central Valley origin; fish sampled from Santa Clara Valley streams are most closely related to Central Valley fall-run hatchery fish (Hedgecock 2002).

These fall-run Chinook salmon typically arrive in South San Francisco Bay streams in October or later, although on rare occasions, adult Chinook salmon have been detected in these streams in summer, and spawning has been observed on Los Gatos Creek as early as September (Salsbery, pers. comm.). Seasonal stream flow and temperature conditions in these streams may not be suitable for successful spawning by Sacramento River winter-run Chinook salmon, which typically spawn in late spring and summer, or by Central Valley spring-run Chinook salmon, which typically spawn in late summer and early fall. Therefore, any adult Chinook salmon found in the South San Francisco Bay in summer are presumed to be either early fall-run fish or strays from a Central Valley run that are not expected to spawn successfully in these streams. The use of tidal channels and sloughs within the SBSP restoration project area by Chinook salmon is unknown. Predation pressure may limit the use of larger sloughs as more than transit habitat, as noted above for steelhead, but it is possible that Chinook salmon use tidal marshes in the South Bay as extensively as has been reported in other areas.

California Brown Pelican (*Pelecanus occidentalis californicus*). Federal Status: Endangered; State Status: Endangered. Brown Pelicans are large seabirds found in coastal and nearshore marine habitats along the Atlantic, Gulf and Pacific coasts of North America. In the middle of the 20^{th} century, Brown Pelican populations were severely reduced. The primary cause of this decline was eggshell thinning related to ingestion of the pesticide DDT, which entered the marine food chain through agricultural runoff and industrial discharge (Anderson and Gress 1983). The Brown Pelican was listed by the USFWS as Endangered in 1970 and by the state of California in 1971, and the state considers it a “fully protected” species. DDT was banned in the United States in 1972, and Brown Pelican populations began recovering. In 1985, the Brown Pelican was delisted in the southeastern U.S. as recovered, but west coast populations did not recover as quickly, and have remained fairly stable since 1985 (Shields 2002). A recovery plan for the species was completed in 1983 (U.S. Fish and Wildlife Service 1983); critical habitat has not been designated for the Brown Pelican.

The California Brown Pelican nests in Mexico, on the California Channel Islands, and at the Salton Sea in early spring, approximately January to May (Anderson and Gress 1983; Shields 2002). Much of the postbreeding dispersal occurs northward (as far north as Canada), and by June, many post-breeding birds are present in central California. Local abundance in central California usually peaks from August to October (Briggs and others 1987; Jaques 1994). Although a small number of non-breeding birds may be found locally year-round, most pelicans return to their southern breeding grounds by January. California Brown Pelicans feed on northern anchovies and other small fishes, which they capture by plunge-diving. Brown Pelicans require secure night-roosts, free of terrestrial predators (Jaques 1994).

Several hundred Brown Pelicans typically occur in San Francisco Bay during summer and fall, but numbers are variable (Ainley 2000a). Post-breeding dispersants typically begin to arrive in the South Bay in June and July, with most individuals departing by late fall. However, a few may also be found in the South Bay in winter and spring as well (Santa Clara County Bird Data Unpublished). California Brown Pelicans occur regularly in some South Bay salt ponds, and often roost on salt pond levees. Recent surveys by USGS included high counts of 237 Brown Pelicans in the Eden Landing Complex (primarily Ponds E1 and E2) in August 2001, and 225 in the Alviso Complex in September 2004, although more typical counts number less than 50 birds at Eden Landing during late summer and fall, and less than 100 at Alviso Ponds (U.S. Geological Survey Unpublished Preliminary Data). In contrast, Brown Pelicans made little use of the Ravenswood ponds during the surveys by USGS from 2002 to 2004. Several ponds in the Alviso Complex are used for roosting by Brown Pelicans, with the greatest use in the vicinity of Alviso Slough and Guadalupe Slough (U.S. Geological Survey Unpublished Preliminary Data), although local concentrations may occur in any of the lower-salinity ponds (which provide fish) throughout the Alviso Complex. Although information on daily activity patterns, habitat use, and key foraging areas of Brown Pelicans in the South Bay is limited, this species uses salt ponds both for foraging (which takes place in the less saline ponds supporting fish) and for roosting (on levees between ponds).

American Peregrine Falcon (*Falco peregrinus anatum*). Federal Listing Status: Delisted; State Listing Status: Endangered, Fully Protected. The Peregrine Falcon occurs throughout much of the world, and is known as one of the fastest flying birds of prey. Peregrine Falcons prey almost entirely on birds, which they kill while in flight. These falcons nest on ledges and caves on steep cliffs, as well as human-made structures like buildings and power towers. In California, they are known to nest along the entire coastline, the northern Coast, and the Cascade Ranges and Sierra Nevada. During winter and migration, this species can be found throughout the state. Peregrine Falcons are most likely to be encountered in coastal or inland marsh habitats where large numbers of waterfowl and shorebirds concentrate, as occurs at the project site.

A severe decline in populations of the widespread North American subspecies *Falco peregrinus anatum* began in the late 1940’s. This decline was attributed the accumulation of DDE, a metabolite of the organochlorine pesticide DDT, in aquatic food chains (Thelander and M. 1994). When concentrated in the bodies of predatory birds such as the Peregrine Falcon, Bald Eagle, Brown Pelican, and Osprey, this contaminant led to reproductive effects, such as the thinning of eggshells. The American Peregrine Falcon was listed as Endangered by the USFWS in 1970 and by the State of California in 1971. Recovery efforts included the banning of DDT in North America and captive breeding programs. The USFWS removed the American Peregrine Falcon from the Endangered Species List in 1999, though the State of California still lists the species as endangered, and as a “fully protected” species.

Peregrine Falcons are uncommon in the SBSP project area, but nonbreeders are present in small numbers in fall and winter. These birds often use electrical transmission towers as perches, hunting waterbirds over salt ponds, marshes, and the open bay. This species is not known to breed in the project area, but individuals occasionally occur in the area during the breeding season; such individuals may be nonbreeders, or breeding birds foraging far from their nesting sites on artificial structures in the North Bay, or on cliffs in the mountains surrounding the bay.

California Clapper Rail (*Rallus longirostris obsoletus*). Federal Listing Status: Endangered; State Listing Status: Endangered. The California Clapper Rail is a secretive marsh bird currently endemic to the marshes of San Francisco Bay. It formerly bred at several other locations, including Humboldt Bay, Elkhorn Slough (Monterey County), and Morro Bay, but is now extirpated from all sites outside of San

Francisco Bay. California Clapper Rails nest in salt and brackish marshes along the edge of the bay, and are most abundant in extensive salt marshes and brackish marshes dominated by cordgrass, pickleweed, and marsh gumplant, and containing complex networks of tidal channels (Harvey 1980). Shrubby areas adjacent to or within tidal marshes are important for predator avoidance at high tides.

California Clapper Rails breed from February through August in the vegetation along tidal sloughs. Breeding generally occurs in two pulses, one in April and May, and a second in June and July. Clapper Rails lay up to 14 eggs, which are incubated by both parents for just under a month. The young are precocial, but are dependent on their parents for food for five to six weeks (Eddleman and Conway 1998). California Clapper Rails are non-migratory, although juveniles disperse around the bay during late summer and autumn. Adults are territorial, and maintain territories throughout the year. Most California Clapper Rails studied via radio-telemetry had home ranges of about 115m in radius (Keldsen 1997). They forage on crabs, clams, and other invertebrates, which they find in exposed mud along tidal channels (usually secondary channels) or in vegetation at the edges of such channels (Shuford 1993).

Since the mid-1800s, about 90% of San Francisco Bay's marshlands have been eliminated through filling, diking, or conversion to salt evaporation ponds (Goals Project 1999). As a result, the California Clapper Rail lost most of its former habitat, and the population declined severely. The subspecies was listed by the USFWS as Endangered in 1970, and by the State of California as Endangered in 1971, and the state considers it a "fully protected" species. The USFWS approved a joint recovery plan of the salt marsh harvest mouse and the California Clapper Rail in 1984 (U.S. Fish and Wildlife Service 1984), and an updated Tidal Marsh Species Recovery Plan is currently under development. Critical habitat has not been proposed for the California Clapper Rail.

In the 1970's, the Bay-wide population estimate for California Clapper Rails was thought to be as high as 4,000 to 6,000 birds, with 55% in the South Bay, 38% in Napa marshes, and the remaining 8% in other North Bay and outer coast marshes (Gill 1979). Based on surveys of most suitable marshes in the San Francisco Bay area in the late 1970s and early 1980s, Harvey (1988) estimated a population of 1500 individuals. The difference between the estimates of Gill (1979)and Harvey (1988) may have reflected a population decline, but was also likely a result of more accurate surveys by Harvey. Nevertheless, density estimates in three South Bay marshes were found to decline from 1.47, 0.89, and 0.69 rails/ha in 1980 (Harvey 1988) to 0.64, 0.26. and zero rails/ha, respectively in 1989 (Foerster and others 1990), indicating an actual, considerable population decline. Populations of rails in five South Bay marshes declined by as much as 85%, apparently as a result of depredation by the non-native red fox (Albertson 1995). By the mid 1980's, approximately 1200-1500 California Clapper Rails remained, with greater than 80% occurring in the South Bay. By 1988, populations were estimated at 700 rails, and by 1991 the bay-wide total was estimated at 300-500 individuals (Alberston and Evens. 2000).

Clapper Rail predation by both red foxes and feral cats has been directly documented in the South Bay by the tracking of radio-marked rails that were depredated in 1991 and 1992 (Albertson 1995). In addition, the remains of Clapper Rails were found at a fox den in a tidal marsh on the refuge (Harding and others 1998), and at the entrance to a den in the outboard levee along salt pond A9 (Steve Rottenborn, pers. obs.). Norway rats are thought to be one of the main predators of California Clapper Rail eggs (Foerster and others 1990; Harvey 1988), and raccoons have also been known to prey on California Clapper Rail eggs (Foerster and others 1990).

A predator management plan implemented by the San Francisco Bay National Wildlife Refuge since 1991 has met with some success in reducing the effects of mammalian predators on Clapper Rails, resulting in an increase in rail populations (Harding and others 1998). Between 1991 and 1996, Clapper Rail population size within a given marsh showed a significant negative relationship with the number of red foxes removed the prior year, and rail population growth rates were significantly related to red fox trapping success the prior year. The most recent population estimate for California Clapper Rails was approximately 1,040 to 1,264 birds in 2000 (Alberston and Evens. 2000). Although management of mammalian predators has helped boost Clapper Rail populations, avian depredation by raptors, Common Ravens (*Corvus corax*), and possibly gulls still poses a threat, and may be increasing (Alberston, pers. comm.). In 2003, the CDFG implemented a predator-control program at the Eden Landing Ecological Reserve to reduce predation on listed species (John Krause, pers. comm.).

Other ongoing threats to Clapper Rails include loss of habitat to sea-level rise (Keldsen 1997), human disturbance, and accumulation of mercury and other contaminants. Few data are available regarding the effects of human disturbance on California Clapper Rails. Clapper Rails are typically shy and reclusive, and avoid areas of high human use. Construction-related disturbance has been found to result in abandonment of territories, but in one instance, use of a jack-hammer within 50 ft. of a territory did not result in abandonment of that territory (Wetlands Research Associates 1994a).

California Clapper Rail eggs collected from several sites around the San Francisco Bay in 1975, 1986, and 1987 were found to have elevated levels of PCBs, selenium, and mercury (Lonzarich and others 1992). Analysis of unhatched eggs from the Central Bay by Schwarzbach and Adelsbach (2003) detected mean mercury concentrations of 0.81 ppm on a fresh wet weight basis, concentrations that were considered embryotoxic. The levels and effects of mercury concentrations in South Bay birds are the subjects of ongoing study.

Breeding-season surveys of South San Francisco Bay marshes for California Clapper Rails through the early 1990's, summarized by Foin and others (1997), indicated that the most substantial populations of Clapper Rails in the South Bay were, predictably, in the largest sections of tidal salt marsh: at Mowry Marsh and Dumbarton Marsh (in the east Bay between the Dumbarton Bridge and Mowry Slough), at the Faber/Laumeister Tracts and other marshes in the Palo Alto/East Palo Alto area, and at Greco Island in Redwood City. Mean counts from these areas include 68 birds at Mowry Marsh, 57 at Faber-Laumeister, and 44 at Dumbarton (Foin and others 1997). Nest searches by San Francisco Bay NWR personnel detected 40 nests in the Faber/Laumeister Tracts, 33 on Greco Island, and 13 in North Mowry Marsh in 1992 (Keldsen 1997). Clapper Rails occurred in many other marshes as well, including Ideal Marsh (adjacent to Cargill pond N5), Calaveras Marsh (adjacent to Cargill Ponds M2 and M3), and Triangle Marsh in Alviso. Other surveys have also documented Clapper Rails in southern Whale's Tale Marsh, adjacent to the Eden Landing salt ponds (Krause, pers. comm.). Clapper Rails have been found to occasionally use salt pond dredge locks as high-tide refugia (Wetlands Research Associates 1994b). Although site-specific surveys have not been conducted in all suitable habitat for Clapper Rails in the

South Bay, this species is likely to occur in tidal salt marsh habitats in a number of additional areas as well (Figure 14).

Although California Clapper Rails are typically found in tidal salt marshes, they have also been documented in brackish marshes in the South Bay. Breeding-season surveys conducted in marshes bordering Coyote Creek in 1989 documented breeding California Clapper Rails in a wide variety of plant associations. Surveys conducted during the 1990 breeding season (H. T. Harvey & Associates 1990d) and winter season (H. T. Harvey & Associates (1990c) found a number of California Clapper Rails occupying salt/brackish transitional marshes and several brackish, alkali bulrush-dominated marshes, including Warm Springs Marsh (immediately east of Pond A19) and the marshes along upper Coyote Slough even farther east. In addition, California Clapper Rails were found in nearly pure stands of alkali bulrush along Guadalupe Slough in 1990 and 1991 (H. T. Harvey & Associates 1990c; H. T. Harvey & Associates 1990d; H. T. Harvey & Associates 1991c). Although it has been suggested that habitat quality may be lower in brackish marshes than in salt marshes (Shuford 1993), further studies comparing reproductive success in different marsh types are necessary to determine the value of brackish marshes to California Clapper Rails.

On rare occasions, California Clapper Rails have been recorded even further upstream, in brackish/freshwater transition marshes, particularly during the nonbreeding season. In the Alviso/Sunnyvale area, such individuals have been recorded along upper Alviso Slough near the Gold Street bridge (14 February 1997; Scott B. Terrill, pers. obs.), in nontidal freshwater ponds between Calabazas and San Tomas Aquino Creeks north of Highway 237 in Sunnyvale (16 August 1998; Steve Rottenborn, pers. obs.), and along Artesian Slough near the Environmental Education Center in January 1999 and January-February 2001 (Santa Clara County Bird Data Unpublished).

No Bay-wide breeding season surveys have been conducted for Clapper Rails since the 1990s. However, the USFWS, in conjunction with other agencies, conducts annual winter high-tide surveys using an airboat. These surveys attempt to cover all South Bay marshes at least once every two years (although areas with dense cordgrass cannot be surveyed with this method except on the highest tides). Recent winter surveys indicate that Clapper Rail populations in the Mowry/Dumbarton Slough area appear to be fluctuating, but populations in other areas seem to be more stable, see Table 20 (Alberston, pers. comm.). This may be the result of higher avian predation rates in the Mowry/Dumbarton area, but this hypothesis has not been studied.

Table 20 – High and low winter counts of Clapper Rails from major tidal salt marshes in the South Bay, 1994-2000 and 2002 (USFWS unpubl. data).

Location	High Count (Year)	Low Count (Year)
Dumbarton	104 (1994)	28 (2000)
Mowry	126 (1997)	4 (2000)
Hooks Island	46 (1997)	16 (2000, 2002)
Palo Alto Harbor	16 (1997)	5 (2002)
Faber	60 (1997)	29 (1995)

Location	High Count (Year)	Low Count (Year)
Laumeister	48 (1997)	24 (1995)
Greco Island	96 (2002)	87 (2000)

Both winter and breeding season surveys suggest that there is substantial annual variability in local distribution and abundance of Clapper Rails in the South Bay. For example, at one of the sites where rails were found in brackish marshes in Guadalupe Slough (discussed above), no rails were found during protocol-level surveys the year before (H. T. Harvey & Associates 1990c; H. T. Harvey & Associates 1990d; H. T. Harvey & Associates 1991c). Table 20 shows the high variability in winter counts, and suggests that populations may be particularly high in certain years, such as 1997, presumably following high breeding success.

California Black Rail (*Laterallus janaicensis coturniculus*). Federal Listing Status: None; State Listing Status: Threatened. The California Black Rail is a small rail that inhabits tidal salt, brackish, and freshwater marshes. This small bird is very secretive, and is most often seen during high tides when it is forced into high marshes. Little information is available regarding the biology of California Black Rails. They are most abundant in tidal marshes with some freshwater input (Evens and others 1991). They nest primarily in pickleweed-dominated marshes with patches or borders of *Scirpus*, often near the mouths of creeks. They build nests in tall grasses or marsh vegetation during spring, and lay about 6 eggs. Nests are usually constructed of pickleweed, and are placed directly on the ground or slightly above ground in vegetation. Black Rails feed on terrestrial insects, aquatic invertebrates, and possibly seeds (Trulio and Evens. 2000).

The California Black Rail reportedly bred in the Alviso area in the early 1900s (Wheelock 1916), but currently it is not known to breed in the South Bay. In the San Francisco Bay area, this small rail currently breeds primarily in marshes in the north San Francisco Bay Area (*i.e.*, San Pablo Bay and Suisun Bay). After breeding, some Black Rails disperse into the South Bay, accounting for most records of the species in this area. Here, the abundance of the Black Rail during the nonbreeding season is unknown due to its very small size and highly secretive nature. Most observations of Black Rails in the South Bay consist of only a few birds observed seeking high-tide refugial cover at the edges of the salt marsh in a few areas during spring tides from November to February. Nearly every winter, small numbers (up to 10 or more in a day, but usually four or fewer) are seen during such spring tides at the Palo Alto Baylands, and occasionally individuals are observed in the East Palo Alto marshes as well. Fewer have been recorded in recent years in the Eden Landing vicinity, most likely due to restricted birder access to this area. This species is likely present in small numbers at other scattered locations as well (*e.g.*, there are unconfirmed reports from the Alviso marina during high winter tides), but the inaccessibility of most suitable areas to look for Black Rails during spring tides, and the species' silence in the South Bay during winter, makes it virtually impossible to survey the species in the study area during this season.

Late-season (April) calling Black Rails have been reported at the Palo Alto Baylands (26-27 April 1993; Santa Clara County Bird Data) and near the east end of the Dumbarton Bridge, and in spring 2004 individuals were heard in brackish marsh about one mile up Old Alameda Creek, near Pond E6A (two birds) and near the mouth of the Alameda Creek Flood Control Channel (Alberston, pers. comm; Morris, pers. comm.). There is also a 30 August 1995 record from the vicinity of the Sunnyvale Water Pollution Control Plan (presumably along Guadalupe Slough) (Santa Clara County Bird Data Unpublished). However, there are no records of Black Rails breeding in the South Bay since at least the 1920's (Trulio and Evens. 2000).

The absence (or scarcity) of breeding Black Rails in the South Bay is presumably a result of habitat loss. Tidal marsh habitat has been lost, but perhaps more important to winter survival is loss of high-tide refugia habitat. Upland transition habitat, both on natural levees within marshes and on landward edges of marshes, has been lost as a result of fill for development, and reductions in marsh size and resultant reductions in natural levees along higher-order channels. Predation by egrets, herons, gulls, and harriers has been observed in these marshes during winter high tides, as Black Rails are forced into the open by rising water. The importance of this predation on a population level, especially in light of impacts to high tide refugia, is unknown, but it may be a significant factor in the extirpation of breeding populations of the species from the South Bay.

Western Snowy Plover (*Charadrius alexandrinus nivosus*). Federal Listing Status: Threatened; State Listing Status: Species of Special Concern. The Snowy Plover is a small shorebird that occurs on almost every continent. In North America, there are two races of Snowy Plover: the Western Snowy Plover (*C. a. nivosus*) occurs west of the Mississippi River, primarily in the Great Basin and along the Pacific coast, and the Cuban Snowy Plover (*C. a. tenuirostris*) occurs in the southeastern United States (Page and others 1995). On the Pacific coast, snowy plovers nest on sandy beaches and salt pan habitat from Washington to Baja Mexico. Because they nest during the summer, primarily on beaches in a temperate climate, Western Snowy Plovers are susceptible to nest disturbance and other negative interactions with humans. Much of their nesting habitat, particularly in southern California, has been lost to development and high human use. In addition, introduced predators, especially the non-native red fox, have had dramatic effects on Snowy Plover nesting success (Neuman and others 2004). In response to severe population declines, the USFWS listed the Pacific coast population of the Western Snowy Plover as Threatened in 1993. Critical habitat was designated for this population in 1999, and a draft recovery plan was released in 2001 (U.S. Fish and Wildlife Service 2001). None of the breeding sites within San Francisco Bay are considered critical habitat. The State of California lists the Western Snowy Plover as a "species of special concern."

In the South San Francisco Bay, Snowy Plovers nest on low, barren to sparsely vegetated salt pond levees and islands, at pond edges, and on salt pan areas of dry ponds (Page and others 2000), and preferentially use light-colored substrates such as salt flats (Feeney and Maffei 1991; Marriott 2003). Nesting areas are located near water, where prey (usually brine flies and other insects) are abundant. In some areas, Snowy Plovers nest within dry salt ponds; in other areas where ponds typically hold water through the summer (*e.g*., the Newark salt ponds), nests are located primarily on levees. Often, nests are located near disruptive objects such as rocks or surface irregularities, and may be constructed in depressions created by footprints and vehicles (Marriott 2003; Page and others 1995). Nests consist of a depression scratched into the substrate sometimes lined with shell fragments, pebbles, or similar local materials (Page and others 2000; Page and others 1995). Eggs are oval and buff-colored with small, brown- and black-colored spots and scrawls.

According to Page and others (1995), pairing begins as early as mid February; egg-laying commences in early March, and may continue with multiple broods into early August. The incubation period ranges from 26 to 32 days. Three eggs are typically laid two to five days apart. Replacement clutches are initiated approximately 6-8 days after the destruction of a completed clutch. Young birds are precocial, leaving the nest within hours of hatching. Chicks are usually cared for exclusively by the male parent, until they fledge at 28 to 33 days. Chicks feed themselves, but require the protection of an adult for brooding and evasion of predators. The breeding season of the Western Snowy Plover in California, from nest initiation to fledging of chicks, is considered to be March 1 to September 31. Although Snowy Plovers can nest as early as March 1, damp nesting substrate in salt ponds, from flooding or normal spring rains, may delay nesting in this habitat until the substrate dries.

Some Snowy Plovers remain in their coastal breeding areas year-round, while others are migratory. Some individuals that nest in the San Francisco Bay Area probably migrate south as far as Mexico (U.S. Fish and Wildlife Service 2001). There is overlap between the San Francisco Bay population and the adjacent coastal nesting population. Birds banded at Monterey Bay and in Oregon have been seen in the San Francisco Bay salt ponds (Feeney and Maffei 1991). Snowy Plovers typically live 3 to 4 years (Page and others 1995).

Snowy Plovers in the South Bay forage primarily on small flies, especially brine flies (*Ephydra cinerea* and *Lipochaeta slossonae*; (Feeney and Maffei 1991)). They also feed on other small invertebrates, including beetles and small marine invertebrates. Snowy Plovers forage visually, and often run after prey which they capture in their bills. In the South Bay, Western Snowy Plovers are likely to forage anywhere where prey is available. Brine flies are usually found in greatest densities at the shallow margins of shallow salt ponds or puddles, but Snowy Plovers also forage in open salt flats, and occasionally, on mudflats adjacent to salt ponds. Feeney and Maffei (1991) recorded 74 Snowy Plovers using mudflats adjacent to the Oliver Salt Ponds north of Highway 92 (just outside the study area) on 2 September 1989.

It is not known whether this species nested inside San Francisco Bay before conversion of salt marsh to salt evaporation ponds. Breeding habitat may have been present in natural salinas prior to the creation of salt ponds, but such features would have provided limited breeding habitat for Snowy Plovers, at best. Salt ponds have provided suitable nesting and foraging habitat since the beginning of the 20th century, and as of 1990, about 10% of the California population of Snowy Plovers bred within San Francisco Bay salt ponds, mostly in the southern part of the Bay (Page and others 2000; Page and others 1991). Surveys conducted by PRBO, SFBBO, and others since the 1970's have shown that the breeding population in the South Bay may be declining. "Window" surveys in the South Bay, which cover most available breeding habitat in a one-week period, detected 351 breeding birds in 1978, 270 in 1984, and 216 in 1989 (Page and others 2000). In 2004, the results of breeding-season monitoring of the Eden Landing, Alviso, and Ravenswood pond complexes resulted in a maximum of only 113 Snowy Plovers (Strong and others 2004b).

Numbers of Snowy Plovers in the South Bay may be considerably higher in winter, when the local population is augmented by wintering birds that likely breed in the Great Basin. High winter counts at Eden Landing alone include 403 birds in 1997 (Casady 1999), and 275 in 1989/1990 (Feeney and Maffei 1991). In contrast, recent surveys by USGS (U.S. Geological Survey Unpublished Preliminary Data) found lower abundance in winter in the Eden Landing, Alviso, and Ravenswood pond complexes (Table 21). These counts were higher in 2003 than 2004 at all locations in both seasons.

Table 21 – High counts of Snowy Plovers in salt ponds censused by USGS from October 2002 through September 2004 (USGS, unpubl. preliminary data).

Location	Breeding (Mar - Sep)	Winter (Oct – Feb)
Eden Landing	66	11
Alviso	23	4
Ravenswood	58	18

Figure 15 depicts the areas where Snowy Plovers have been recorded breeding in the South Bay since 1989 (although no recent data are available from the Newark and Redwood City salt ponds). During both the winter and breeding seasons, the greatest concentration of Snowy Plovers in the San Francisco Bay area has consistently occurred in the Eden Landing/Hayward area. Use of individual ponds may vary annually, depending on habitat conditions, but at Eden Landing, Snowy Plovers have recently (2003 and 2004) bred primarily in Ponds E12 and E16B (outside the Project Area), and in E6A and E6B (Strong and Dakin 2004; Strong and others 2004b). Population trends from the 1980s and 1990s here appear to have mirrored bay-wide declines. As many as 157 breeding birds were reported historically at Eden Landing (U.S. Fish and Wildlife Service 2001). Feeney and Maffei (1991) found 51 nests here in 1989, and Casady (1999) reported 42 nests in 1997, 12 nests in 1998, and 10 nests in 1999. In contrast, numbers appear to be increasing here in recent years. In 2003, only 4 nests were found, although more than 35 juveniles and chicks were found, indicating a total nest count of at least 12 nests, and likely many more (Strong and Dakin 2004). In 2004, high counts of adult Snowy Plovers during the breeding season at Eden Landing included 70 at Pond E6B and 59 at Pond E8 (Strong and others 2004b).

Within the SBSP restoration project area, substantial breeding populations also occur in the Ravenswood salt pond complex and in the Warm Springs salt ponds (Ponds A22 and A23) in the Alviso Complex. Most of the Ravenswood ponds are used regularly for nesting (e.g., > 40 adults found during the 2003 breeding season; (Strong and Dakin 2004)). High counts here during the 2004 nesting season included 53 birds at Pond R2, 23 at SF2, and 18 at R1 (Strong and others 2004b). At Warm Springs, Ponds A22 and A23 are used, with > 10 adults found during the 2003 nesting season, and a high count of 32 plovers at A22 in 2004 (Strong and others 2004b). Low densities of Snowy Plovers have been recorded during the breeding season, sometimes with nests or chicks, at some other Alviso salt ponds, primarily at A6 and A8 (Ryan and Parkin 1998b; Strong and others 2004b); the species also nested in the late 1990s in Alviso Pond A3N and in a small impoundment immediately east of Pond A12 (Santa Clara County Bird Data Unpublished). However, Snowy Plovers have not been documented breeding anywhere in Santa Clara County in several years (Strong 2004a).

Outside the study area, Snowy Plovers also breed in Cargill Ponds near the east end of the Dumbarton Bridge (*e.g.*, N2, N3), and north of the San Mateo Bridge in managed ponds in Hayward. The Oliver Salt Ponds, relatively small ponds adjacent to Eden Landing on either side of east end of the San Mateo Bridge, have been used regularly for nesting. In 1989, Feeney and Maffei (1991) found 29 nests here, and 152 individual Snowy Plovers during the nesting season. To the south, in 1995, Hannon and Clayton (1995) found 90 nests in the Newark Ponds near the Dumbarton Bridge. The Patterson ponds, between Ponds N4A and N1A, have also been used regularly by nesting Snowy Plovers. In 2001, eight nests were found here (Marriott and Schelin 2001). Page and others (1979) and Rigney and Rigney (1981) also provide census information for Cargill Ponds between Eden Landing and Warm Springs, but current data on the number of Snowy Plovers breeding in these ponds are not available. Marriott and Schelin (2001) surveyed the Newark ponds and found no nests, and they noted that levee over-topping by Cargill in 2000 had diminished the suitability of levees in these ponds for Snowy Plover nesting. Very few Snowy Plovers have been reported from Newark ponds since 2000. Historic high counts (as of 2001) of nesting birds for major nesting areas area provided in Table 22.

Table 22 – Historic high counts of breeding Snowy Plovers in South Bay salt ponds as of 2001, compiled from various sources and reported in the species' recovery plan (USFWS 2001).

Location	USFWS (2001) High Count
Within Project Area	
Eden Landing	157
Turk Island	31 (some outside SBSP project area)
Warm Springs	7
Alviso (including Knapp)	27
Ravenswood	6
Project Area Subtotal	228
Outside Project Area	
Oliver	43
Coyote Hills	70
Dumbarton	37
Plummer Creek	40
Mowry	10
Moffett/Crittenden	8
Redwood City	9
Redwood Creek/Bair Island	6
Outside Project Area Subtotal	223

Numbers in Table 22 are not from any one year, but represent high counts from surveys conducted any time between the 1970s and 2001. Habitat conditions (including water depth and predator density) change over time at each of these nesting areas, so these numbers are not necessarily representative of the current distribution of Snowy Plovers in the South Bay. For example, Ravenswood salt ponds have been used more extensively in recent years, with > 40 adults in 2003 (Strong and Dakin 2004), and Newark ponds have been used less since 2000 (Marriott and Schelin 2001). However, despite the limitations of the data from outside the project area, it is possible that salt ponds outside the project area, particularly in the Coyote Hills/Newark area between Eden Landing and Mowry Slough, support numbers of nesting Snowy Plovers roughly comparable to those found within the project area. Surveys of these areas are needed to determine the current bay-wide distribution and abundance of the species.

Under the ISP (the implementation of which began in 2004 at some salt ponds), habitat conditions in the Project Area have changed somewhat. Suitable habitat for Western Snowy Plovers has increased, through conversion of "system ponds," which previously held water virtually year-round, to seasonal ponds expected to dry up in summer. The total area of seasonal ponds will increase from 725 acres prior to implementation of the ISP to 3,233 acres after implementation. Thus, distribution of Snowy Plovers may shift over the next several years to include nesting in ponds that have rarely or never been used in the past.

The Snowy Plover is opportunistic, capable of moving around among potential breeding areas and breeding where conditions are suitable. The abundance and distribution of Snowy Plovers in the South Bay shifts annually, and is also dynamic within a given nesting season. Early in each breeding season, many ponds may not be suitable for nesting due to late rains creating muddy substrates, and nesting may be concentrated at a few ponds with suitable conditions. Later in the season, as more ponds dry out and become available for nesting, Snowy Plovers may be more dispersed among many nesting locations, and nest in lower densities. Densities have not been reported for all Snowy Plover monitoring studies in the South Bay, but nest density at four Oliver/Eden Landing ponds averaged 1 nest/6.3 acres, with range of 1 nest per 3.1 to 14.2 acres (Feeney and Maffei 1991).

Primary threats to the Western Snowy Plover are mammalian and avian predators, and human disturbance (Page and others 1995). Non-native predators, such as red fox, have had major effects on populations in California; in the South Bay, two Snowy Plover nests were known to have been depredated by red foxes in 1993 and 1994 in the Coyote Hills and Dumbarton areas (Harding and others 1998), and such events have probably occurred much more frequently than is known. Efforts to curtail nest depredation by mammalian predators have greatly enhanced nesting success by Snowy Plovers in some areas (Neuman and others 2004). In the South Bay, no strong increase in nest success was noted between 1991 and 1996, after a predator management plan was implemented, except at a few nests where exclosures were used; such nests had generally high success rates (Harding and others 1998). Overall nest success in the South Bay has been fairly high in some recent years, with 80% nest success in 2001 (N=78 nests) and most of 2004 (N=54 nests as of July) (Wilson 2004). However, fledging success is unknown, and may be far less due to predation by avian predators.

Avian predators, particularly corvids (crows and ravens), are increasingly becoming an issue for Snowy Plover reproductive success (Wilson 2004). American Crows (*Corvus brachyrhynchos*) and Common Ravens are adept at finding Snowy Plover nests and preying on eggs. Corvid numbers may be increasing throughout California, at least partially in response to increased availability of food from anthropogenic sources, such as garbage dumps. Other avian predators, including Loggerhead Shrikes, American Kestrels, and Northern Harriers have been documented taking Snowy Plover chicks, and in some areas, have dramatically reduced fledging success (Neuman, pers. comm.). Human disturbance can also be a serious factor limiting nesting and fledging success. Human disturbance (including disturbance from domestic dogs) can lead to nest abandonment or direct trampling of eggs or chicks (Page and others 1995). In addition, because young chicks are dependent on adults for protection, human disturbance resulting in the separation of chicks from adults can lead to the death of the chicks.

California Least Tern (*Sterna antillarum browni*). Federal Listing Status: Endangered; State Listing Status: Endangered. Least Terns are small fish-eating birds that nest primarily on beaches. The California Least Tern nests during summer from Baja California north to San Francisco Bay. Least Terns are migratory, and spend winter months in coastal areas of Mexico and Central America. Most breeding colonies are located in southern California. The California Least Tern is listed as endangered on the state and federal levels, and the state considers it a "fully protected" species.

Currently, the breeding colony at Alameda is one of the most important breeding colonies in the state, and as of 2004 was the only nesting colony in San Francisco Bay. In 2003, this colony had 301 breeding pairs (Hurt 2004). This total is up considerably from prior decades: 128 pairs were found in 1993, and only 70 pairs nested in 1982 (Collins 1994). Least Terns nesting at Alameda typically arrive at the colony in late April, and fledge chicks from late June to early August. They forage for small fish in shallow coastal waters near the colony, mainly around Alameda Point (Hurt 2004). Adults and juveniles typically start dispersing south from the Alameda colony in early July.

Least Terns also nested in 2000 and 2001 at Albany (near Alameda), with up to 12 pairs in 2000. At Pittsburg, on Suisun Bay, 13 pairs nested in 2001 and 8 pairs nested in 2003. Historically, small numbers of birds have nested at the Oakland International Airport (last reported in 1995), Bay Farm Island (last reported 1975), Bair Island (last reported 1984), Port Chicago (last reported in 1988), the Bay Bridge Sand Spit (one-time attempt in 1985), and Tern Island (one-time attempt in 1990) (U.S. Geological Survey Unpublished Preliminary Data).

In addition, South Bay salt ponds have been used historically for sporadic and limited nesting attempts. These include attempts on levees at Ponds E10/E11 at Eden Landing (last reported 1985), Ponds N5/N7 (last reported 1983) and N1A in the Newark salt ponds, and Pond R3 in the Ravenswood Compex (Hurt 2004; Wetlands Research Associates 1994a). Currently, however, Least Terns use the SBSP area only as a post-breeding staging area from about late June through late August, prior to their southward migration. Here, both adult and juvenile Least Terns roost on salt pond levees (both outboard levees and interior levees between ponds) and boardwalks, and forage both in the salt ponds and over the open waters of the Bay. At the Alameda colony, Least Terns forage primarily on silversides (*e.g*., topsmelt), northern anchovies, Pacific herring, and surfperches (Elliott and others 2004). Although data are unavailable regarding diet during the post-fledging period in the South Bay, diet is likely similar.

In recent years, the main post-breeding (late summer/fall) staging area for Least Terns in the South Bay has been in the complex of salt ponds immediately north of Moffett Field (Ponds AB1, A2E, and AB2; Figure 14). For example, 276 Least Terns were seen in these three ponds on 27 July 2004 (Steve Rottenborn, pers. obs.). This site is used predictably for roosting and foraging by both adult and juvenile Least Terns in July and August each year, with typical counts of 20 to100 birds. Least Terns have also been recorded at a number of other ponds in the project area, including A1, A2E, A3N, A3W, A4, A5, A7, A9, A10, A11, A14, E10, E11, Hurt (2004), and Krause (pers. comm.). Ravenswood ponds, particularly R1, are used occasionally for foraging and roosting, with counts of 96 in July 2002 (Hurt 2004), 42 in July 2003, and 110 in July 2004 (U.S. Geological Survey Unpublished Preliminary Data). Eden Landing Ponds are also used irregularly for foraging, but 50 Least Terns were observed at pond E1 in August 1996, and several dozen were seen foraging in shallow Bay waters immediately adjacent to E2 in July 2004. USGS recorded 29 Least Terns at Eden Landing in August 2003, and 23 in August 2004 (U.S. Geological Survey Unpublished Preliminary Data). Least Terns have often been observed foraging in South Bay salt ponds, but they also forage heavily in adjacent open Bay waters. For example, 50 of 58 Least Terns observed foraging in the SBSP project area on 14 July 2004 were doing so over the Bay, with only eight individuals actively foraging in salt ponds (Steve Rottenborn, pers. obs.). However, the relative importance of salt ponds versus Bay waters for foraging by Least Terns in the South Bay is largely unknown.

Salt Marsh Harvest Mouse (*Reithrodontomys raviventris*). Federal Listing Status: Endangered; State Listing Status: Endangered. The salt marsh harvest mouse is a small mouse endemic to salt marshes of San Francisco Bay. The USFWS listed the salt marsh harvest mouse as an Endangered Species under the authority of the Federal Endangered Species Act on 13 October 1970, based on population declines and loss of habitat. The State of California listed the salt marsh harvest mouse as an Endangered Species on 27 June 1971, and considers it a “fully protected” species. The USFWS approved a joint recovery plan for the salt marsh harvest mouse and the California Clapper Rail on 16 November 1984 (U.S. Fish and Wildlife Service 1984). Critical habitat has not been established for either the California Clapper Rail or salt marsh harvest mouse.

The salt marsh harvest mouse’s current distribution includes salt marshes in San Francisco, San Pablo, and Suisun Bays. The species no longer occurs on the Peninsula north of Coyote Point (Shellhammer 2000a). *Reithrodontomys raviventris* is separated into two subspecies, *R. r. raviventris* of the South Bay and *R. r. halicoetes* of the North Bay. *R. r. raviventris* is restricted along both sides of San Francisco Bay to an area from San Mateo County on the west side and Alameda County on the east side, south to Santa Clara County; this subspecies was one of the pivotal species upon which the decision to initially establish a National Wildlife Refuge in the South San Francisco Bay was based (H.R. Bill 17047, (1970), and Senate Bill 2291, (1969)).

These mice are dependent on dense vegetative cover, usually in the form of pickleweed and other salt dependent or salt tolerant vegetation in both tidal and diked salt marshes (Fisler 1965; Shellhammer 1982; Shellhammer 2000a; Shellhammer and others 1988; Shellhammer and others 1982). Pickleweed provides more horizontal branches (and therefore more cover) than other halophytic species. Closely tied to the cover of dense pickleweed, salt marsh harvest mice make little use of pure alkali bulrush or pacific cordgrass stands (Shellhammer 1977; Wondolleck and others 1976). Grasslands adjacent to pickleweed marshes are generally used only in the spring when new growth affords suitable cover and possibly forage (Johnson and Shellhammer 1988). Salt marsh harvest mice may also use adjacent grasslands on a daily basis to avoid high tide events, but only a small percentage of the edge of the South Bay has grassland or even much in the way of escape cover adjacent to it, hence the salt marsh harvest mice have almost nowhere to go to escape from high tides. Refugial vegetation, especially that composed of peripheral halophytes, is necessary in tidal marshes and in diked marshes that flood seasonally. On the highest spring tides in winter, the lack of high-tide refugia exposes salt marsh harvest mice to intense predation, and numerous small mammals (many of which are likely salt marsh harvest mice) have been observed being depredated by gulls, herons, egrets, and raptors on such high tides in the South Bay. Marshes without appropriate cover, and narrow marshes without refugial zones into which the mice can escape during flooding or high tides, generally lack salt marsh harvest mice. Figure 16 depicts areas currently providing pickleweed habitat that is known to support, or could potentially be supporting, salt marsh harvest mice within the SBSP project site and adjacent areas, as well as locations where this species has and has not been detected during survey efforts, and locations providing suitable escape cover; relatively few areas provide high-quality habitat.

Salt marsh harvest mice build loose nests of dry grasses (Shellhammer 1982). Average litter size is between 3.7 and 4.2 and most animals are thought to have only one litter per year (Fisler 1965). However, recent evidence shows multiple reproduction (Geissel and others 1988), with reproduction in the Grizzly Island Wildlife Area occurring as often as three times per year (Krause, pers. comm.). Reproduction occurs from March through November (Fisler 1965). There are few data on foraging by harvest mice, but they probably subsist on leaves and stems of plant species, primarily pickleweed, found in tidal and diked salt marshes. Fisler (1965) reported a high seasonal variation in stomach contents. In winter, fresh green grasses were preferred; while in the rest of the year, pickleweed and other halophytes such as salt grass were the main food sources. The salt marsh harvest mouse is capable of drinking pure seawater, but it generally prefers brackish water (Fisler 1965).

Historically, the marshes in San Francisco Bay were a complex mosaic of vegetation zones, generally consisting of low marsh adjacent to mudflats dominated by cordgrass, high marsh plains dominated by pickleweed, and broad transitions of peripheral halophytes (salt-tolerant plants that cannot tolerate as much inundation by the tides) into upland habitats, with narrower transitional zones on natural levees along larger channels within the marshes. Most of the tidal marshes around the Bay and especially in the South Bay were eliminated, and those remaining have lost the upper portion of their pickleweed zones as well as the higher zone of peripheral halophytes (Shellhammer 1982; Shellhammer and Duke 2004). For example, detailed mapping by H.T. Harvey & Associates for the South Bay Salt Pond Restoration project reveals that pickleweed dominated habitat and peripheral halophyte habitat comprise only 92 and 13 acres, respectively, within the 1,600 acre Ravenswood Complex, 638 and 58 acres, respectively, within the 5,500 acre Eden Landing Complex, and 275 acres and 113 acres, respectively, within the 8,000 acre Alviso Complex; much of the peripheral halophyte acreage in the Alviso Complex, however, is adjacent to little used brackish vegetation. Most of the tidal salt marshes in the South Bay are small, isolated strip-like marshes along backshores against levees or other hardened structures that promote predation, inhibit further high marsh development, and are threatened by sea level rise (Shellhammer 1989). Similarly, most of the marshes do not have higher order tidal channels within them and hence lack a pattern of natural levees supporting shrubs such as gum plant, and other peripheral halophytes, within them that might act as escape cover for mice within the marshes. Shellhammer and Duke (2004) note that most of the marshes of the South Bay are de facto corridors, likely not wide enough to support viable populations but wide enough to function as dispersal corridors.

Recent mapping is also documenting the fragmentation of the habitat. For example, sections of bare, riprapped bayfront levees more than 3,500 feet long separate appropriate pickleweed dominated habitat in the Ravenswood Complex (Figure 16). A similar gap of approximately 3,600 feet occurs in the Eden Landing area, between the Alameda Creek Flood Control Channel and the pickleweed-dominated habitat at the “Whale’s Tail” marsh near Old Alameda Creek. Cover-dependent salt marsh harvest mice are unlikely to move long distances over bare areas, and thus, isolation of suitable habitat may lead to genetic isolation of populations. While they are known to swim well, especially in comparison with western harvest mice, they have not been documented to move more than 4 to 5 meters across water or more than 5 m over bare ground (Bias 1994; Geissel and others 1988). The maximum movement through brackish or fresh water vegetation is reported in H.T. Harvey & Associates (Shellhammer 1982) in which two salt marsh harvest mice moved several hundred meters along a levee side-slope at the upper edge of a brackish marsh. Based on this information, Shellhammer and Duke (2004) have hypothesized that barren areas of land more than 5 m wide, reaches of water more than 4 m wide, and brackish or freshwater marsh more than 250 m wide act as barriers to movement of the southern subspecies of the salt marsh harvest mouse, and hence barriers to gene flow. Areas of bare ground, water, or fresh/brackish marsh less than or equal to these distances may act as filters, reducing the movement of animals (and hence the rate of gene flow) between populations or between portions of a semi-fragmented population. The isolation of populations has contributed to the decline of the species (Shellhammer and Duke 2004)and could lead to local extinctions due to demographic processes or genetic “death”. Based on their assessment of potential barriers in the South Bay, Shellhammer and Duke (2004) estimated that there were potentially 25 separate populations of salt marsh harvest mice in the South Bay as of 2002 (not including mice that might be present in very small patches of pickleweed). Figure 16 indicates the locations of major barriers and filters to dispersal of salt marsh harvest mice among the tidal salt marsh remnants in the South Bay.

Habitat degradation has also occurred as a result of the conversion of existing tidal salt marsh to brackish or even freshwater marsh over the past four decades. Within the Alviso Complex, the combination of treated effluent discharge, sedimentation that has reduced the tidal prism, and freshwater flows from rivers and streams (especially in high-rainfall years) has created conditions too fresh for pickleweed to compete and survive (H. T. Harvey & Associates 1994; 1997b; 1998; 1999a; 2000; 2001a; 2002a; 2003; Shellhammer 1982; Shellhammer and others 1988; Shellhammer and others 1982). The habitat value of brackish marsh needs reexamination after recent results in the Suisun Marsh. The brackish species alkali bulrush (*Scirpus robustus*) appears to have little habitat value in either tidal or diked situations in the South Bay, but trapping in salt marsh harvest mouse preserves in the range of the northern subspecies in the Suisun Bay by Barthman-Thompson of CDFG has shown that salt marsh harvest mice do use other species of bulrush and cattail (*Typha* spp.) in the area. This is contrary to the results of trapping conducted in the range of the southern subspecies. Preliminary results from a number of mouse trapping projects (most of which were done in the Suisun Bay) suggest that monocultures of peppergrass, which dominate large areas of brackish marsh in the South Bay, are not used by the mice.

As a result of habitat loss, degradation, and fragmentation, salt marsh harvest mouse populations are low. A database for all salt marsh studies carried out in the South San Francisco Bay, including the entire project area, was compiled by H. Shellhammer at H.T. Harvey and Associates (Shellhammer and Duke 2004). Trapping records from permits issued by the USFWS and the CDFG were reviewed and compiled.

The database, which includes 198 trapping projects (estimated 95% of all such projects and studies) representing 134,204 trap nights (TN) completed through 2003, shows that 37% of all trapping projects (73 of 198, or 49,481 TN of a total of 134,204 TN) captured no salt marsh harvest mice. The average capture efficiency (C.E., or total effort in TN divided by the number of mice captured) of all trapping projects was 0.01268. In terms of unit effort, it took an average of 79 TN to capture one salt marsh harvest mouse. The approximately 64 percent of the projects in which at least one mouse was captured (153 of 198) had a capture efficiency equal to or less than 0.019, or it took 77 TN to capture a single mouse. There were few projects in which numerous salt marsh harvest mice were captured, *i.e.*, in 8 projects was there a C.E. of 0.06 or more.

Thirty-three trapping projects by various firms, agencies and universities have been carried out over the years within the boundaries of the Eden Landing Complex and most of them occurred in the early 1980's, primarily from 1982 through 1986. There are no recorded trapping projects for the marshes within the Ravenswood Complex. The nearest trapping projects to Ravenswood included one on lower Ravenswood Slough, i.e., the southern tip of Greco Island, in 1974-75 and another on lower Flood Slough to the west of the Ravenswood Complex in 1988. The largest of the three complexes, the Alviso Complex, has had eleven projects in the New Chicago area (mostly from the 1970's and 1980's), and eleven or more in the Triangle Marsh and its western extension (north of Alviso), but again most of them date from the 70's and 80's. There are nine or more, widely-spaced projects in the middle of the Alviso Complex: two were done along Guadalupe Slough, six on or near the northwestern edge of Moffet Field, and one in the southeastern corner of the Sunnyvale Baylands Park. The highest density of trapping projects in the area of the Alviso Complex is just to the west of the complex, where 13 projects have been carried out between Charleston Slough and San Francisquito Creek. Most of the harvest mouse trapping projects in the three South Bay Salt Pond complexes were carried out in the late 1980's and 1990's. The reason for the relatively small number of projects within these complexes compared to other parts of the South Bay is because they were protected from development for most of the last few decades.

Despite the species' low populations, the salt marsh harvest mouse is known to rapidly colonize restored areas. This species quickly moves into areas of appropriate habitat from nearby inhabited areas as has been shown in numerous trapping projects' reports. A representative sample of those studies in the South Bay area include H. T. Harvey and Associates (1984a; 1985a; 1985b; 1985c; 1987; 1996; 1997a).

4.5.3 Other Special-Status Species

Western Pond Turtle (*Clemmys marmorata*). Federal Listing Status: None; State Listing Status: Species of Special Concern. The western pond turtle is an aquatic turtle found west of the Sierra Nevada from the Columbia River south to northern Baja, Mexico. This turtle requires some slack or slow water, although it will occur where enough food resources occur in faster moving water; it usually leaves the aquatic site to reproduce, to aestivate, and to over-winter. Typical habitat includes freshwater ponds and backwaters in slow-moving rivers with abundant aerial and aquatic basking sites. Nesting usually occurs in upland areas from March to July, in hard-packed clay soil. Hatchlings disperse from the nest with winter rains. Threats to the western pond turtle include impacts to nesting habitat from agricultural and grazing activities, human development of habitat, and increased predation pressure from native and non-native predators as a result of human-induced landscape changes. Many of the current records for the species are from the greater San Francisco Bay area, including the Santa Clara Valley (Jennings and Hayes 1994).

Western pond turtles are absent from most of the SBSP restoration project area, due to a lack of suitable freshwater habitat. A small population occurs in brackish habitats near Moffett Field and the Sunnyvale WPCP, in the vicinity of Pond A3W (Alderete and McGowan 2003; Figure 14). Here, up to five turtles were found on 31 May 2002, in the "Northern Channel" on the south side of A3W (Alderete and McGowan 2003). This population is clearly isolated from other pond turtle populations in the South Bay. A review of western pond turtle records in Santa Clara County in 1999 (H. T. Harvey & Associates 1999b) included a single record along lower Stevens Creek near Moffett Field from 1987, but the next closest records to Moffett Field were more than 7 miles away at Lagunita at Stanford, along San Francisquito Creek in Palo Alto, and in a pond along San Tomas Aquino Creek in Santa Clara. Pond turtles may occasionally disperse into brackish waters from populations in the upper watersheds of the larger streams in the project area, but they are expected to occur rarely, if at all, at other location within the project area.

Double-crested Cormorant (*Phalacrocorax auritus*). Federal Listing Status: None; State Listing Status: Species of Special Concern (Rookery Site). Double-crested Cormorants are large fish-eating waterbirds resident along the entire coast of California and on inland lakes and estuaries. Breeding occurs at undisturbed sites, typically in trees or on man-made structures beside water. Double-crested Cormorants are considered Species of Special Concern by the CDFG only at rookery sites. Double-crested cormorants nest during spring and summer (and occasionally into early fall), and are resident in the South Bay year-round. Numbers are augmented considerably in fall and winter, when non-breeding birds from other locations visit San Francisco Bay (Ainley 2000b).

Double-crested Cormorants bred have increased as breeders in the San Francisco Bay area in recent decades. First breeding records for Alameda County, the bayside of San Mateo County, and Santa Clara County were established only as recently as 1984, 1989, and 1992, respectively. As of 1991, there were approximately 2,800 Double-crested Cormorants nesting around San Francisco Bay, primarily on North Bay bridges(Ainley 2000b). Relatively few, however, breed in the SBSP project area. Here, this species nests on electrical transmission towers at several sites, including towers in ponds A18, AB1, AB2, and A2W, in the Greco Island/Bair Island/Redwood Shores area, and along the western reaches of the San Mateo Bridge ((Strong 2004a); Figure 14). Santa Clara County Bird Data indicate that cormorants were first recorded nesting in the Alviso Complex on electrical towers in Pond A2W in 1992. Nesting by as many as 10 pairs per year at this location has continued through 2004, and new colonies appeared on towers in Ponds AB1/AB2 in 1993 (with up to eight nests in subsequent years) and Pond A18 in 1994 (with a high of 27 nests in 1997). Double-crested cormorants use salt pond levees in the South Bay primarily for roosting, but a colony established in 1998 on the levee between Ponds A9 and A10 has contained up to 70+ nests in years since.

These birds probably forage primarily in the open Bay, but cormorants also forage for fish in salt ponds. Counts from USGS censuses in South Bay salt ponds from 2002 through 2004 peaked in October and November, with high counts of 3,198 at Eden Landing ponds in November 2003 and 1,963 at the Alviso Ponds in October 2003 (U.S. Geological Survey Unpublished Preliminary Data). Numbers during surveys by USGS were lowest from January through March, with high counts typically under 100 birds at each of the three study areas (Eden Landing, Alviso, and Ravenswood). Large foraging flocks occasionally form around high fish concentrations, as indicated by counts of 1,550 in Pond A9 on 9 October 2000 and 1,200 on Shoreline Lake in Mountain View on 16 November 1996 (Santa Clara County Bird Data Unpublished).

White-faced Ibis (*Plegadis chihi*). Federal Listing Status: None; State Listing Status: Species of Special Concern (nesting colony). The White-faced Ibis is a medium-sized wading bird that is an uncommon breeder in California; it is considered a Species of Special Concern only at nesting colonies. White-faced Ibises have nested at only a few locations in California, including the Salton Sea, Honey Lake, isolated locations in the Central Valley, and at Mallard Slough, in the South Bay. Currently, most ibises in California now nest at Kern NWR, in the Central Valley. Nests are built of vegetation, in dense stands of tule, cattail, or similar marsh vegetation.

The only nesting by the White-faced Ibis in the South Bay occurred at Mallard Slough, between Ponds A16 and A18 (Figure 14). Here, six adults were observed in and around a large mixed-species heronry in 1985, and adults were seen carrying nesting material in 1991 and 1992 (Santa Clara County Bird Data Unpublished). However, successful breeding was not documented, and there has been no subsequent evidence of breeding by this species in the South Bay since that time. White-faced Ibises occur irregularly throughout the San Francisco Bay Area during the nonbreeding season.

Northern Harrier (*Circus cyaneus*). Federal Listing Status: None; State Listing Status: Species of Special Concern (nesting). The Northern Harrier is a raptor commonly found in open grasslands, agricultural areas, and marshes. Nests are built on the ground in areas where long grasses or marsh plants provide cover and protection. Harriers hunt for a variety of prey, including rodents, birds, frogs, reptiles, and insects by flying low and slowly in a traversing manner. Northern Harriers are considered Species of Special Concern in California only at nesting sites.

This species is a common forager over San Francisco Bay marshes and extensive areas of ruderal habitat immediately surrounding the Bay, particularly during the non-breeding season (winter) when migrant and wintering birds augment the local resident population. Northern Harriers breed in small numbers within the South Bay, nesting in the larger expanses of tidal marsh that remain, such as Triangle Marsh in Alviso, the Warm Springs marshes, the Palo Alto/East Palo Alto marshes, Greco Island, and Bair Island. This species also nests in extensive tracts of tall ruderal vegetation, moist fields, and nontidal or muted tidal marsh, such as occurs on Moffett Field and in the Palo Alto Flood Control Basin. The minimum patch size needed to support a pair of nesting harriers in the South Bay is unknown, and the narrow strips of marsh along some of the sloughs between salt ponds in the study area are likely too narrow to provide suitable nesting habitat for this species. However, nest-building along Guadalupe Slough near the Sunnyvale WPCP in 1993 and a successful nesting along Mountain View Slough, between Ponds A1 and

A2W in Mountain View, in 2000 indicates that some of these narrower marshes do provide suitable nesting habitat (Santa Clara County Breeding Bird Atlas Committee Unpublished). Northern Harriers may be important predators of nesting shorebirds and terns in the South Bay, with individuals or pairs “keying in” on certain areas having concentrations of nesting waterbirds. This species has been known to take both adult and young Snowy Plovers in the Eden Landing Complex (Krause, pers. comm.).

White-tailed Kite (*Elanus leucurus*). Federal Listing Status: None; State Listing Status: Fully Protected Species. This raptor species prefers habitats with low ground cover and variable tree growth. Kite nests are usually built near the tops small trees or large shrubs near open habitats, such as partially cleared or cultivated fields, grassy foothills, and marsh. Kites prey primarily on small rodents (especially the California vole), but also feed on birds, insects, reptiles, and amphibians.

This species occurs in the South Bay commonly throughout the year, primarily in the upland fringes of the project area. Breeding occurs primarily in spring and early summer, although breeding activity as early as February, with young in the nest as late as October, has been noted in the South Bay (Santa Clara County Bird Data Unpublished). This species breeds in a number of locations around the SBSP project area where nest sites (*e.g*., trees and shrubs) occur adjacent to open fields, ruderal habitats (e.g., active and closed landfills), and marshes.

Merlin (*Falco columbarius*). Federal Listing Status: None; State Listing Status: Species of Special Concern (wintering). The Merlin is a medium-sized falcon that breeds in North America primarily in Canada. Merlins do not breed in California, but have been listed as a Species of Special Concern due to concerns over the specie’s wintering populations here. Non-breeding Merlins occur in the San Francisco Bay area from September through April.

Like most falcon species, the Merlin feeds primarily on small birds. Merlins are widespread, but in low abundance, throughout the entire Bay area during migration and winter, where they forage aerially. Shorebirds (*e.g.*, sandpipers) provide abundant prey, thus Merlins can often be found foraging over salt ponds and mudflats. They also forage on a variety of other bird species, and can be found in virtually all habitats in the SBSP project area.

California Gull (*Larus californicus*). Federal Listing Status: None; State Listing Status: Species of Special Concern (nesting colony). The California Gull breeds colonially throughout the western United States, often in colonies of several thousand birds. They typically start attending colonies in early April, and lay eggs in early May (Winkler 1996). Incubation takes about 27 days, and chicks hatch in the late May to early June. Chicks remain near the nest until fledging about six weeks after hatching. Typical nesting habitat is barren or sparsely vegetated borders of saline lakes. Abundant nesting populations from the Great Basin (*e.g.*, Great Salt Lake) disperse to coastal California after breeding, greatly augmenting the wintering population in the Bay area.

Historically, California Gulls bred primarily on saline inland lakes, and this species was declared a Species of Special Concern at nesting colonies by CDFG due to concern over impacts to inland breeding colonies.   In 1980, a small group colonized abandoned levees on Pond A6 in Alviso. This colony steadily increased in size over the next two decades, and by 2000 this colony had grown to over 10,000 nesting individuals, making it the second largest colony in California (Shuford and Ryan 2000). Adult California Gulls attend the Pond A6 colony year-round, but numbers increase during spring. Egg laying occurs between mid-April and mid-May, and most young are fledged by mid-August (Shuford and Ryan 2000). Adult California Gulls breeding in the South Bay forage on natural prey, such as brine flies and their larvae, and brine shrimp, supplemented by food obtained from human sources, including the Newby Island Landfill near Milpitas and the Tri-Cities Landfill in Fremont. It is likely that the availability of food at these landfills has been at least partly responsible for the increase in South Bay breeding populations, both by providing food during the breeding season and by aiding in the survival of younger birds during the nonbreeding season. The degree to which California Gulls prey on the eggs or young of other birds, such as Snowy Plovers, American Avocets, and Black-necked Stilts, or on salt marsh harvest mice, is unknown. However, California Gulls at Mono Lake are known to prey on Snowy Plover eggs and chicks (Page and others 1983), and given the abundance of California Gulls in the South Bay during the breeding season, even low levels of predation may be important to nesting waterbirds.

Table 23 – Numbers of California Gulls at colonies in ponds in the SBSP area, from 1982 to 2004. All numbers are either total number of adults counted on the colony, or twice the number of nests counted on the colony. Dash = no data. Data from Strong (Strong 2004b).

Year	A1	AB2	A6	A9/10	M4/5	M1/2	M11/26	N1A/2A
1982	0	0	412	434	0	0	0	0
1983	0	0	1342	0	0	0	--	0
1984	0	0	2000	150	0	0	44	0
1985	0	0	3000	374	0	0	600	0
1986	0	0	3000	97	0	0	398	0
1987	0	0	4000	100	0	0	18	0
1988	0	0	4600	180	0	0	2	0
1989	0	0	5310	434	0	0	30	0
1990	2	0	7600	122	0	0	0	0
1991	0	0	5250	0	0	0	0	0
1992	0	0	5500	200	0	1294	0	0
1993	200	82	6912	234	0	415	0	0
1994	350	556	9000	300	1540	0	0	0
1995	74	300	7236	4	2009	0	0	0
1996	0	282	6558	1410	174	0	0	0
1997	164	1000	6256	1722	3000	0	0	0
1998	0	400	6562	1628	0	480	0	12
1999	145	248	9380	2117	0	475	0	0
2000	0	254	11482	1986	0	2526	0	0
2001	278	624	11216	3056	0	1824	0	0
2002	510	712	11302	3590	0	3120	0	0
2003	862	384	13644	1010	0	4310	0	0

Year	A1	AB2	A6	A9/10	M4/5	M1/2	M11/26	N1A/2A
2004*	445	531	8600	1047	0	2233	0	0

* Numbers are based on a single aerial survey, and are likely underestimates.

California Gulls also nest in smaller numbers at several other sites within the SBSP project area. As of 2004, they are nesting in at least five colonies in the South Bay (Table 23). Figure 11 depicts the locations where this species has nested in the South Bay since 1994. Numbers of California Gulls in the South Bay increase during winter, when the local population is augmented considerably by birds moving from interior populations.

Black Skimmer (*Rynchops niger*). Federal Listing Status: None; State Listing Status: Species of Special Concern (nesting colony). The Black Skimmer is a unique species, with a lower mandible longer than the upper mandible. This extended lower mandible allows these birds to fly over the surface of the water, "skimming" for small fish. Black Skimmers nest primarily on the coasts of the Southeast United States, the Gulf of California, and the Pacific Coast of Baja, California, north to San Diego, and in California, Black Skimmers are considered Species of Special Concern only at nesting sites.

Black Skimmers were first detected nesting in California in 1972, and since that time, this species' populations have increased considerably (*e.g.*, to approximately 1200 pairs in 1995 (Collins and Garrett 1996). Until the mid-1990s, the Black Skimmer was considered a very rare nonbreeding visitor to the San Francisco Bay area. However, the species was documented nesting in San Francisco Bay in 1994, when one pair nested in Pond AB2 in Santa Clara County, and one pair nested at Hayward Regional Shoreline in Alameda County (Layne and others 1996). Since 1994, this species has occurred in the South Bay every year and has nested at several additional sites, including ponds A1, A2W, AB1, A8, A16, E4C, E10, N2A, and R1 ((Strong 2004b); Figure 14). In these areas, Black Skimmers have usually nested among Forster's Terns (*Sterna forsteri*), on small dredge-spoil islands (including both bare islands and islands vegetated, sometimes heavily, with pickleweed) in salt ponds. Exact nesting locations vary from year to year.

Skimmer populations in the South Bay have slowly but steadily increased (e.g., to a high count of 27 in Pond A8 on 28 September 2003; (Santa Clara County Bird Data Unpublished)). Because nesting success in the South Bay has apparently been low, judging by the low number of chicks surviving to fledging age, this population increase has likely been primarily the result of immigration from the increasing southern California population. Within the SBSP project area, the species is most abundant in the vicinity of the Alviso Complex and most post-breeding flocks have been recorded in this area (e.g., on Pond A8 and in Charleston Slough).

Burrowing Owl (*Athene cunicularia*). Federal Listing Status: None; State Listing Status: Species of Special Concern. The Burrowing Owl is a small, terrestrial owl of open country. Burrowing Owls occupy grasslands and sparsely-vegetated shrubland ecosystems. In California, Burrowing Owls are found in close association with California ground squirrels. Ground squirrels provide nesting and refuge burrows, and maintain areas of short vegetation height, providing foraging habitat and allowing for visual detection of avian predators by Burrowing Owls. Burrowing Owls are semi-colonial nesters, and group size is one of the most significant factors contributing to site constancy by breeding Burrowing Owls. The nesting season, as recognized by the California Department of Fish and Game, runs from February 1 through August 31.

Burrowing Owl populations in the South San Francisco Bay have been decreasing rapidly and significantly in recent decades. As of 1990, the South Bay Burrowing Owl population was thought to have declined at least 50% since 1981 (Barclay and others 1998). A statewide census, the largest and most comprehensive undertaken to that date or since, suggested that the rate of disappearance of South Bay Burrowing Owls was greater than the rate found for owls in the Central Valley, and that the rate of decline for both regions was accelerating (DeSante and others 1993; DeSante and others 1997).

Despite recent declines, Burrowing Owls still breed in a number of locations offering suitable burrows and open foraging habitat around the upland perimeter of the South Bay. Such sites include Byxbee Park in Palo Alto, Shoreline Park and Moffett Field in Mountain View, the Sunnyvale Baylands Park, the San Jose/Santa Clara WPCP buffer lands, National Wildlife Refuge lands in Fremont and Newark, the Eden Landing Ecological Reserve restoration site, and a few other scattered locations in SBSP restoration project area. Burrowing Owls are occasionally observed in shoreline, rocky, and upland habitats that rim the South Bay, and they are believed to nest at least infrequently in salt pond levees. This species could nest in the immediate SBSP project area where suitable habitat occurs on levees and in adjacent upland habitats, and it likely forages widely over marshes and ruderal habitats in the project area (Trulio 2000).

Short-eared Owl (*Asio flammeus*). Federal Listing Status: None; State Listing Status: Species of Special Concern (nesting). Short-eared Owls occur in open habitats such as grasslands, wet meadows, and marshes. They require tall herbaceous vegetation for nesting or daytime refuge. Short-eared Owls once bred much more widely in California, including the San Francisco Bay Area. However, the species now occurs primarily as a migrant and winter visitor, and it is a rare and local breeder in the South Bay. The most recent nesting record in the South Bay was of three pairs producing four fledglings at Bair Island in 1994 (Yee and others 1994). Other breeding-season records in the South Bay include a pair at the Palo Alto Baylands in 1966 (Chase and Chandik 1966) and two nests in the Palo Alto Flood Control Basin in 1972 (Gill 1977). The species is apparently much more abundant in the North Bay, with over 100 fledglings banded at Grizzly Island (Solano County) in 1987 (Campbell and others 1987). Potential breeding habitat does occur in the project area, but the status of this species as a breeder in the SBSP project area is unknown. If Shore-eared Owls currently breed in the South Bay, they are likely to nest only in the larger tracts of suitable habitat.

During winter, the species is more widespread, though in low numbers, with many records from bayside locations virtually throughout the project area. Locations of more regular observations in winter include Bair Island, Greco Island, Bayfront Park, Byxbee Park and the Palo Alto Flood Control Basin, Coyote Hills Regional Park, and Hayward Regional Shoreline (just north of the study area). Short-eared Owls are considered Species of Special Concern only at nesting sites.

Loggerhead Shrike (*Lanius ludovicianus*). Federal Listing Status: None; State Listing Status: Species of Special Concern (nesting). These predatory songbirds are year-round residents in grassland

and scrub habitats in California. Shrikes generally build their nests in shrubs and trees in fairly open areas, and nest in spring and early summer. They hunt in open areas, usually from a low perch, such as a fence post or overhead wire. They forage primarily on large insects, lizards, and small mammals, but some individuals also prey on Snowy Plover chicks and other young shorebirds. Loggerhead Shrike numbers have declined dramatically in eastern North America, but populations in California may be more stable. Loggerhead Shrikes are considered Species of Special Concern only at nesting sites.

The species nests in low numbers throughout the SBSP project area. Loggerhead Shrikes are found in a number of locations around the SBSP project area where nest sites (*e.g*., trees and shrubs) occur adjacent to open fields, ruderal habitats (*e.g*., active and closed landfills), and marshes. Shrikes forage in ruderal habitats, on salt pond levees, and in marshes in the project area.

California Horned Lark (*Eremophila alpestris actia*). Federal Listing Status: None; State Listing Status: Species of Special Concern. Horned Larks are songbirds that occur over much of North America in bare ground habitats with short grass, scattered bushes, or no vegetation. In winter, they often form large flocks that sometimes contain several subspecies. The California Horned Lark is a widespread breeder along the coast and in the Central Valley of California. They breed from March through July, with peak activity in May. Horned Larks build grass-lined nests directly on the ground, in dry, open habitats with sparse vegetation.

Horned Larks occur primarily as migrants and winter visitors in the SBSP project area, when they may be found in small numbers foraging along salt pond levees, in salt pans within dried-out salt ponds, and in short grassland and ruderal habitats (*e.g*., active and closed landfills) around the South Bay. A few pairs likely breed in these locations as well, as evidenced by scattered breeding-season records in and around all three salt pond complexes (Steve Rottenborn, pers. obs.; Santa Clara County Bird Data Unpublished).

Saltmarsh Common Yellowthroat (*Geothlypis trichas sinuosa*). Federal Listing Status: None; State Listing Status: Species of Special Concern. The Saltmarsh Common Yellowthroat is a small songbird that inhabits emergent vegetation, primarily in fresh and brackish marshes, and associated upland areas in the San Francisco Bay Area. This subspecies (one of approximately 12 subspecies of Common Yellowthroat recognized in North America) breeds from mid-March through early August, and pairs frequently raise two clutches per year. Because this subspecies cannot be reliably distinguished in the field from other races that occur in the South Bay as migrants, determination of the presence of Saltmarsh Common Yellowthroats can be achieved only by observation of presence during the summer months when other subspecies are not expected to be present. Although little is known regarding the movements of this taxon, the wintering areas have been described as coastal salt marshes from the San Francisco Bay region to San Diego County (Terrill 2000).

Despite their common name, Saltmarsh Common Yellowthroats breed primarily in fresh and brackish marshes. In the South Bay, this species is a fairly common breeder in such habitats virtually wherever they occur, although very small patches of marsh often lack this species. Particularly large populations occur in brackish and fresh marshes in the Alviso Complex (*e.g*., along the middle and upper reaches of the major sloughs and in the Warm Springs/Alviso marshes) and along Alameda Creek and the Alameda

Flood Control Channel in the Eden Landing Complex. Such brackish/freshwater marsh habitat is much less abundant in the Ravenswood Complex; an adult Saltmarsh Common Yellowthroat with two fledglings in the East Palo Alto Baylands on 2 July 1996 was considered the first documented nesting record of the species for the baylands of San Mateo County (Bailey and others 1996), even though it nests commonly in some freshwater wetlands elsewhere in the county. The Saltmarsh Common Yellowthroat likely breeds to some extent in salt marshes providing taller herbaceous vegetation (Ray 1919), as evidenced by the species' presence during the breeding season in such marshes (Santa Clara County Bird Data Unpublished; Santa Clara County Breeding Bird Atlas Committee Unpublished).

Alameda Song Sparrow (*Melospiza melodia pusillula*). Federal Listing Status: None; State Listing Status: Species of Special Concern. The Alameda Song Sparrow is one of three subspecies of Song Sparrow breeding only in salt marsh habitats in the San Francisco Bay Area. Locally it is most abundant in the taller vegetation found along tidal sloughs, including salt marsh cordgrass and marsh gumplant. Populations of the Alameda Song Sparrow have declined due to the loss of salt marshes around the Bay, although within suitable habitat it is still fairly common. The location of the interface between populations of the Alameda Song Sparrow and those of the race breeding in freshwater riparian habitats (*M. m. gouldii*) along most creeks is not known due to difficulties in distinguishing individuals of these two races in the field.

In salt marshes, *pusillula* are most abundant in tall marsh vegetation, particularly in the marsh gumplant/California cord grass association immediately adjacent to tidal sloughs. *Pusillula* are also found in peppergrass in the upper, drier portions of salt marshes and occasionally in brackish marshes dominated by bulrushes (Marshall and Dedrick 1994). Except during very high tides, they make more limited use of the broad expanses of short pickleweed favored by Savannah Sparrows. Along several streams in the South Bay, Song Sparrows seem to be distributed continuously from the upper reaches down to tidal salt marsh. This distribution indicates that *gouldii* and *pusillula* come into contact along these streams, probably at the interface of brackish and freshwater habitats, as Grinnell (1901) found at San Francisquito Creek.

Song Sparrows nest as early as March, but peak nesting activity probably occurs in May and June. Salt marsh-breeding Song Sparrows in the Bay area (including *pusillula*) are known to breed about two weeks earlier than *gouldii* (Johnston 1954; Johnston 1956). This early breeding by *pusillula* is apparently an adaptation to breeding in a tidal environment, as high tides in late spring and early summer may destroy large numbers of nests.

Optimum habitat for this subspecies is tidal salt marsh, although it occurs in tidal brackish marsh, seasonal wetlands, salt pond complexes and other adjacent habitats. Alameda Song Sparrows occur commonly in suitable habitat throughout the South Bay, including the SBSP project area, being particularly abundant in more extensive marshes but also occurring fairly commonly in narrower marshes along tidal sloughs as long as taller herbaceous vegetation for nesting is present.

Tricolored Blackbird (*Agelaius tricolor*). Federal listing status: None; State Listing Status: Species of Special Concern (nesting colony). Tricolored Blackbirds are found almost exclusively in the Central

Valley and central and southern coastal areas of California. This species was originally listed as a Species of Special Concern (at its nesting colonies) in California due to concerns over the loss of wetland habitats in the state. However, in 1992, surveys by the California Department of Fish and Game determined that the population of this species was much larger than previously believed (Beedy and Hamilton 1997), lessening concern for the species.

The Tricolored Blackbird is highly colonial in its nesting habits and forms dense breeding colonies, which in some Central Valley areas may consist of up to tens of thousands of pairs. This species typically nests in tall, dense, stands of cattails or tules, but also nests in blackberry, wild rose bushes and tall herbs. Nesting colonies are usually located near standing or flowing fresh water. Tricolored Blackbirds form large, often multi-species, flocks during the non-breeding period and range more widely than during the reproductive season.

Appropriate breeding habitat for this species in the SBSP project area is limited, and most breeding sites in the South Bay area are well inland from areas of tidal influence. A CNDDB record from 1986 indicates the presence of a colony in North Marsh in Coyote Hills Regional Park, south of the Eden Landing Complex, but no breeding records are known from the immediate SBSP project area. Freshwater-influenced marshes providing fairly extensive stands of tules and cattails are present along upper Artesian, Alviso, and Guadalupe Sloughs, in the Warm Springs marshes, and along the Moffett Channel. However, the Tricolored Blackbird typically nests only in nontidal freshwater marshes, and it is therefore unlikely to use such tidal marshes for nesting.

Salt Marsh Wandering Shrew (*Sorex vagrans halicoetes*). Federal Listing Status: None; State Listing Status: Species of Special Concern. Formerly more widely distributed in the Bay Area, this small insectivorous mammal is now confined to salt marshes of the South Bay (Findley 1955). Salt marsh wandering shrews occur most often in medium-high wet tidal marsh (6 to 8 feet above sea level), with abundant driftwood and other debris for cover (Shellhammer 2000b). They have also been recorded occasionally in diked marsh. This species is typically found in fairly tall pickleweed, in which these shrews build nests. They breed and give birth during spring, although very little is known regarding the natural history of the species.

This subspecies was formerly recorded from marshes of San Pablo and San Francisco Bays in Alameda, Contra Costa, San Francisco, San Mateo, and Santa Clara Counties, but captures in recent decades have been very infrequent anywhere in these areas. Shrews are occasionally captured during salt marsh harvest mouse trapping studies (see Table 18 above), but the difficulty in identifying them to species has precluded a better understanding of the current distribution of this species in the South Bay. As of 1986, there were only four locations, including Bair Island, the Alameda Creek mouth, Dumbarton Point, and Mowry Slough, where this species had been positively identified between 1980 and 1985, although the species was considered likely present in a number of other marshes in the South Bay (Western Ecological Services Company (WESCO) 1986).

This species is likely present, albeit probably in low numbers, in extensive tidal salt marshes within the SBSP project area. Much of the previous discussion of the habitat requirements of the salt marsh harvest mouse, such as extensive salt marsh with high-tide refugia, and of the effects of habitat fragmentation and barriers to dispersal, applies to the salt marsh wandering shrew as well.

Pacific Harbor Seal (*Phoca vitulina richardsi*). Federal Listing Status: None; State Listing Status: None. Pacific harbor seals are currently the only marine mammals that are permanent residents of San Francisco Bay. Although they are not listed by the state as a Species of Special Concern, harbor seals are protected under the federal Marine Mammal Protection Act, and are sensitive to human disturbance. NOAA Fisheries (the agency that oversees the protection of marine mammals) recommends a 100-yard disturbance-free buffer around harbor seals. Disturbance can lead to separation of pups from nursing mothers, can add physiological stress to adults, and can lead to long-term abandonment of historic haul-out sites (Lidicker and Ainley 2000).

Pacific harbor seals occur along the Pacific coast of North America from Alaska south to Baja California. In San Francisco Bay, they haul out at a number of sites to rest and pup (give birth). Most pupping occurs during spring, with a peak in April (Fancher and Alcorn 1982). Females nurse pups for about 28 days, during which time they are susceptible to being separated as a result of human disturbance. Haul-out sites are typically mudflats far from areas used regularly by humans, and near deeper water, where seals forage. Harbor seals forage in nearshore marine habitats on variety of fishes and invertebrates. Kopec and Harvey (1995) studied diet at several haul-out sites in 1991-1992, and found that in the South Bay, major diet items included yellowfin goby (*Acanthogobius flavimanus*), staghorn sculpin (*Leptocottus armatus*), and white croaker (*Genyonemus lineatus*).

More than 10 sites around the Bay may be used by seals at any given time (Lidicker and Ainley 2000), and any undisturbed intertidal habitat accessible to the open Bay could potentially be used by harbor seals. Primary haul-out sites in San Francisco Bay are Mowry Slough (243 seals in 1999), Castro Rocks near the Richmond-San Rafael Bridge (107 seals in 1999), and Yerba Buena Island (72 seals in 1999; (Lidicker and Ainley 2000). Mowry Slough, the most important site in the South Bay, produced 78 pups in 1999, 90 in 2000, 102 in 2001 and 144 in both 2002 and 1003 (Green and others 2004); surveys in April 2004 found 283 seals, including 59 pups, at Mowry Slough and 34 seals, including 9 pups, near the mouth of Coyote Creek at Calaveras Point (Bell Unpublished). At both these sites, mudflats and adjacent pickleweed marsh at various locations may be used at any particular time. Use of haul-out sites varies over time, and other South Bay sites, including Guadalupe Slough near the northeastern end of Pond A3N, the mouth of the Alameda Flood Control Channel, Newark Slough, Bair Island, and Greco Island are currently used or have been important haul-outs historically (Bell Unpublished; Fancher and Alcorn 1982; Kopec and Harvey 1995) (Figure 14).

5. WETLAND TECHNICAL ASSESSMENT

5.1 Survey Purpose

The primary purpose of this effort was to provide a technical assessment of potential jurisdictional waters located within the SBSP pond complexes under conditions existing at the time of the survey, based on reconnaissance-level habitat mapping of each pond complex. The project site has extensive areas of Section 404 and Section 10 jurisdictional Waters; however, efforts to distinguish between current and historic Section 10 Waters were beyond the scope of this study.

5.2 Waters of the U.S. Regulations Overview

5.2.1 Section 404 Wetlands

Section 404 wetlands are defined as those areas inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. Generally, surveys for Waters of the U.S. are conducted by examining the vegetation, soils, and hydrology using the "Routine Determination Method, On-Site Inspection Necessary: (Section D) outlined in the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987). This multi-parameter approach to identifying wetlands is based upon the presence of hydrophytic vegetation, hydric soils and wetland hydrology.

5.2.2 Section 404 Other Waters

"Other waters" in the project area include lakes, seasonal ponds, channels, tributary waters, and former salt ponds. Such areas are identified by the presence of standing or running water and generally lack hydrophytic vegetation. The regulatory jurisdiction within "other waters" extends to the OHW mark on opposing channel banks in non-tidal areas and to the high tide line (HTL) in tidal areas. The OHW mark is typically indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in character of soil, destruction of vegetation, exposed roots on the bank, deposition of leaf litter and other debris materials or lower limit of moss growth on channel banks.

5.2.3 Section 10 Waters

Current Section 10 waters include tidal channels and adjacent special aquatic sites (wetlands, mudflats, etc) up to the limit of the mean high water mark (MHW) in areas currently exposed to fully tidal or muted-tidal action.

5.3 Project Area Description

As described above, the SBSP Restoration Project area consists of three main areas on the shoreline of the southern San Francisco Bay including the Ravenswood, Alviso and Eden Landing pond complexes (Figure 1). The Alviso and Ravenswood Complexes are managed by the USFWS. The Ravenswood Complex is located on both sides of State Route 84 west of the Dumbarton Bridge in San Mateo County. The Alviso Complex is located from Charleston Slough east around the South Bay to the Union Pacific Railroad line north of Mud Slough in Santa Clara County. The Eden Landing Complex is managed by the California Department of Fish and Game and is located between the San Mateo Bridge and the Alameda Creek Flood Control Channel in Alameda County.

The U. S. Fish and Wildlife Service has described the three salt pond complexes using 3 different habitat classifications. These habitats include a great variety of Lacustrine (salt pond), estuarine (salt and brackish marsh, and mudflat), and palustrine (freshwater marsh) wetland resources. These areas therefore include extensive areas that are regulated by Section 10 of the Rivers and Harbors Act of 1899; these include historical and current Section 10 Waters.

The salt pond complexes are underlain predominantly by various phases of the Novato, Alviso and Reyes soils series. These series all consist of very deep, very poorly drained soils in tidal marshes along the margins of San Francisco Bay, including current tidal flats or areas of former tidal flats that have since been converted into the salt ponds.

5.4 Survey Methods

Potential Waters of the U.S. were identified during habitat mapping of each SBSP pond complex during the summer of 2004. Generally, surveys for Waters of the U.S. are conducted by examining the vegetation, soils, and hydrology using the "Routine Determination Method, On-Site Inspection Necessary: (Section D) outlined in the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987). However, given the extensive acreage within the SBSP project area, it was not possible to conduct a routine delineation based on this three-parameter method.

While the SBSP complexes have been substantially modified over the years (*i.e.*, diked, drained, etc.) in terms of topography, hydrologic conditions and vegetative cover, both the soil and hydrology parameters are expected to be present wherever hydrophytic vegetation can be found. Therefore, all areas dominated by at least facultative-wet hydrophytic vegetation occurring in areas having obvious topography capable of providing adequate hydrology, were expected to meet the criteria for Section 404 wetlands.

The boundaries of potential jurisdictional waters were digitized in the field using two laptop computers equipped with GIS software (ArcView 9), as described above. These computers and software utilized the IKONOS imagery for in-house mapping and subsequent ground truthing of wetland and other water habitats in the field. All mapping was conducted at a scale of 1:2400. Jurisdictional acreages and color-coded figures for the entire SBSP complex were then generated using GIS software (ARCMAP) as performed for the biotic habitats.

Following the digitization process, topographic maps and aerial photographs of the SBSP complexes were reviewed to determine mapping accuracy. These maps included U. S. Geological Survey maps, and the USFWS National Wetlands Inventory Maps for five quadrangles including Redwood Point, Newark, Palo Alto, Mountain View, and Miplitas. The soils underlying each SBSP complex were also reviewed to confirm the hydric status of soils underlying areas mapped as potentially jurisdictional using the *Soil Survey of San Mateo County, Eastern Part, and San Francisco County, California* (Soil Conservation Service 1991), the *Soils of Santa Clara County, California* (Soil Conservation Service 1968), and the *Soil Survey of Alameda County, Western Part* (Soil Conservation Service 1981).

5.5 Summary of Findings

Historically, the majority of the project area was exposed to the full ebb and flow of the tides. These habitats included tidal sloughs and channels, salt marshes above and below the MHW mark, transition zone wetlands extending up to the high tide line, salt pans, and mudflats. This complex of habitats comprises several different categories of jurisdictional waters including Historical and Current Section 10, and Section 404 waters.

Due to several factors, the methodology used to describe and quantify the extent and distribution of potential jurisdictional waters within the defined project boundaries was modified somewhat from the approach commonly employed by following the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987), definitions contained in federal regulations, and guidance provided in Regulatory Guidance Letters. These factors included:

- The approach was to utilize the vegetation signatures on the aerial imagery for mapping these habitats with field verification. This task was conducted with a high degree of certainty, as the vast majority of the ponds possess obvious wetland characteristics.
- The vast majority of the project site consists of former salt ponds.
- The outboard side of the levees support bands of tidal marsh most of which are dominated by pickleweed (*Salicornia virginica*). All of the dominant plant species observed on site (and their wetland indicator status) can be found in the Habitat Mapping section of the report.
- The portions of the study area targeted for restoration are currently not tidally influenced. The primary source of water is surface runoff during the rainfall season, pumping of water as per the ISP, and lateral seepage.

In the absence of reliable elevation data for the study area taken prior to the construction of the levees, the full extent of Historical Section 10 is approximated by the location of the historic sloughs presented in a T-chart taken from 1857. Current Section 10 and 404 jurisdictional waters were identified within the project boundaries and are presented in Figures 17-19. Approximately 16,700 acres of these habitats, including wetlands (2,584 acres) and other waters (14,266 acres; salt ponds, mudflats, salt pan and open water) were identified on site.

The remainder of the project site (*i.e.*, uplands; approximately 1,421 acres) met none of the regulatory definitions of jurisdictional waters under Section 404 of the Clean Water Act nor Section 10 of the Rivers and Harbors Act. A summary of habitat acreages for the project site is presented in Table 24.

Table 24 – Jurisdictional Habitat Acreages

Habitats	**Acres**
Upland:	1,421
Current Section 10/ Section 404Wetlands and Other Waters:	16,851
Total:	18,272

5.6 Areas <u>Not</u> Meeting the Regulatory Definition of Jurisdictional Waters

Approximately 1,421 acres of the project site (uplands) did not meet the regulatory definition of jurisdictional waters. Vegetation characteristic of these upland habitats included numerous ornamental species occurring in landscaped areas adjacent to the pond complexes. Most of the upland habitat is dominated by assemblages of annual, non-native plants that thrive in disturbed areas (ruderal species). This includes all tree, shrub and herbaceous species found in upland areas. The predominant ruderal species in the SBSP Restoration Project area include Italian ryegrass (*Lolium multiflorum*), ripgut brome (*Bromus diandrus*), black mustard (*Brassica nigra*), wild radish (*Raphanus sativus*), Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*), wild oats (*Avena fatua*), yellow star-thistle (*Centaurea solstitialis*), common sow thistle (*Sonchus oleraceus*), bull thistle (*Cirsium vulgare*), bristly ox-tongue (*Picris echioides*), rabbitsfoot grass, brass buttons, alkali heath, and coyote brush (*Baccharis pilularis*).

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PERSONAL COMMUNICATIONS

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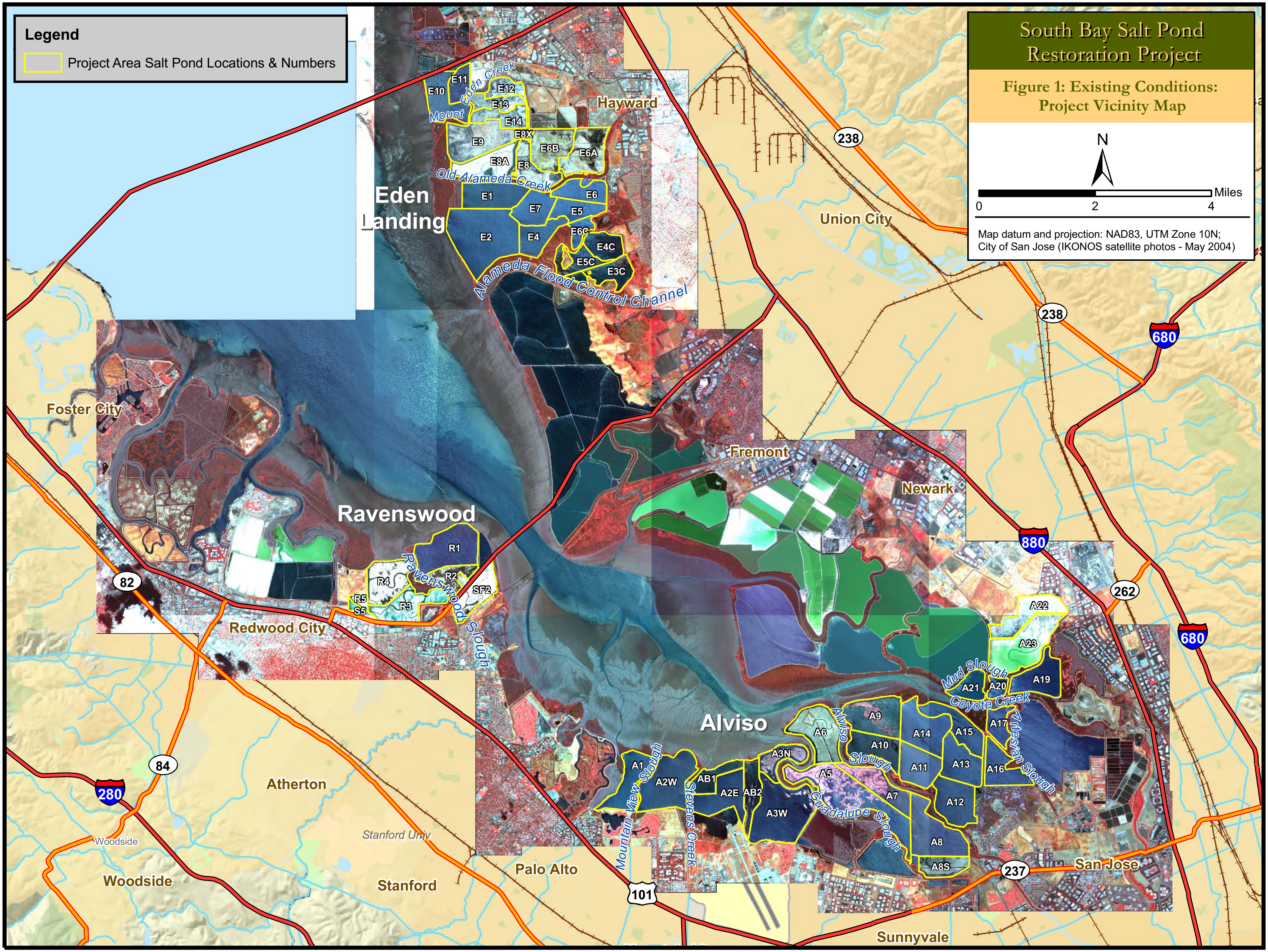


South Bay Salt Pond Restoration Project
Figure 1: Existing Conditions: Project Vicinity Map
Legend
Project Area Salt Pond Locations & Numbers
N
Miles
0
2
4
Map datum and projection: NAD83, UTM Zone 10N;
City of San Jose (IKONOS satellite photos - May 2004)
Eden Landing
Hayward
Union City
Fremont
Newark
Ravenswood
Foster City
Redwood City
Alviso
Atherton
Woodside
Stanford
Stanford Univ
Palo Alto
Sunnyvale
San Jose
Eden Creek
Mount
Old Alameda Creek
Alameda Flood Control Channel
Ravenswood Slough
Mud Slough
Coyote Creek
Alviso Slough
Artesian Slough
Guadalupe Slough
Mountain View Slough
Stevens Creek
E1
E2
E3C
E4
E4C
E5
E5C
E6
E6A
E6B
E6C
E7
E8
E8A
E8X
E9
E10
E11
E12
E13
E14
R1
R2
R3
R4
R5
S5
SF2
A1
A2W
AB1
A2E
AB2
A3W
A3N
A5
A6
A7
A8
A8S
A9
A10
A11
A12
A13
A14
A15
A16
A17
A19
A20
A21
A22
A23
238
680
880
262
237
101
82
84
280

Figure 2 – Mean Salinity Comparison for the Three Continuous Data Recorders (floating sensor), derived from the Raw Data.

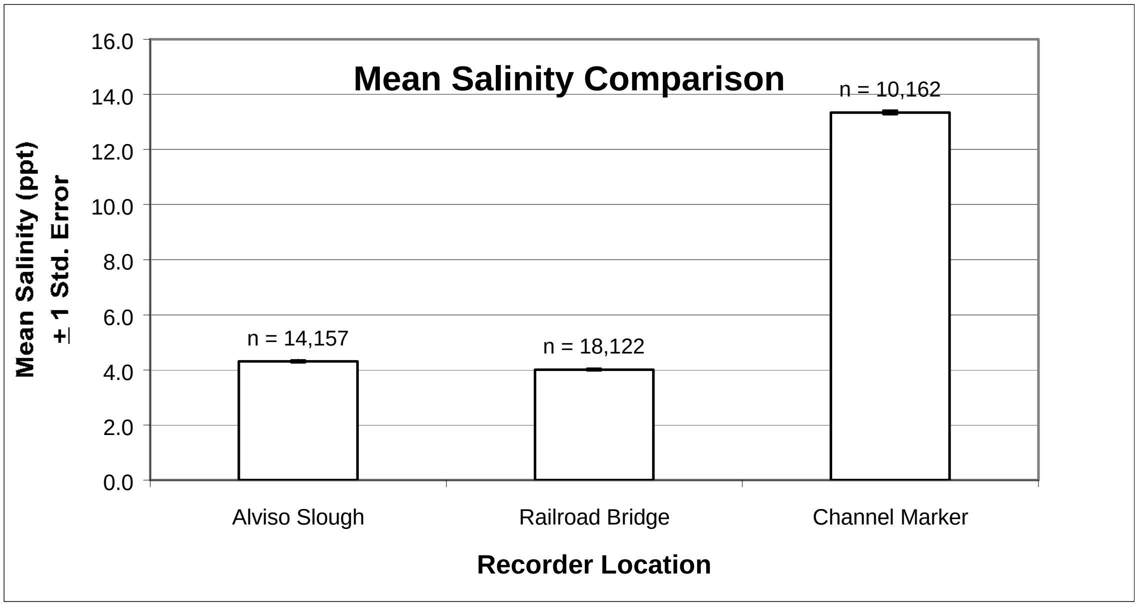


Figure 3 – Mean Interstitial Salinities (ppt) and Standard Error by Habitat Type, September 1999, 2000 and 2001.

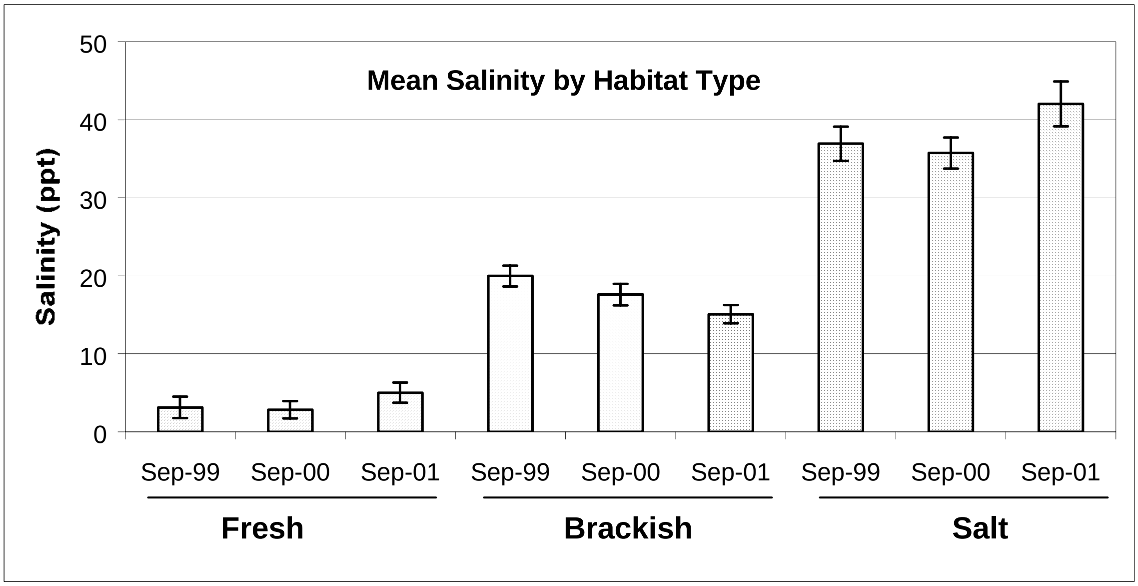
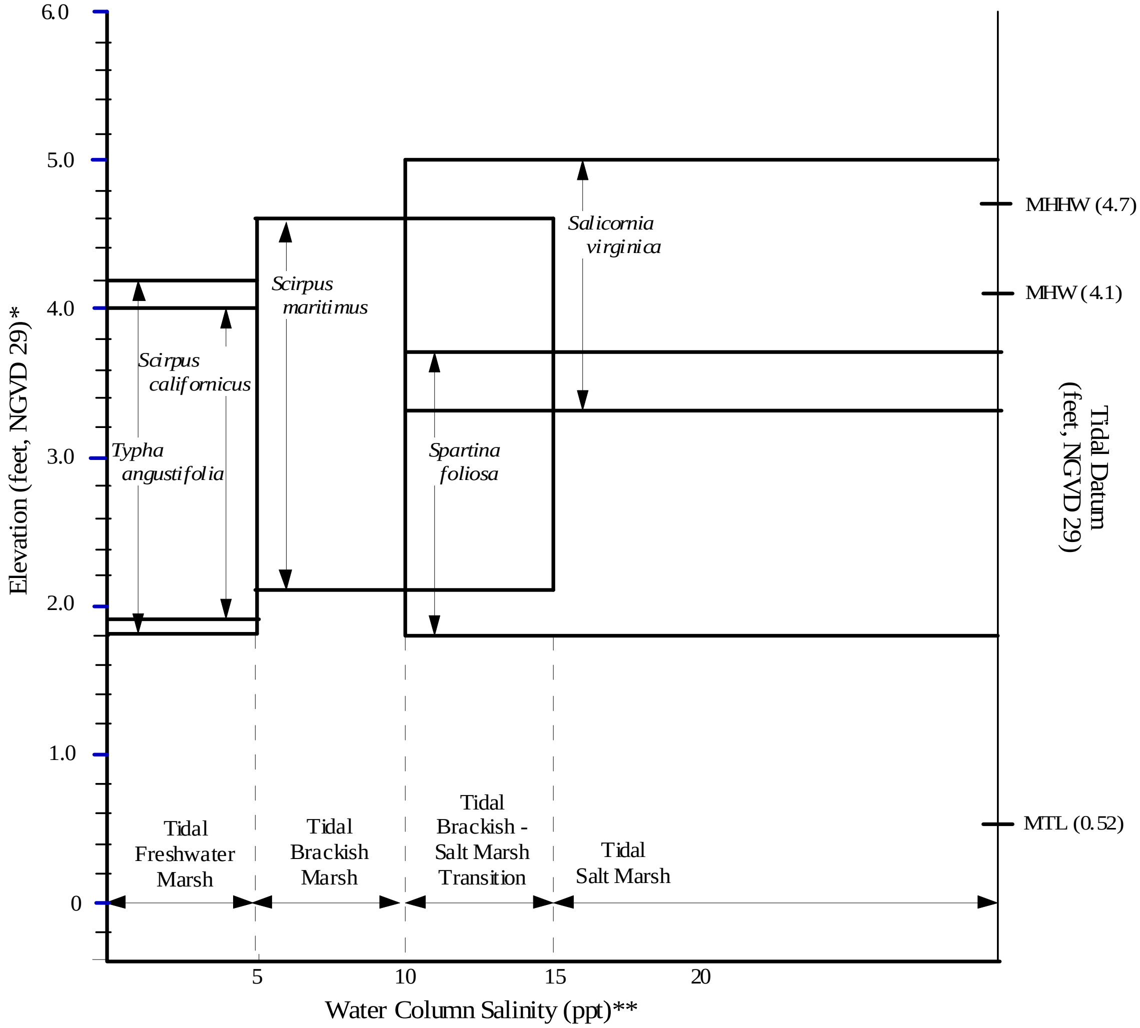
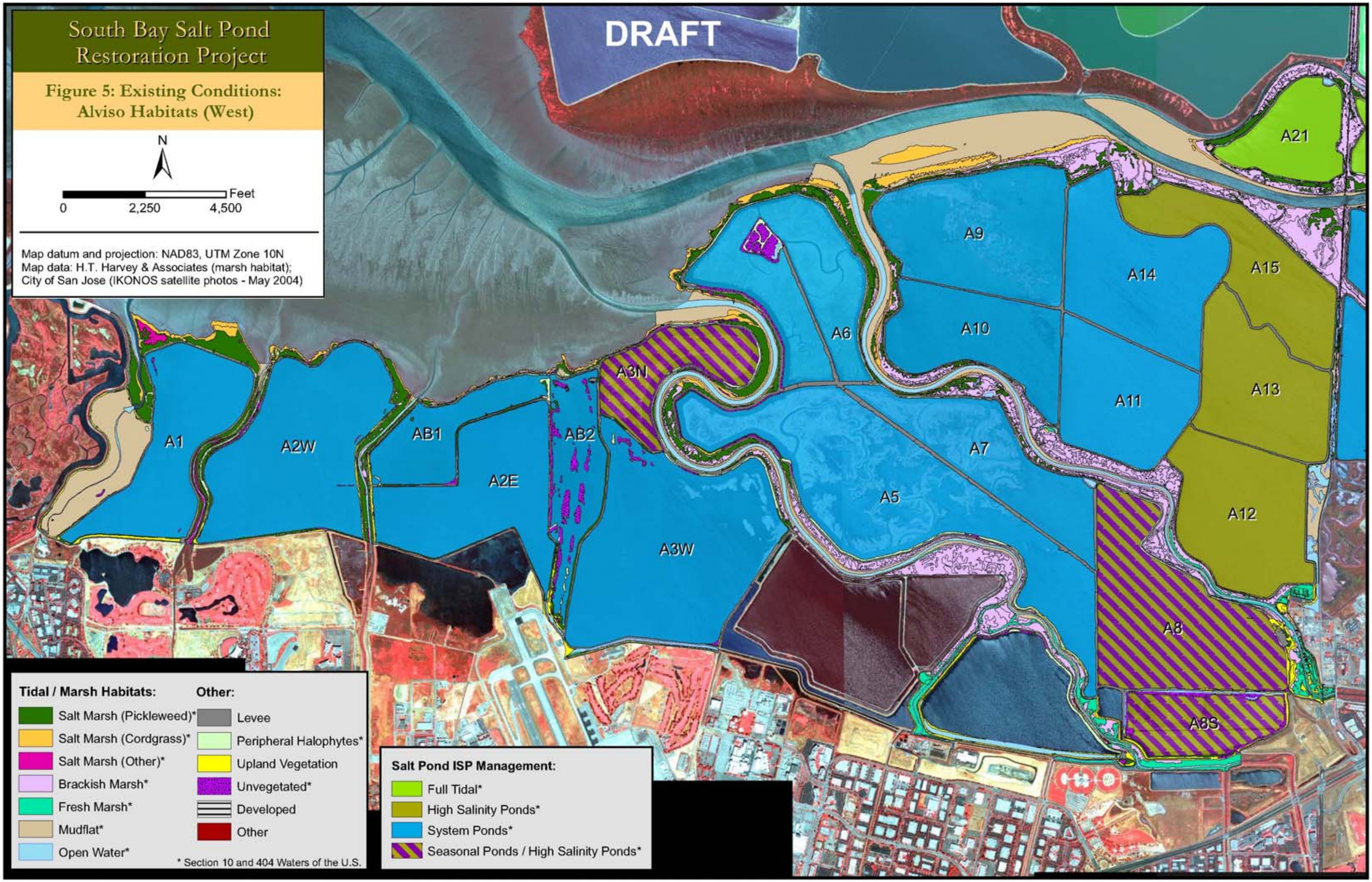
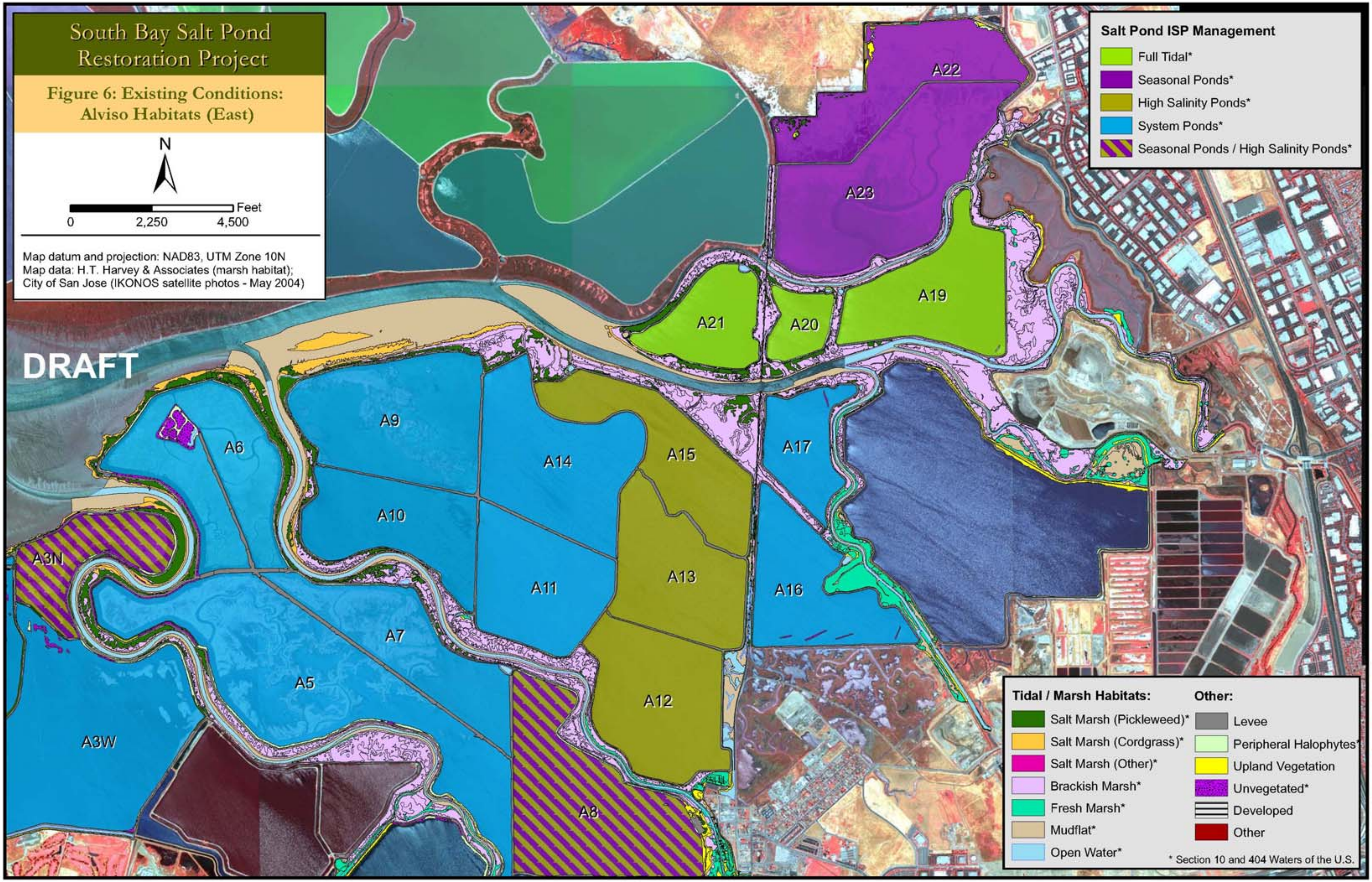


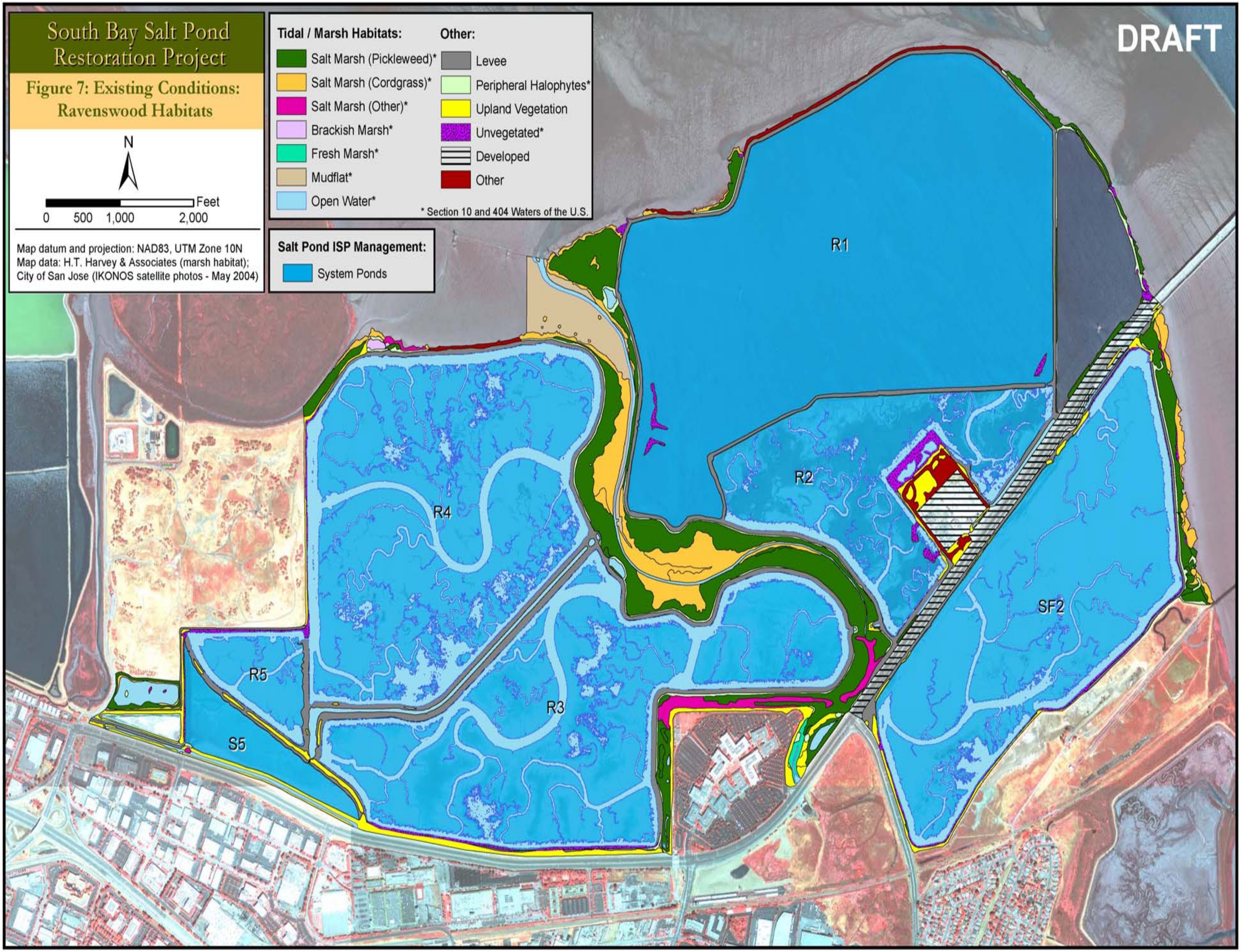
Figure 4 – Approximate Elevation and Water Column Salinity Range of Dominant Plant Species in Tidal Marsh Habitats along the Coyote Creek and Mud Slough (South Bay).



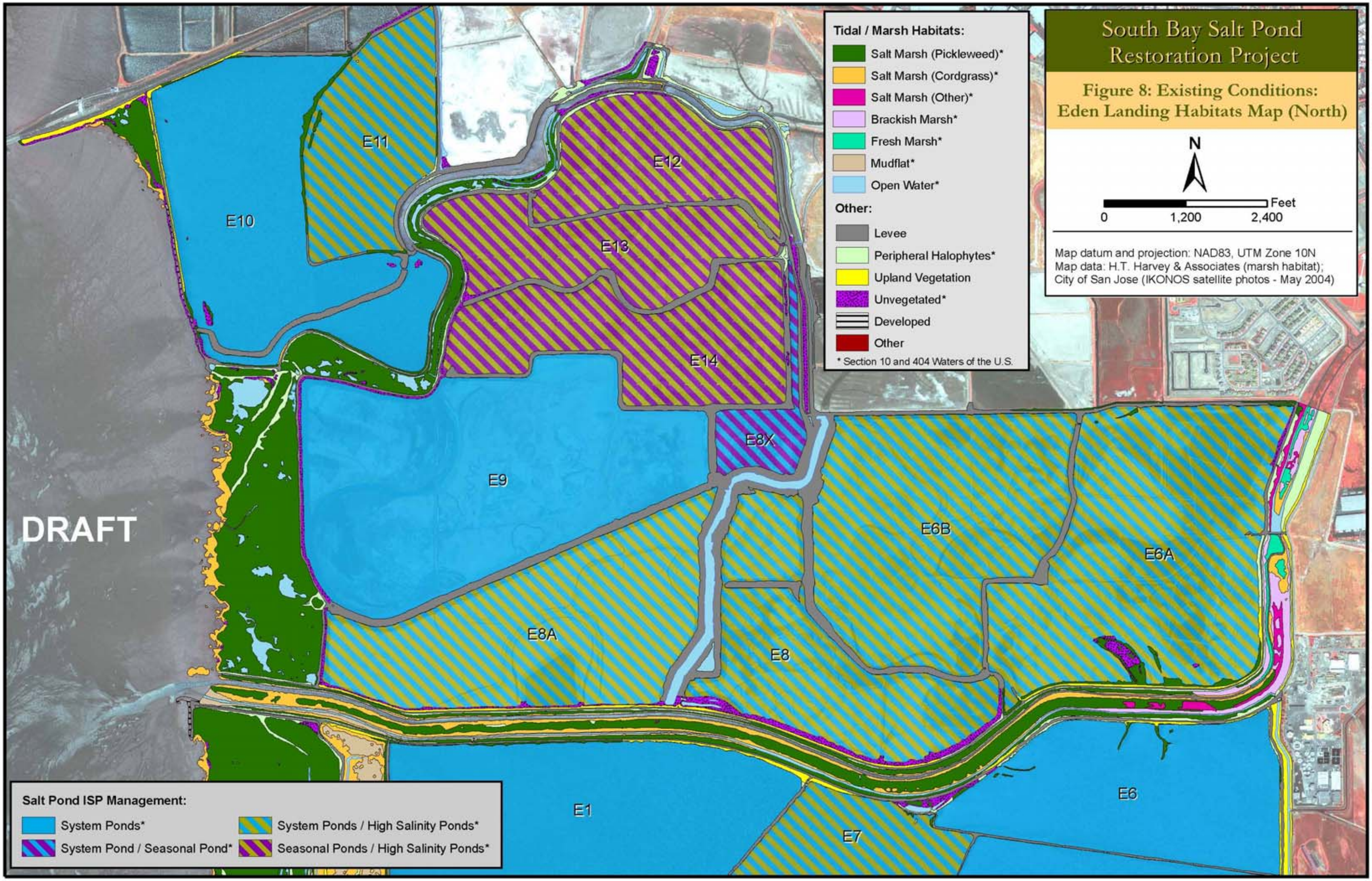
* Shows means of elevation limits. Island Pond Report (2456-01) Appendix B contains complete data.
** Salinity data modeled (Gross, 2003). Elevation and habitat data is empirical.


South Bay Salt Pond
Restoration Project
Figure 5: Existing Conditions:
Alviso Habitats (West)
N
Feet
0
2,250
4,500
Map datum and projection: NAD83, UTM Zone 10N
Map data: H.T. Harvey & Associates (marsh habitat);
City of San Jose (IKONOS satellite photos - May 2004)
DRAFT
A1
A2W
AB1
AB2
A2E
A3N
A3W
A5
A6
A7
A8
A8S
A9
A10
A11
A12
A13
A14
A15
A21
Tidal / Marsh Habitats:
Salt Marsh (Pickleweed)*
Salt Marsh (Cordgrass)*
Salt Marsh (Other)*
Brackish Marsh*
Fresh Marsh*
Mudflat*
Open Water*
Other:
Levee
Peripheral Halophytes*
Upland Vegetation
Unvegetated*
Developed
Other
* Section 10 and 404 Waters of the U.S.
Salt Pond ISP Management:
Full Tidal*
High Salinity Ponds*
System Ponds*
Seasonal Ponds / High Salinity Ponds*

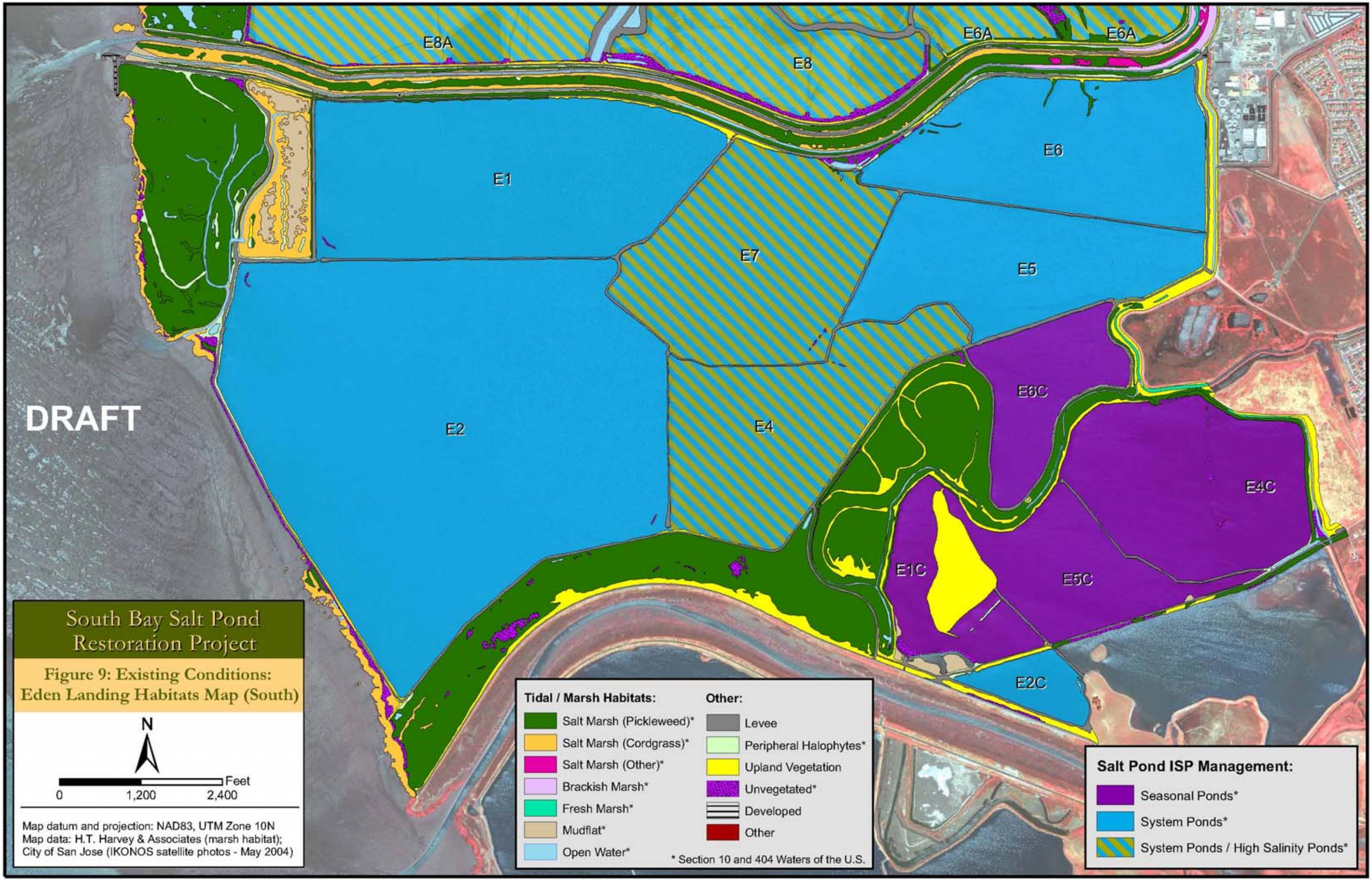

South Bay Salt Pond Restoration Project
Figure 6: Existing Conditions: Alviso Habitats (East)
N
Feet
0
2,250
4,500
Map datum and projection: NAD83, UTM Zone 10N
Map data: H.T. Harvey & Associates (marsh habitat);
City of San Jose (IKONOS satellite photos - May 2004)
DRAFT
Salt Pond ISP Management
Full Tidal*
Seasonal Ponds*
High Salinity Ponds*
System Ponds*
Seasonal Ponds / High Salinity Ponds*
A22
A23
A19
A21
A20
A9
A6
A14
A15
A17
A10
A3N
A11
A13
A16
A7
A5
A12
A3W
A8
Tidal / Marsh Habitats:
Salt Marsh (Pickleweed)*
Salt Marsh (Cordgrass)*
Salt Marsh (Other)*
Brackish Marsh*
Fresh Marsh*
Mudflat*
Open Water*
Other:
Levee
Peripheral Halophytes*
Upland Vegetation
Unvegetated*
Developed
Other
* Section 10 and 404 Waters of the U.S.



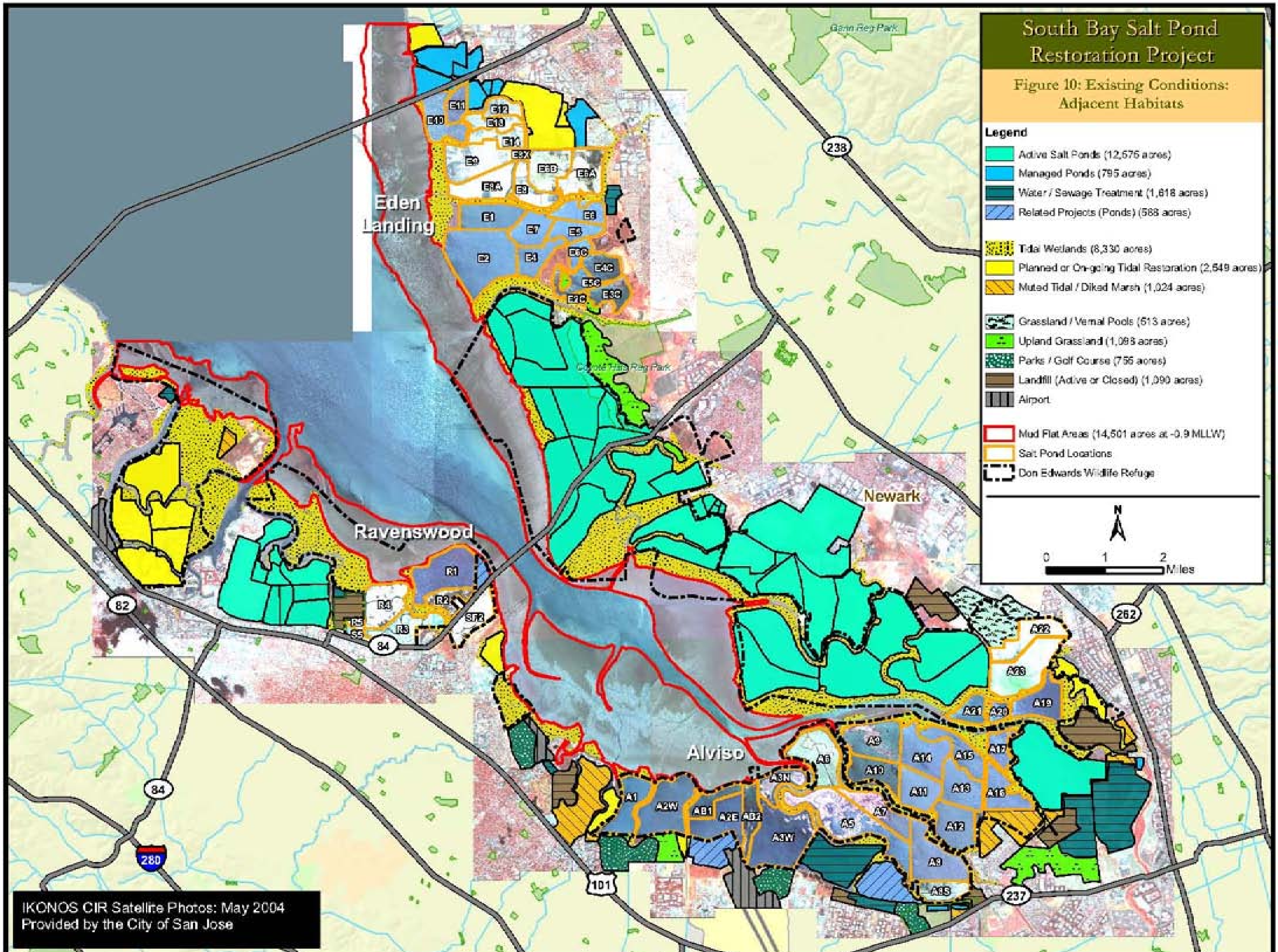
South Bay Salt Pond Restoration Project
Figure 7: Existing Conditions: Ravenswood Habitats
N
0 500 1,000 2,000 Feet
Map datum and projection: NAD83, UTM Zone 10N
Map data: H.T. Harvey & Associates (marsh habitat); City of San Jose (IKONOS satellite photos - May 2004)
Tidal / Marsh Habitats:
Salt Marsh (Pickleweed)*
Salt Marsh (Cordgrass)*
Salt Marsh (Other)*
Brackish Marsh*
Fresh Marsh*
Mudflat*
Open Water*
Other:
Levee
Peripheral Halophytes*
Upland Vegetation
Unvegetated*
Developed
Other
* Section 10 and 404 Waters of the U.S.
Salt Pond ISP Management:
System Ponds
DRAFT
R1
R2
R3
R4
R5
S5
SF2



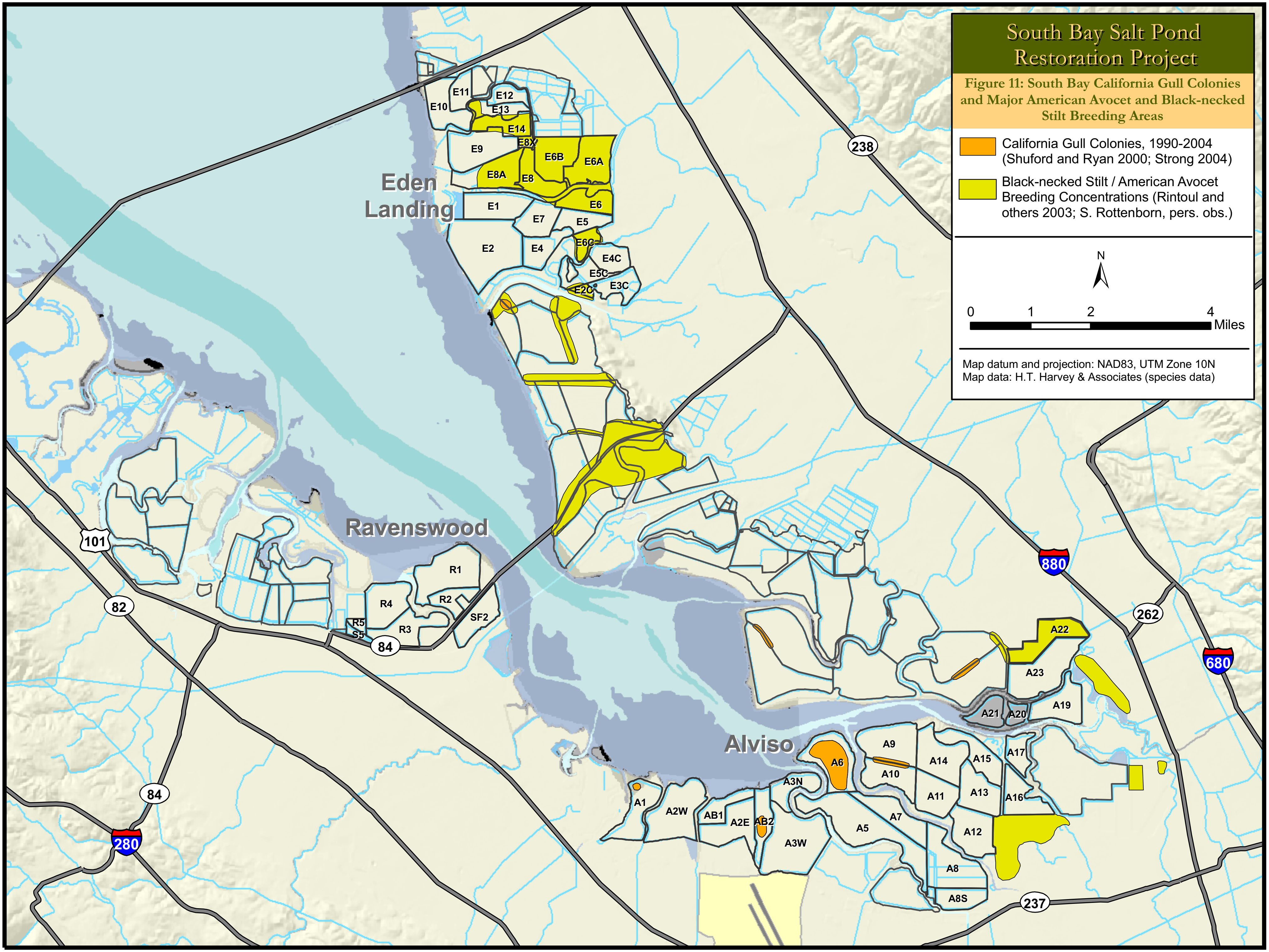
South Bay Salt Pond Restoration Project
Figure 8: Existing Conditions: Eden Landing Habitats Map (North)
N
Feet
0
1,200
2,400
Map datum and projection: NAD83, UTM Zone 10N
Map data: H.T. Harvey & Associates (marsh habitat);
City of San Jose (IKONOS satellite photos - May 2004)
Tidal / Marsh Habitats:
Salt Marsh (Pickleweed)*
Salt Marsh (Cordgrass)*
Salt Marsh (Other)*
Brackish Marsh*
Fresh Marsh*
Mudflat*
Open Water*
Other:
Levee
Peripheral Halophytes*
Upland Vegetation
Unvegetated*
Developed
Other
* Section 10 and 404 Waters of the U.S.
Salt Pond ISP Management:
System Ponds*
System Ponds / High Salinity Ponds*
System Pond / Seasonal Pond*
Seasonal Ponds / High Salinity Ponds*
DRAFT
E10
E11
E12
E13
E14
E8X
E9
E8A
E8
E6B
E6A
E1
E7
E6



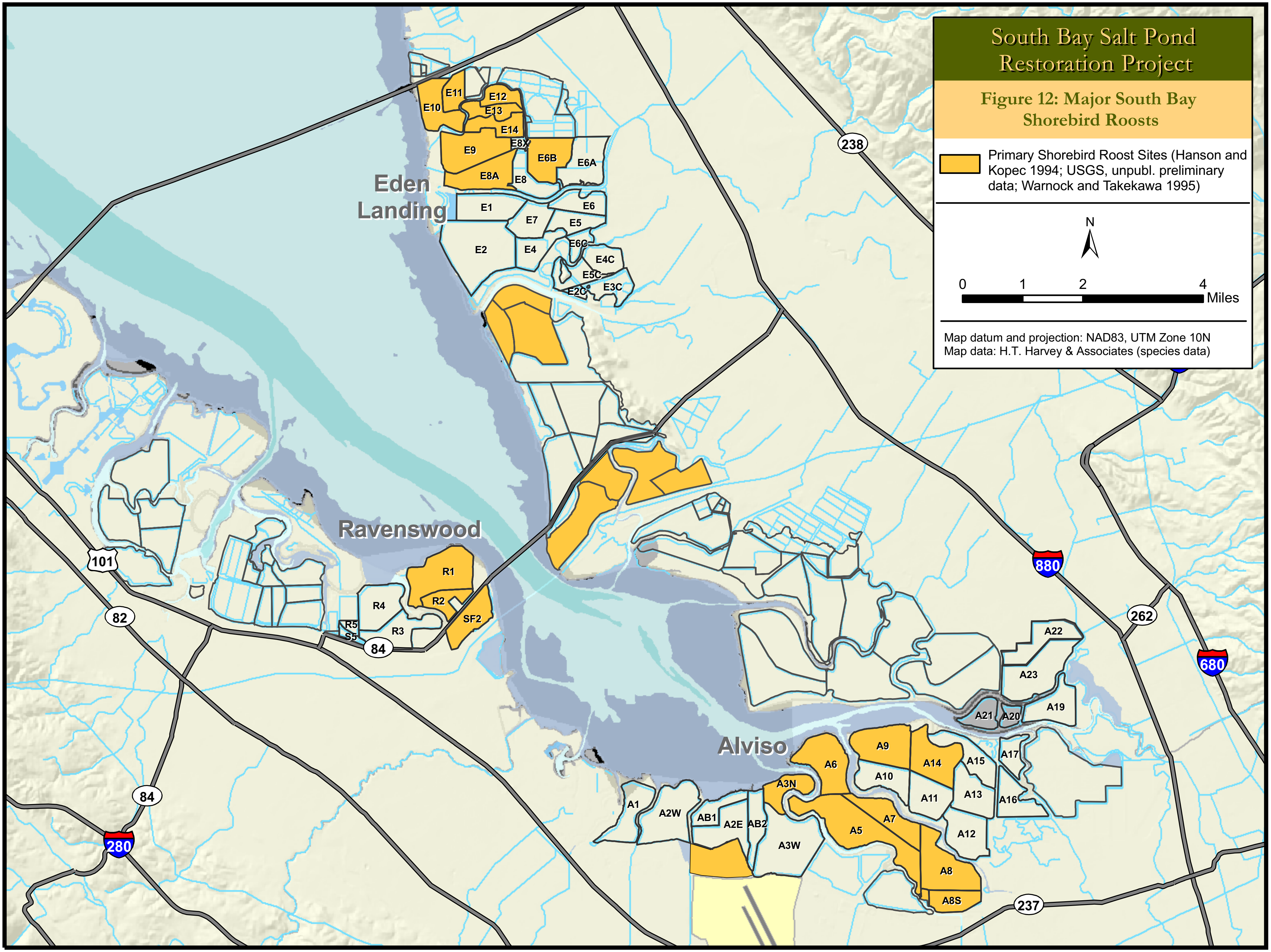
E8A
E8
E6A
E6A
E6
E1
E7
E5
E2
E4
E6C
E4C
E1C
E5C
E2C
DRAFT
South Bay Salt Pond Restoration Project
Figure 9: Existing Conditions: Eden Landing Habitats Map (South)
N
Feet
0
1,200
2,400
Map datum and projection: NAD83, UTM Zone 10N
Map data: H.T. Harvey & Associates (marsh habitat);
City of San Jose (IKONOS satellite photos - May 2004)
Tidal / Marsh Habitats:
Salt Marsh (Pickleweed)*
Salt Marsh (Cordgrass)*
Salt Marsh (Other)*
Brackish Marsh*
Fresh Marsh*
Mudflat*
Open Water*
Other:
Levee
Peripheral Halophytes*
Upland Vegetation
Unvegetated*
Developed
Other
* Section 10 and 404 Waters of the U.S.
Salt Pond ISP Management:
Seasonal Ponds*
System Ponds*
System Ponds / High Salinity Ponds*



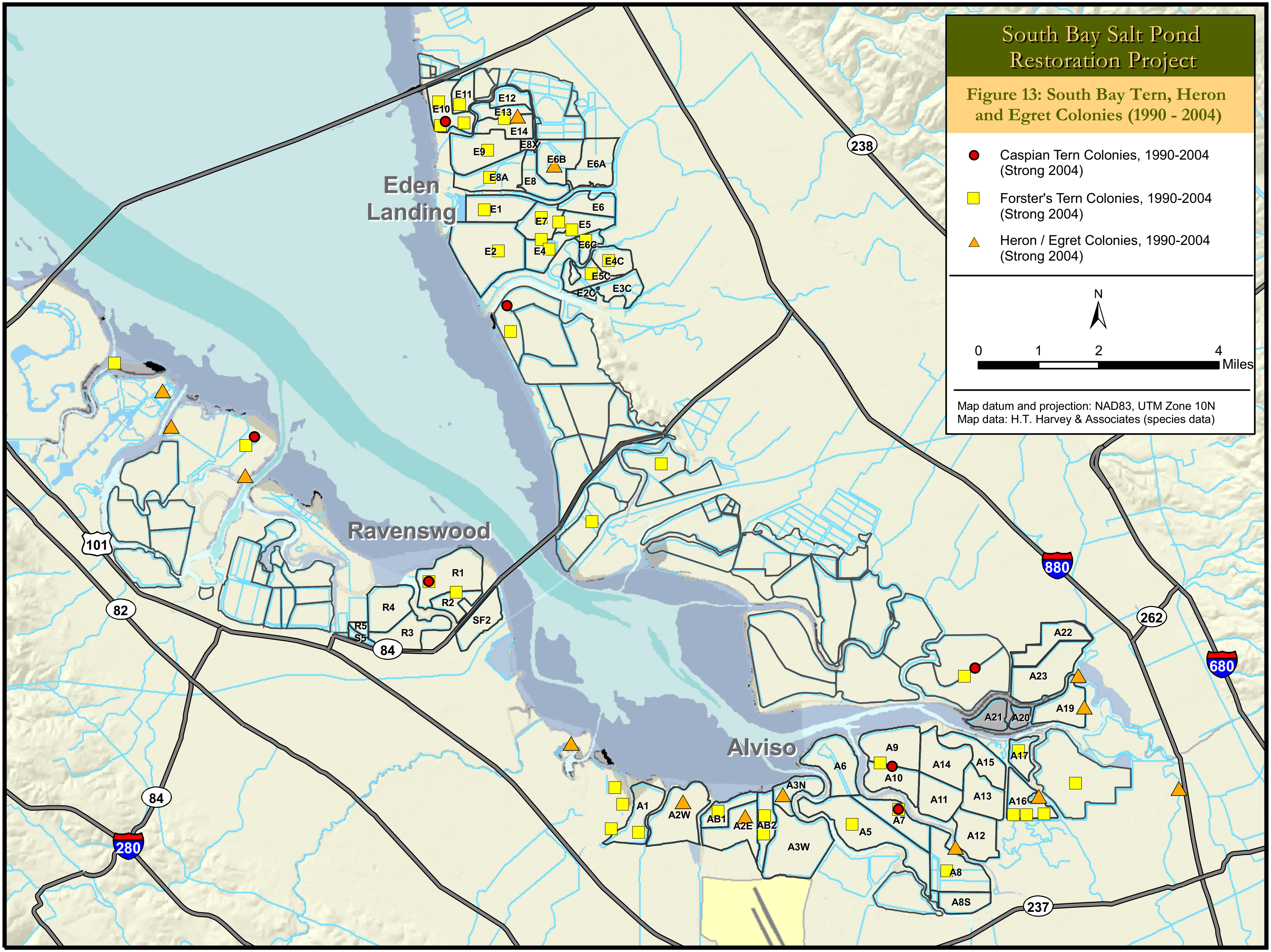
South Bay Salt Pond Restoration Project
Figure 10: Existing Conditions: Adjacent Habitats
Legend
Active Salt Ponds (12,676 acres)
Managed Ponds (795 acres)
Water / Sewage Treatment (1,618 acres)
Related Projects (Ponds) (568 acres)
Tidal Wetlands (8,330 acres)
Planned or On-going Tidal Restoration (2,549 acres)
Muted Tidal / Diked Marsh (1,024 acres)
Grassland / Vernal Pools (513 acres)
Upland Grassland (1,088 acres)
Parks / Golf Course (756 acres)
Landfill (Active or Closed) (1,090 acres)
Airport
Mud Flat Areas (14,501 acres at -0.9 MLLW)
Salt Pond Locations
Don Edwards Wildlife Refuge
N
0
1
2
Miles
Eden Landing
Ravenswood
Alviso
Newark
IKONOS CIR Satellite Photos: May 2004
Provided by the City of San Jose



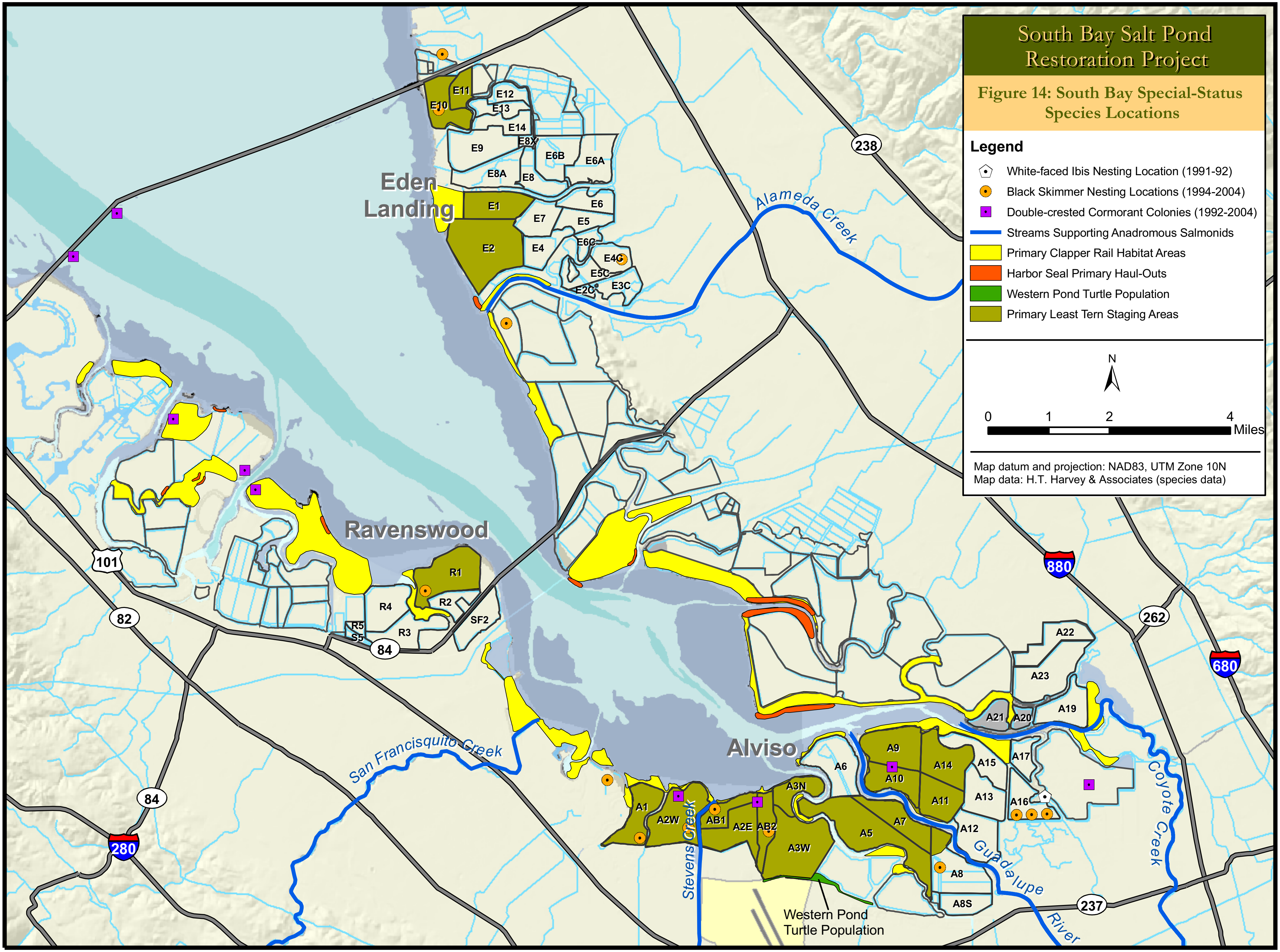
South Bay Salt Pond Restoration Project
Figure 11: South Bay California Gull Colonies and Major American Avocet and Black-necked Stilt Breeding Areas
California Gull Colonies, 1990-2004 (Shuford and Ryan 2000; Strong 2004)
Black-necked Stilt / American Avocet Breeding Concentrations (Rintoul and others 2003; S. Rottenborn, pers. obs.)
N
0
1
2
4
Miles
Map datum and projection: NAD83, UTM Zone 10N
Map data: H.T. Harvey & Associates (species data)
Eden Landing
Ravenswood
Alviso
E1
E2
E4
E5
E6
E6A
E6B
E6C
E7
E8
E8A
E8X
E9
E10
E11
E12
E13
E14
E4C
E5C
E3C
E2C
R1
R2
R3
R4
R5
S5
SF2
A1
A2W
AB1
A2E
AB2
A3N
A3W
A5
A6
A7
A8
A8S
A9
A10
A11
A12
A13
A14
A15
A16
A17
A19
A20
A21
A22
A23
238
880
262
680
101
82
84
280
237



South Bay Salt Pond Restoration Project
Figure 12: Major South Bay Shorebird Roosts
Primary Shorebird Roost Sites (Hanson and Kopec 1994; USGS, unpubl. preliminary data; Warnock and Takekawa 1995)
N
0 1 2 4 Miles
Map datum and projection: NAD83, UTM Zone 10N
Map data: H.T. Harvey & Associates (species data)
Eden Landing
Ravenswood
Alviso
E1
E2
E4
E5
E6
E6A
E6B
E6C
E7
E8
E8A
E8X
E9
E10
E11
E12
E13
E14
E4C
E5C
E2C
E3C
R1
R2
R3
R4
R5
S5
SF2
A1
A2W
AB1
A2E
AB2
A3W
A3N
A5
A6
A7
A8
A8S
A9
A10
A11
A12
A13
A14
A15
A16
A17
A19
A20
A21
A22
A23
101
82
84
280
238
880
262
680
237



South Bay Salt Pond Restoration Project
Figure 13: South Bay Tern, Heron and Egret Colonies (1990 - 2004)
Caspian Tern Colonies, 1990-2004 (Strong 2004)
Forster's Tern Colonies, 1990-2004 (Strong 2004)
Heron / Egret Colonies, 1990-2004 (Strong 2004)
N
0 1 2 4 Miles
Map datum and projection: NAD83, UTM Zone 10N
Map data: H.T. Harvey & Associates (species data)
Eden Landing
Ravenswood
Alviso
E1
E2
E4
E5
E6
E6A
E6B
E6C
E7
E8
E8A
E8X
E9
E10
E11
E12
E13
E14
E4C
E5C
E2C
E3C
R1
R2
R3
R4
R5
S5
SF2
A1
A2W
A2E
AB1
AB2
A3N
A3W
A5
A6
A7
A8
A8S
A9
A10
A11
A12
A13
A14
A15
A16
A17
A19
A20
A21
A22
A23
238
880
262
680
101
82
84
280
237


South Bay Salt Pond Restoration Project
Figure 14: South Bay Special-Status Species Locations
Legend
White-faced Ibis Nesting Location (1991-92)
Black Skimmer Nesting Locations (1994-2004)
Double-crested Cormorant Colonies (1992-2004)
Streams Supporting Anadromous Salmonids
Primary Clapper Rail Habitat Areas
Harbor Seal Primary Haul-Outs
Western Pond Turtle Population
Primary Least Tern Staging Areas
N
0
1
2
4
Miles
Map datum and projection: NAD83, UTM Zone 10N
Map data: H.T. Harvey & Associates (species data)
Eden Landing
Ravenswood
Alviso
Alameda Creek
San Francisquito Creek
Stevens Creek
Guadalupe River
Coyote Creek
Western Pond Turtle Population
E1
E2
E4
E5
E6
E6A
E6B
E6C
E7
E8
E8A
E8X
E9
E10
E11
E12
E13
E14
E4C
E5C
E2C
E3C
R1
R2
R3
R4
R5
S5
SF2
A1
A2W
AB1
A2E
AB2
A3N
A3W
A5
A6
A7
A8
A8S
A9
A10
A11
A12
A13
A14
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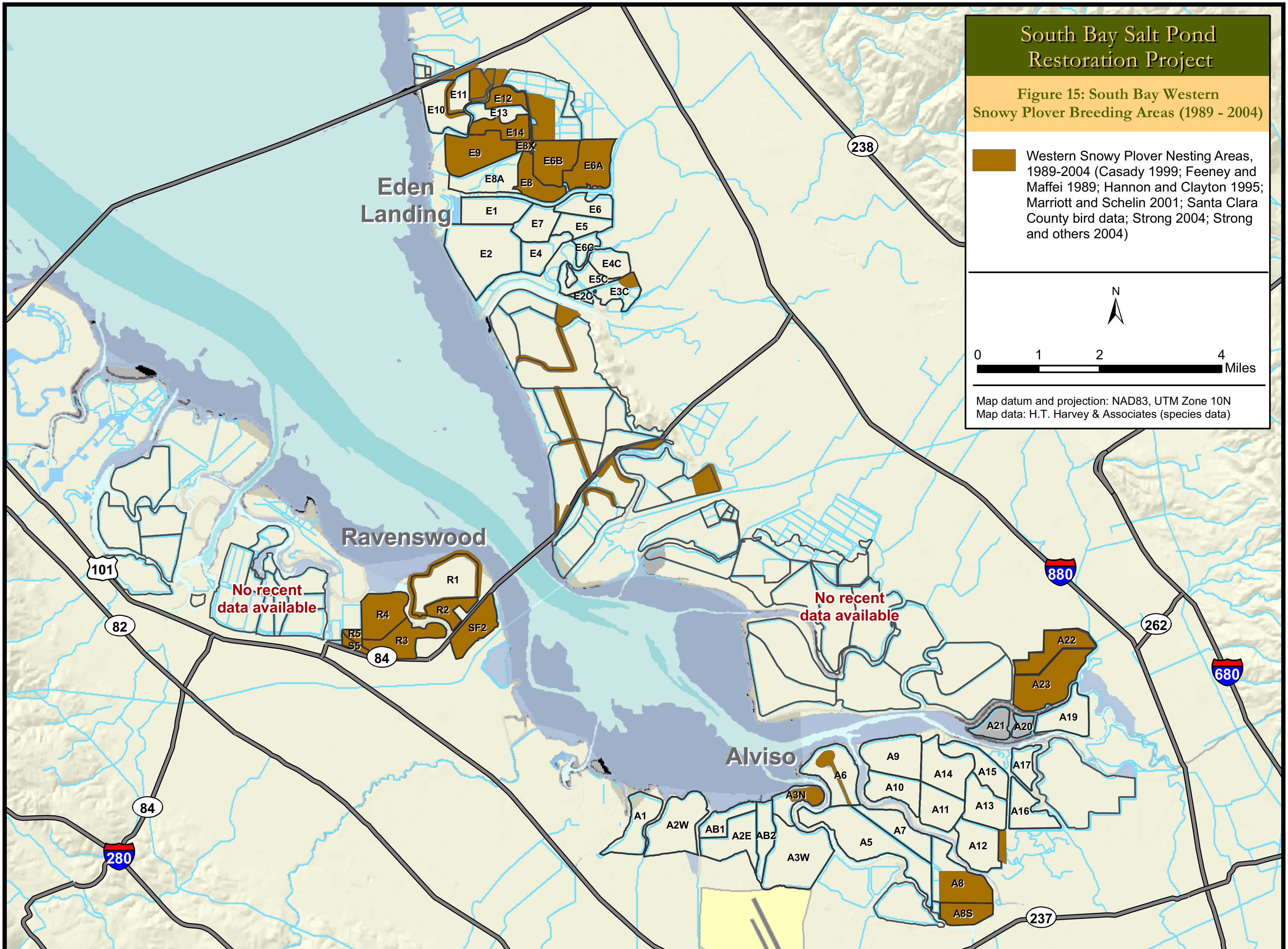
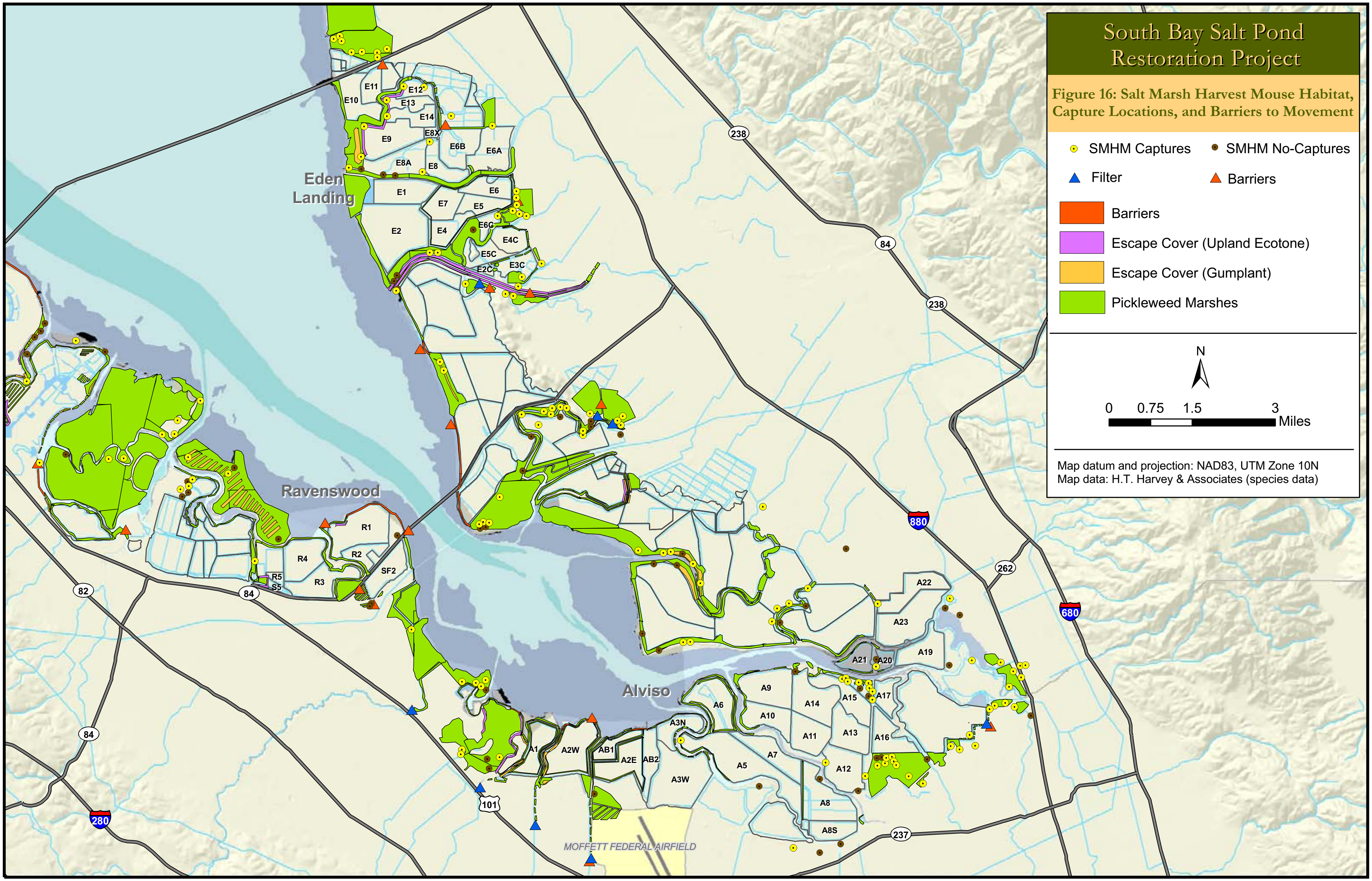
101
82
84
280
237



South Bay Salt Pond Restoration Project
Figure 15: South Bay Western Snowy Plover Breeding Areas (1989 - 2004)
Western Snowy Plover Nesting Areas, 1989-2004 (Casady 1999; Feeney and Maffei 1989; Hannon and Clayton 1995; Marriott and Schelin 2001; Santa Clara County bird data; Strong 2004; Strong and others 2004)
N
0 1 2 4 Miles
Map datum and projection: NAD83, UTM Zone 10N
Map data: H.T. Harvey & Associates (species data)
Eden Landing
Ravenswood
Alviso
No recent data available
No recent data available
E1
E2
E4
E5
E6
E6A
E6B
E6C
E7
E8
E8A
E8X
E9
E10
E11
E12
E13
E14
E4C
E5C
E2C
E3C
R1
R2
R3
R4
R5
S5
SF2
A1
A2W
AB1
A2E
AB2
A3W
A3N
A5
A6
A7
A8
A8S
A9
A10
A11
A12
A13
A14
A15
A16
A17
A19
A20
A21
A22
A23
238
880
262
680
237
101
82
84
84
280


South Bay Salt Pond Restoration Project
Figure 16: Salt Marsh Harvest Mouse Habitat, Capture Locations, and Barriers to Movement
SMHM Captures
SMHM No-Captures
Filter
Barriers
Barriers
Escape Cover (Upland Ecotone)
Escape Cover (Gumplant)
Pickleweed Marshes
N
0 0.75 1.5 3 Miles
Map datum and projection: NAD83, UTM Zone 10N
Map data: H.T. Harvey & Associates (species data)
Eden Landing
Ravenswood
Alviso
MOFFETT FEDERAL AIRFIELD
E1
E2
E4
E5
E6
E7
E8
E8A
E8X
E9
E10
E11
E12
E13
E14
E6A
E6B
E6C
E4C
E5C
E3C
E2C
R1
R2
R3
R4
R5
S5
SF2
A1
A2W
AB1
A2E
AB2
A3N
A3W
A5
A6
A7
A8
A8S
A9
A10
A11
A12
A13
A14
A15
A16
A17
A19
A20
A21
A22
A23
238
84
880
262
680
82
280
101
237

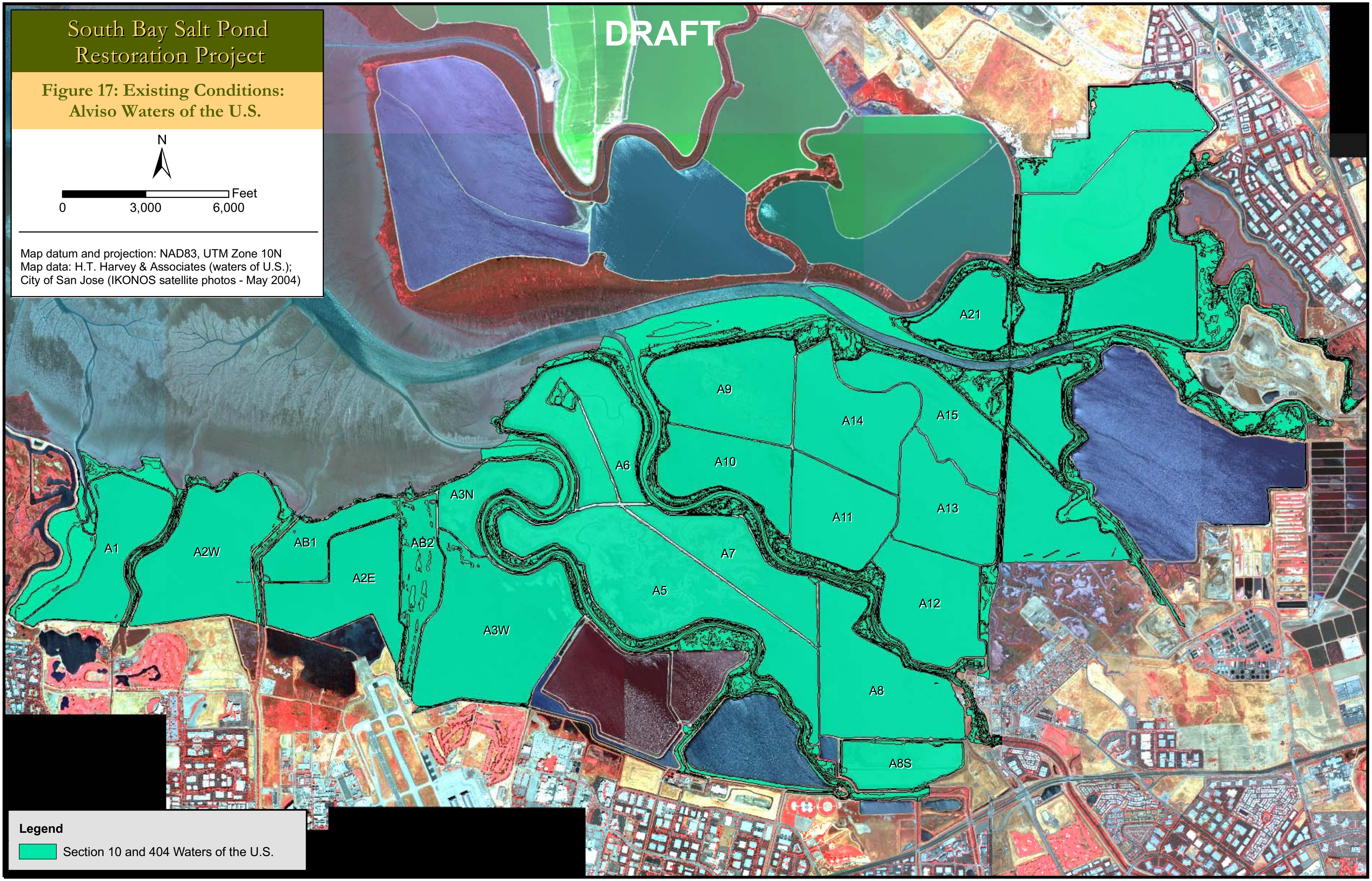
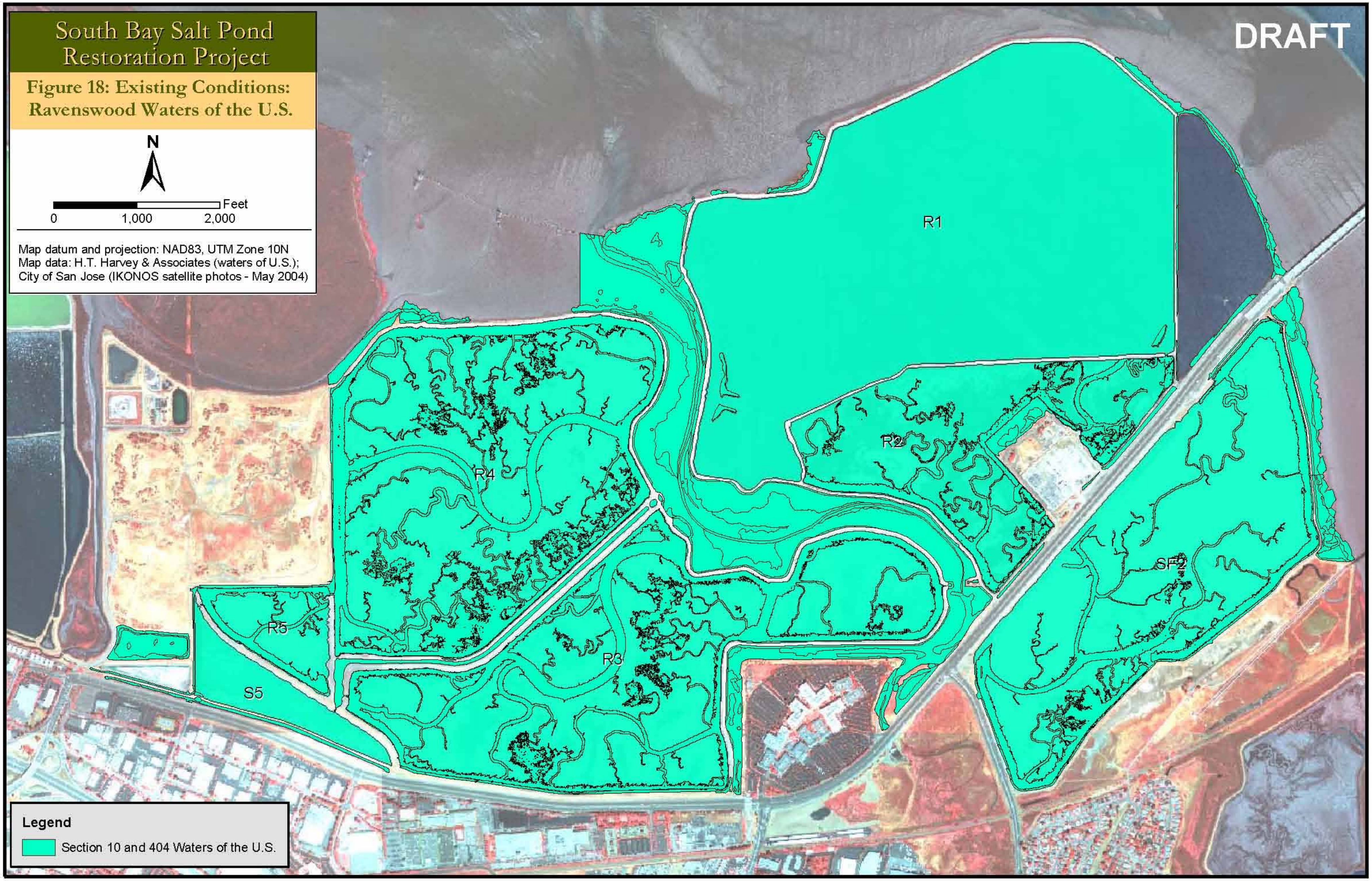
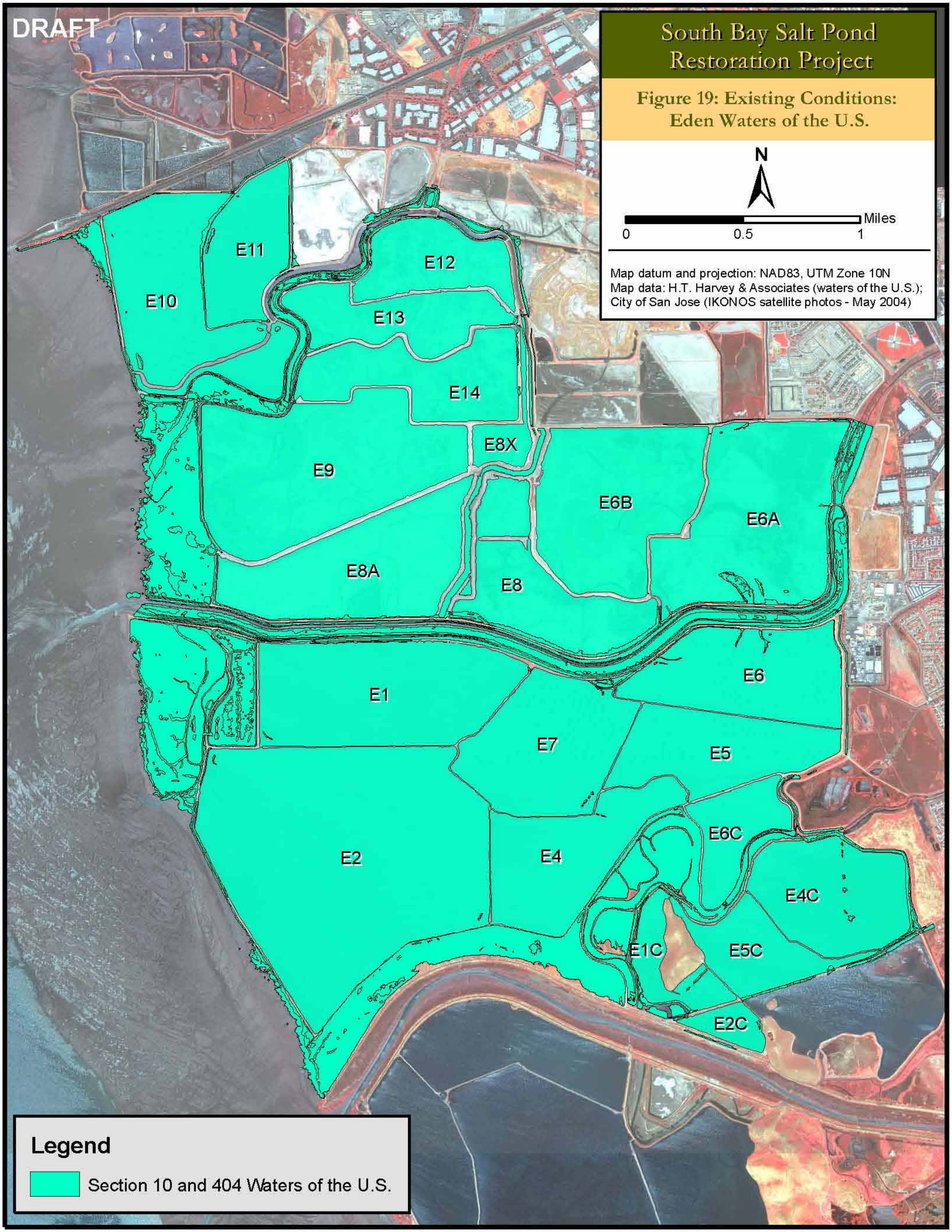


Figure 17: Existing Conditions: Alviso Waters of the U.S.



South Bay Salt Pond Restoration Project
Figure 18: Existing Conditions: Ravenswood Waters of the U.S.
DRAFT
N
Feet
0
1,000
2,000
Map datum and projection: NAD83, UTM Zone 10N
Map data: H.T. Harvey & Associates (waters of U.S.);
City of San Jose (IKONOS satellite photos - May 2004)
R1
R2
R3
R4
R5
S5
SF2
Legend
Section 10 and 404 Waters of the U.S.


DRAFT
South Bay Salt Pond Restoration Project
Figure 19: Existing Conditions: Eden Waters of the U.S.
N
Miles
0
0.5
1
Map datum and projection: NAD83, UTM Zone 10N
Map data: H.T. Harvey & Associates (waters of the U.S.); City of San Jose (IKONOS satellite photos - May 2004)
E10
E11
E12
E13
E14
E9
E8X
E6B
E6A
E8A
E8
E1
E6
E7
E5
E2
E4
E6C
E4C
E1C
E5C
E2C
Legend
Section 10 and 404 Waters of the U.S.

Appendix A

ISP Operations

Pond	Summer Depth (ft)		Summer Change	Winter Depth (ft)		Winter Change	Summer Salinity (ppt)		Summer Change	Winter Salinity (ppt)		Winter Change
	Existing	ISP		Existing	ISP		Existing	ISP		Existing	ISP	
A1	1.8	1.4	-0.4	1.8	1.7	-0.1	26	<40	NS	22	<40	NS
A2W	1.8	1.9	0.1	1.8	2.2	0.4	28	<40	NS	25	<40	NS
A2E	2	2.6	0.6	1.9	3.1	1.2	30	<40	NS	28	<40	NS
AB1	1.4	1.2	-0.2	1.6	1.7	0.1	24	<40	NS	21	<40	NS
AB2	1.2	1	-0.2	1.4	1.5	0.1	26	<40	NS	22	<40	NS
A3W	1.9	1.8	-0.1	2	2.1	0.1	34	<40	NS	30	<40	NS
A3N	0.8	B/S	unknown	0.6	B/S	unknown	27	<40	NS	25	<40	NS
A5	0.7	1	0.3	0.8	1.2	0.4	45	<40	slight -	41	<40	slight -
A6			0									
A7	0.5	0.9	0.4	0.7	1.1	0.4	58	<40	-18	45	<40	slight -
A8	1.4	B/S	unknown	1.8	B/S	unknown	74	<40	-34	60	<40	-20
A9	4.1	2.2	-1.9	4.1	1.7	-2.4	25	<40	NS	24	<40	NS
A10	3.3	2.6	-0.7	3.4	2.3	-1.1	28	<40	NS	26	<40	NS
A11	3.3	3.1	-0.2	3.6	3.2	-0.4	44	<40	slight -	49	<40	-9
A12	3.1	B	unknown	3.7	B	unknown	49	135	86	47	135	88
A13	1.2	B	unknown	2.7	B	unknown	58	135	77	52	135	83
A14	0.8	0.9	0.1	1.5	1.3	-0.2	85	<40	-45	75	<40	-35
A15	2.1	B	unknown	2.3	B	unknown	66	135	69	59	135	76
A16	1.9	1.7	-0.2	2.3	1.6	-0.7	74	<40	-34	67	<40	-27

Pond	Summer Depth (ft)		Summer Change	Winter Depth (ft)		Winter Change	Summer Salinity (ppt)		Summer Change	Winter Salinity (ppt)		Winter Change
	Existing	ISP		Existing	ISP		Existing	ISP		Existing	ISP	
A17	1.4	1.2	-0.2	1.8	1.1	-0.7	77	<40	-37	67	<40	-27
A19	2	T	unknown	2.1	T	unknown	152	<40	-112	132	<40	-92
A20	1.7	T	unknown	2	T	unknown	158	<40	-118	139	<40	-99
A21	1	T	unknown	1.5	T	unknown	173	<40	-133	151	<40	-111
A22	unknown	dry	unknown	unknown	unknown	unknown	236	unknown	unknown	185	unknown	unknown
A23	unknown	dry	unknown	unknown	unknown	unknown	275	unknown	unknown	240	unknown	unknown
S5	-2.5	1.2	3.7	-2.5	1.2	3.7	unknown	unknown	unknown	unknown	unknown	unknown
SF2	1	0.7	-0.3	1	0.8	-0.2	202	<40	-162	157	<40	-117
R1	0.4	0.9	0.5	0.8	1	0.2	150	<40	-110	130	<40	-90
R2	1.4	0.8	-0.6	1.7	0.9	-0.8	211	<40	-171	176	<40	-136
R3	0.9	0.8	-0.1	1.6	0.9	-0.7	244	<40	-204	191	<40	-151
R4	0	0.7	0.7	0.7	0.7	0	276	<40	-236	198	<40	-158
R5	0.3	1	0.7	1	1	0	274	<40	-234	200	<40	-160
E1	2.5	1.3	-1.2	2.8	2.3	-0.5	31	<40	NS	27	<40	NS
E2	2.5	1	-1.5	2.9	2.3	-0.6	35	<40	NS	29	<40	NS
E4	1.4	0.2	-1.2	0.9	1.5	0.6	41	<40	slight -	30	<40	NS
E7	2.2	0.6	-1.6	2.5	1.9	-0.6	42	<40	slight -	30	<40	NS
E5	2	2.7	0.7	2.3	2.5	0.2	64	<40	-24	62	<40	-22
E6	2.1	2.8	0.7	2.5	2.5	0	67	<40	-27	64	<40	-24
E1C	0.5	0.9	0.4	0.1	1.2	1.1	46	<40	-6	46	<40	-6

Pond	Summer Depth (ft)		Summer Change	Winter Depth (ft)		Winter Change	Summer Salinity (ppt)		Summer Change	Winter Salinity (ppt)		Winter Change
	Existing	ISP		Existing	ISP		Existing	ISP		Existing	ISP	
E2C	1	1.3	0.3	1.6	1.7	0.1	77	<40	-37	48	<40	-8
E3C	1.1	1.1	0	1.6	1.7	0.1	76	<40	-36	48	<40	-8
E4C	0.8	1.3	0.5	1.3	1.6	0.3	72	<40	-32	49	<40	-9
E5C	0.6	1.1	0.5	1.1	1.4	0.3	61	<40	-21	49	<40	-9
E6C	1.5	2.2	0.7	1.8	2.1	0.3	67	<40	-27	56	<40	-16
E6A	1.9	S	unknown	2.4	2.1	-0.3	94	<40	-54	63	<40	-23
E6B	0.6	S	unknown	1.2	0.9	-0.3	108	<40	-68	71	<40	-31
E8	2.8	S		2.8	0.6	-2.2	138	<40	-98	110	<40	-70
E8A	0.4	-2	-2.4	1	0.6	-0.4	159	<40	-119	118	<40	-78
E8X	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
E9	1.8	0.8	-1	2.4	2	-0.4	149	<40	-109	111	<40	-71
E12	1.4	S	unknown	1.9	1.1	-0.8	107	<40	-67	81	<40	-41
E13	1.2	S	unknown	1.7	0.9	-0.8	99	<40	-59	81	<40	-41
E14	0.9	S	unknown	1.4	0.5	-0.9	124	<40	-84	91	<40	-51
E10	1.3	1.2	-0.1	1.4	1.6	0.2	37	<40	3	27	<40	NS
E11	1.3	S	unknown	1.6	1.1	-0.5	47	<40	-7	32	<40	NS

Appendix B
Preliminary Results Of Bird Surveys
On South Bay Salt Ponds
(January 2002 – September 2004)

(USGS, Unpublished Preliminary Data)

Appendix B-1. Monthly counts of waterbird species of the major foraging guilds in Alviso salt ponds of the South Bay subregion, San Francisco Bay estuary, from January 2002 through December 2003. Counts conducted January, April, June and August of 2002 on ponds A9-A17. Counts conducted monthly from October 2002 through September 2004 on A1, A5-A17, A19-A23, A2E, A2W, A3N, A3W, AB1, and AB2.

Species	2002							2003												
	Jan	Apr	Jun	Aug	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dabblers																			
American coot	12				368	1188	500	2453	2658	1948	147		1		13	15	326	310	3239
American wigeon	35	7				623	231	3149	4248	4422	2	2				68	284	3336	7557
Blue-winged teal								1							1			5	
Cinnamon teal							4					1				2		5	
Dabbler spp.					60														
Eurasian wigeon								2											3
Gadwall		16	2	1	23	12		88	198	148	135	112	53	33	432	113	52	146	1018
Green-winged teal					2	44										3	2	18	1127
Mallard	6	21	20	3	89	52	10	4	41	51	72	114	43	80	363	213	40	125	22
Northern pintail	72	24			729	236	53	19	422	159	19	13				785	1027	2203	1275
Northern shoveler	1045	453			5974	4882	2246	885	1144	1549	38	1	2		59	11471	6468	7390	5173
Divers																			
Bufflehead	239					519	132	227	1094	595		1			1	1		227	813
Canvasback	1126	19			11	690	1536	345	819	659	2	1						1	899
Clark's grebe		3	1	4	1	13		6		28	8	15	5	5	3	6	2	7	7
Common goldeneye	16	10				13	9	10	9	3	3							13	133
Eared grebe	984	611	1		986	4564	3609	1642	3524	5351	3795	965	20	1	134	663	934	1677	3930
Horned grebe					2														

Species	2002							2003											
	Jan	**Apr**	**Jun**	**Aug**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Lesser scaup	12																		
Pied-billed grebe	2			29	98	230	27	29	8	6		1	6	34	192	217	460	339	260
Redhead	31					120		87	16						1				10
Ruddy Duck	1307	306		2	7520	9062	7513	12280	17069	10802	4265	241	125	112	93	1004	5460	6763	13730
Scaup (lesser, greater)	99	332			34	1433	424	2756	5767	2711	836	849	14	5	3	11	60	725	3773
Surf Scoter									2	43									
Western grebe	165	133	10		8	88	60	98	180	181	73	39	9	1	1	3	32	61	79
Piscivores																			
American white pelican	3		154	117	794	408	71	27	20	19	33	200	521	953	1404	869	1246	836	102
Black-crowned night heron			4	1	2	2		1			1	2	7	8	27	6	5	2	3
Belted Kingfisher															1	1	2		
Black skimmer				4		8		2		6	1	2	6	5	14	18	21		
Brown pelican				24	19	15	16	20					3		101	84	68	9	2
Caspian tern			5	6	1						11	11	60	32	58	4		1	
Common merganser										2									
Double-crested cormorant	6	72	49	108	426	695	53	48	20	39	205	176	219	223	852	998	1963	786	447
Forster's tern		34	166	48	100	41	22	12	7	144	181	513	901	814	824	495	310	7	22
Great blue heron	3	2	7	7	7	10	4	5	8	3		3	9	14	27	35	37	16	23

Species	2002							2003												
	Jan	**Apr**	**Jun**	**Aug**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Great egret	9	22	22	50	25	57	21	14	15	35	13	19	17	58	249	76	290	150	92
Hooded merganser						4													
Least tern	1														51				
Red-breasted merganser	43	16				18	12	4	50	27		1						30	87
Snowy egret	7	23	49	10	212	75	39	13	18	37	11	44	104	78	522	206	480	283	271
Shallow Probers																			
Black-bellied plover					5	12			1711	256	335	2	40	9	77	504	1276	3026	742
Black turnstone					1														
Dunlin	2	8				74	17	8	1089	2854	4975	1416			1	10	62	17	2311
Killdeer	6			3	4				1		6		4	11	3	16	4	1	
Least sandpiper	52			187	78	291	169	41	1367	3044	231			317	317	1107	1385	518	180
Least or Western sandpiper					216			18											
‘Peep’		9							121	54	200								
Red knot											18								
Ruddy turnstone						1									1				
Sanderling									16	7						1	1	2	1
Semipalmated plover				7	1				3	8					64	20	137		
Semipalmated sandpiper												2							

Species	2002							2003											
	Jan	**Apr**	**Jun**	**Aug**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Snowy plover						4					2	6		23	17			4	
Western sandpiper	48			63	39	29	7	41	1428	5314	8956	6568		8727	10779	8183	11402	9222	2781
Deep Probers																			
Dowitcher (long, short-billed)				151	522	46	28	10	1	6	249	1		227	1606	1181	1311	1024	1614
Greater yellowlegs		1			16	10	1		5	45		2			43	28	110	7	7
Long-billed curlew				22		87		40	25	353			24	513	7	241	541	1208	4
Lesser yellowlegs				1			5		2		1					2	11	17	2
Marbled godwit				5	13	587	15	20	36	14	1		102	200	155	459	1710	1195	703
Whimbrel								1								1			
Willet	18	36		49	116	203	63	129	73	697	67	37		325	367	658	608	2574	140
Yellowlegs spp.						1													
Sweepers																			
American avocet	1	453	225	177	1357	1481	604	100	360	2272	531	624	1056	2034	1929	2368	2044	2016	1275
Black-necked stilt		3	15	164	694	113	162	472	112	64	18	43	151	1181	2297	1719	741	761	352
Red-necked phalarope				2				4	1			185			10701	2934	4	35	
Wilson's phalarope			7									21	4	746	2419	36	69		

Species	2002							2003												
	Jan	**Apr**	**Jun**	**Aug**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Other																			
Bonaparte's gull	66	44				442	476	200		29	159				19	9	2	299	729
Canada goose	190	3			6	25		59	101	84	42	73	18	16					17
California gull	14528	1638	1891	248	2488	1	1		419	5557	9092	12643	12532	12821	18913	4651	6234	1702	4611
Gull spp.		15	67		3291	38417	1978	530	14092	4297	2095	594	1931	683	4		130	44	83
Greater white-fronted goose										1									
Glaucous-winged gull									118								1		6
Herring gull	7835	35			1	3615	6407	5001	1430	2819	5						9	2660	7943
Mew gull	1	1																	
Ring-billed gull	17	26			495	177	6845	1164	28	629		1		5	68	33	211	218	938
Thayer's gull	369	9							7	1							2	2	
Western gull	6689	83	29	1811	329	2252		1	1	5	34			3	243	171	154	36	6
Totals	**35045**	**4468**	**2724**	**3304**	**27163**	**72970**	**33360**	**32066**	**59884**	**57378**	**36868**	**25544**	**17987**	**30297**	**55456**	**41699**	**47728**	**52059**	**68546**

Appendix B-2. Monthly counts of waterbird species of the major foraging guilds in Alviso salt ponds A1, A5-A17, A19-A23, A2E, A2W, A3N, A3W, AB1 and AB2 of the South Bay subregion, San Francisco Bay estuary, from January 2004 through December 2004.

Species	2004								
	Jan	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sept**
Dabblers									
American coot	2771	3006	2483	116	2		5	7	115
American wigeon	9351	8862	3328	100		3			196
Blue-winged teal							1		
Cinnamon teal	15		14						
Eurasian wigeon	3	5							
Gadwall	1440	686	111	84	103	95		28	358
Green-winged teal	294		5						
Mallard	27	30	45	83	84	71	7	89	244
Northern pintail	611	1413	88	8	3		1	3	75
Northern shoveler	2610	2442	818	195				2154	3619
Divers									
Bufflehead	1297	1342	494	25	6	7	5	4	4
Canvasback	407	370	513	12					
Clark's grebe	37	22	13	29	1	4		2	5
Common goldeneye	87	78	116						
Eared grebe	3780	2487	1675	2494	83	16	9	28	195
Horned grebe		1			1				
Long-tailed Duck	1								
Pied-billed grebe	317	116	29	13	3	2	63	98	274
Redhead	471	473	8						
Ruddy Duck	13525	16114	11614	4349	102	105	105	107	765
Scaup (lesser, greater)	8024	14100	4781	727	22	14	7		19
Surf Scoter	10	75	1						
Western grebe	58	112	92	61	1		1		

Species	2004								
	Jan	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sept**
White-winged scoter	3							1	
Piscivores									
American white pelican	55	12	10	48	291	461	1352	942	1306
Black-crowned night heron	1		6	5	17	7	3	3	4
Belted Kingfisher									1
Black skimmer					26	6	14	14	37
Brown pelican						1	27	86	225
Caspian tern				9	34	17	34	65	19
Common merganser		11	1	4					
Double-crested cormorant	381	98	93	108	403	349	607	538	1307
Forster's tern	55	4		105	737	567	1258	761	144
Great blue heron	8	5	5	4	6	14	11	21	22
Great egret	22	22	33	19	39	39	60	99	108
Least tern								17	
Red-breasted merganser	53	63	37		1				
Snowy egret	107	53	43	55	131	95	237	306	325
Shallow Probers									
Black-bellied plover	399	64		9		28		5	246
Black turnstone			2						
Dunlin	290	29	267	148				84	64
Killdeer	1	4			1	1	3	4	6
Least sandpiper	666	113	148	201			59	568	2414
Sanderling	2		1						3
Semipalmated plover		3					45	2	109
Semipalmated sandpiper					1				
Snowy plover							8		

Species	2004								
	Jan	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sept**
Western sandpiper	1349	97	4352	388			22569	4619	8007
Deep Probers									
Dowitcher (long, short-billed)	263		85	23	1		301	286	302
Greater yellowlegs	9		1	9			12	20	23
Long-billed curlew	223	159	93				56	137	262
Lesser yellowlegs	4					8		1	
Marbled godwit	1977	64	40	6	120		133	154	280
Willet	115	469	319	40	10	1	424	171	988
Sweepers									
American avocet	1444	306	599	633	889	590	612	662	1699
Black-necked stilt	731	187	3	49	304	137	102	714	411
Red-necked phalarope					48		657	300	
Chilean flamingo								1	
Other									
Bonaparte's gull	251	25	26	774		2			
Canada goose	156	205	112	83	1	9	95	8	1
California gull	79	973	6313	12614	18497	11060	5998	3903	3736
Franklin's gull					1				
Gull spp.	2545	2842	400	80	3	1	3079	740	31
Glaucous-winged gull	3	1	43						
Herring gull	7582	6502	5778	67				104	
Mew gull				2					
Ring-billed gull	240	2857	260	9	3	145		82	2978
Thayer's gull	1		1						
Western gull	30	39	7	9	19			1665	1452
Totals	**64181**	**66941**	**45306**	**23797**	**21994**	**13855**	**37960**	**19603**	**32379**

Appendix B-3. Counts of waterbird species of the major foraging guilds in Alviso salt ponds A1, A2E, A2W, A3N, A3W, A5-A8, AB1 and AB2 of the South Bay subregion, San Francisco Bay estuary, from October 2002 through September 2004 (counts conducted monthly).

Species		**Pond**										
		A1	**A2E**	**A2W**	**A3N**	**A3W**	**A5**	**A6**	**A7**	**A8**	**AB1**	**AB2**
Dabblers												
American coot	*Fulica americana*	6115	3638	2468	746	1579			4		1646	3388
American wigeon	*Anas americana*	584	2900	7169	1180	771	13		11		143	563
Blue-winged teal	*Anas discors*	1					2					1
Cinnamon teal	*Anas cyanoptera*						1				2	12
Dabbler spp.	*Anas spp.*											60
Eurasian wigeon	*Anas penelope*		1	6								2
Gadwall	*Anas strepera*	158	581	611	39	119	244	2	185	38	144	422
Green-winged teal	*Anas crecca*			1								5
Mallard	*Anas platyrhynchos*	213	64	230	49	70	366	2	146	33	344	85
Northern pintail	*Anas acuta*	120	99	113	179	330	754		137	4	200	24
Northern shoveler	*Anas clypeata*	3081	2752	875	113	1367	17883		8309	1979	544	2794
Divers												
Bufflehead	*Bucephala albeola*	192	78	499	122	117	230	197	472	847	12	7
Canvasback	*Aythya valisineria*	27	47	222	19	3				1	970	167
Clark's grebe	*Aechmophorus clarkii*	7	5	5		98	2				1	
Common goldeneye	*Bucephala clangula*	30	9	22	1	18	170	12	12	4		6
Eared grebe	*Podiceps nigricollis*	311	127	369	41	1236	1178	1	409	4531	23	59
Horned grebe	*Podiceps auritus*		1			1						
Long-tailed duck	*Clangula hyemalis*				1							
Pied-billed grebe	*Podilymbus podiceps*	299	234	442	113	700	80		5	4	68	43
Redhead	*Aythya americana*	16	14	9		1						27
Ruddy Duck	*Oxyura jamaicensis*	26624	10361	26222	6230	14273	1126		365	494	7954	12831
Scaup (lesser, greater)	*Aythya affinis, A. marila*	2625	2400	19690	1155	1554	180	340	392	162	435	1980
Surf Scoter	*Melanitta perspicillata*	120		1	2							

Species		Pond										
		A1	**A2E**	**A2W**	**A3N**	**A3W**	**A5**	**A6**	**A7**	**A8**	**AB1**	**AB2**
Western grebe	*Aechmophorus occidentalis*	35	27	90	4	267	131	1	3		7	2
White-winged scoter	*Melanitta fusca*	3										
Piscivores												
American white pelican	*Pelecanus erythrorhynchos*	1348	483	592	203	744	1023	4	1133	15	634	1989
Black-crowned night heron	*Nycticorax nycticorax*	9	6	6	2	3	57		9	6	6	4
Belted Kingfisher	*Ceryle alcyon*			4			1					
Black skimmer	*Rynchops niger*	41		9			1			97	3	9
Brown pelican	*Pelecanus occidentalis*	16	22	26	6	140	90		97		3	5
Caspian tern	*Sterna caspia*	10	15	2	4		12		270	2	6	16
Common merganser	*Mergus merganser*	1				10	1				1	
Double-crested cormorant	*Phalacrocorax auritis*	492	424	1777	202	2274	719		117	18	139	135
Forster's tern	*Sterna forsteri*	1307	703	758	80	346	1443		298	613	336	814
Great blue heron	*Ardea herodias*	12	17	14	26	19	68	1	40	12	23	22
Great egret	*Casmerodius albus*	42	38	68	136	103	420	1	135	9	173	63
Least tern	*Sterna antillarum*		15			2	42				3	6
Red-breasted merganser	*Mergus serrator*				4	25	154		9	4	4	2
Snowy egret	*Egretta thula*	227	136	149	339	390	874	1	87	18	424	282
Shallow Probers												
Black-bellied plover	*Pluvialis squatarola*	19	18	1			7211	18	187	6	17	76
Black turnstone	*Arenaria melanocephala*							2	1			
Dunlin	*Calidris alpina*	22			3		8980	833	508	325		245
Killdeer	*Charadrius vociferous*	1				5	13	1		3		20
Least sandpiper	*Calidris minutilla*	260	134	91	788	239	4939	930	639	581	85	868
Least or Western sandpiper	*Calidris* spp.	18	14	32	50	9	30		31			2
'Peep'	*Calidris* spp.						120					
Red knot	*Calidris canutus*						18					

Species		Pond										
		A1	**A2E**	**A2W**	**A3N**	**A3W**	**A5**	**A6**	**A7**	**A8**	**AB1**	**AB2**
Ruddy turnstone	*Arenaria interpres*	1										1
Sanderling	*Calidris alba*						11	2	7	8		4
Semipalmated plover	*Charadrius semipalmatus*	1			7	1	190	5	129	2	12	38
Semipalmated sandpiper	*Calidris pusilla*									1		
Snowy plover	*Charadrius alexandrinus*						1			8		
Western sandpiper	*Calidris mauri*	97	24	35	1533	144	64264	8973	22762	3834	495	2879
Deep Probers												
Dowitcher (long, short-billed)	*Limnodromus scolopaceus, L. griseus*	15	3	34	10	1	3291		2222	20	137	806
Greater yellowlegs	*Tringa melanoleuca*	4	12	2	16	9	85		14	52	9	73
Long-billed curlew	*Numenius americanus*	1			160		1582	4	749	1	84	46
Lesser yellowlegs	*Tringa flavipes*				12		13		1	9		8
Marbled godwit	*Limosa fedoa*	560		25			2226	13	1661	2	578	385
Whimbrel	*Numenius phaeopus*								1			
Willet	*Catoptrophorus semipalmatus*	95	3	1619	26	8	3549	198	502	96	198	216
Yellowlegs spp.	*Tringa melanoleuca, T. flavipes*											1
Sweepers												
American avocet	*Recurvirostra americana*	3015	18	564	1050	9	3196	210	1640	3967	1866	4158
Black-necked stilt	*Himantopus mexicanus*	119	24	58	52	21	3833	18	2927	2235	71	350
Red-necked phalarope	*Phalaropus lobatus*			1			7053		4633	2131		
Wilson's phalarope	*Phalaropus tricolor*						109		2293	128		
Other												
Bonaparte's gull	*Larus philadephia*	133	16			43	283		84	1901	84	
Canada goose	*Branta Canadensis*	183	26	93	42	47	126	27	37	47	18	24
California gull	*Larus californicus*	5272	56	553	263	978	4862	81696	3313	1306	110	4566
Gull spp.	*Larus* spp.	563	13	126	61	618	1979	60	417	1833	73	12
Greater white-fronted goose	*Anser albifrons*						1					

Species		Pond										
		A1	**A2E**	**A2W**	**A3N**	**A3W**	**A5**	**A6**	**A7**	**A8**	**AB1**	**AB2**
Glaucous-winged gull	*Larus glaucescens*	1	3								1	
Herring gull	*Larus argentatus*	20	126	275	399	297	913	374	653	845	103	93
Ring-billed gull	*Larus delawarensis*	92	44	111	19	205	1375		147	653	69	63
Thayer's gull	*Larus thayeri*				2				2			
Western Gull	*Larus occidentalis*	3	13	50	38	81	131	5	164	985	10	1
Totals		**54561**	**25744**	**66119**	**15527**	**29261**	**147663**	**93931**	**58369**	**29870**	**18268**	**40760**

Appendix B-4. Counts of waterbird species of the major foraging guilds in Alviso salt ponds A9-A23 of the South Bay subregion, San Francisco Bay estuary, for January, April, June, August, and October through December 2002 and monthly from January 2003 through September 2004. Counts through August 2002 included ponds A9-A17; all later counts (October 2002 – September 2004) included A9-A23.

Species		**Pond**													
		A9	**A10**	**A11**	**A12**	**A13**	**A14**	**A15**	**A16**	**A17**	**A19**	**A20**	**A21**	**A22**	**A23**
Dabblers															
American coot	*Fulica americana*	1696	400	2										1	
American wigeon	*Anas americana*	27826	4619	14		9			2						
Blue-winged teal	*Anas discors*	4													
Cinnamon teal	*Anas cyanoptera*	25									1				
Eurasian wigeon	*Anas penelope*	1	3												
Gadwall	*Anas strepera*	2631	170	27	17	10	6	23	22	38					
Green-winged teal	*Anas crecca*	1485	4												
Mallard	*Anas platyrhynchos*	250	83	15	13	3	1	26	24	27	1				4
Northern pintail	*Anas acuta*	7116	151	4	2		5								
Northern shoveler	*Anas clypeata*	17316	365	405	12	38	722	994	867	198	4				
Divers															
Bufflehead	*Bucephala albeola*	2588	1422	222	3		4	12	6	2				1	
Canvasback	*Aythya valisineria*	4546	1361	14		1			4	28					
Clark's grebe	*Aechmophorus clarkii*	11	53	22		16		3	3	1					
Common goldeneye	*Bucephala clangula*	55	157						3				1		
Eared grebe	*Podiceps nigricollis*	223	557	3962	1942	2366	5749	9820	6451	2406	664	591	1142		
Horned grebe	*Podiceps auritus*		1						1						
Lesser scaup	*Aythya affinis*							12							
Pied-billed grebe	*Podilymbus podiceps*	351	466		2		1		38	5		2			
Redhead	*Aythya americana*	63	1083				4								
Ruddy Duck	*Oxyura jamaicensis*	20086	16391	396	69	160	301	313	185	40			19		
Scaup (lesser, greater)	*Aythya affinis, A. marila*	5814	9275	960	53		472	8	11	20					
Surf Scoter	*Melanitta perspicillata*		8												

Species		Pond													
		A9	**A10**	**A11**	**A12**	**A13**	**A14**	**A15**	**A16**	**A17**	**A19**	**A20**	**A21**	**A22**	**A23**
Western grebe	*Aechmophorus occidentalis*	51	595	210	46	68	4	5							
White-winged scoter	*Melanitta fusca*		1												
Piscivores															
American white pelican	*Pelecanus erythrorhynchos*	2576	740	128	54	42	358	4	51	133					
Black-crowned night heron	*Nycticorax nycticorax*	1	2					1	4	1					
Black skimmer	*Rynchops niger*								24						
Brown pelican	*Pelecanus occidentalis*	57	133	39	22		44								
Caspian tern	*Sterna caspia*	5	12	2	1	2	3		5						
Common merganser	*Mergus merganser*	1	4												
Double-crested cormorant	*Phalacrocorax auritis*	1807	2336	396	99	111	155	3	32	32		1			
Forster's tern	*Sterna forsteri*	353	106	116	65	18	126	7	763	1	1		12	6	
Great blue heron	*Ardea herodias*	31	9	6	3	6	2	1	4						
Great egret	*Casmerodius albus*	337	36	36	22	27	4	1	9	3	3	1		6	2
Hooded merganser	*Lophodytes cucullatus*		4												
Least tern	*Sterna antillarum*	1													
Red-breasted merganser	*Mergus serrator*	76	107	1		10		2		44					
Snowy egret	*Egretta thula*	497	160	63	116	33	15	9	11	2			1		
Shallow Probers															
Black-bellied plover	*Pluvialis squatarola*	915	50	9			80	69	1				69		
Dunlin	*Calidris alpina*	2259					8	14	17				7	504	1
Killdeer	*Charadrius vociferous*				5			4	23					4	
Least sandpiper	*Calidris minutilla*	158	41	3	3	243	535	459	698	157	255	12	66	1224	45
Least or Western sandpiper	*Calidris* spp.		8		4	9		9						12	6
'Peep'	*Calidris* spp.	200				1	9							54	
Sanderling	*Calidris alba*	2													

Species		Pond													
		A9	**A10**	**A11**	**A12**	**A13**	**A14**	**A15**	**A16**	**A17**	**A19**	**A20**	**A21**	**A22**	**A23**
Semipalmated plover	*Charadrius semipalmatus*	3					4	2	3	2					
Semipalmated sandpiper	*Calidris pusilla*												2		
Snowy plover	*Charadrius alexandrinus*													55	
Western sandpiper	*Calidris mauri*	3185	34	27	43	147	4596	94	163	3	5		105	1525	1
Deep Probers															
Dowitcher (long, short-billed)	*Limnodromus scolopaceus, L. griseus*	1985		45			516	144	9						
Greater yellowlegs	*Tringa melanoleuca*	5	1	1	6		2		4					54	
Long-billed curlew	*Numenius americanus*	27	9	6			826	479		7	3		11		
Lesser yellowlegs	*Tringa flavipes*	1					1		4					5	
Marbled godwit	*Limosa fedoa*	1816	18	27			441	81	2	4	15		135		
Whimbrel	*Numenius phaeopus*						1								
Willet	*Catoptrophorus semipalmatus*	479	26	15	13	14	627	223	82	5		1	528	174	
Sweepers															
American avocet	*Recurvirostra americana*	2449	8	30	139	394	1914	201	1581	458	8	24	549	892	1
Black-necked stilt	*Himantopus mexicanus*	80	5	27	81	52	125	21	408	164	161	3	129	655	81
Red-necked phalarope	*Phalaropus lobatus*		4	25	221	86	46	21	650						
Wilson's phalarope	*Phalaropus tricolor*				13	2	2		751				4		
Chilean flamingo	*Phoenicopterus chilensis*						1								
Other															
Bonaparte's gull	*Larus philadephia*	23	13	53	177	97	362	166	115			2			
Canada goose	*Branta Canadensis*	25	204	6	8		12	2	15	36	30	61	2	148	85
California gull	*Larus californicus*	10193	5622	4067	13733	5536	4409	990	745	4005	5079	102	1706	3941	10040
Franklin's gull	*Larus pipixcan*								1						
Gull spp.	*Larus* spp.	1616	731	728	1478	1487	1635	228	679	1458	40282	383	1906	4434	15172
Glaucous-winged gull	*Larus glaucescens*						1			161				1	4
Herring gull	*Larus argentatus*	2313	513	5171	259	4430	5746	1423	4081	5464	845	315	1706	4995	16454

Species		Pond													
		A9	**A10**	**A11**	**A12**	**A13**	**A14**	**A15**	**A16**	**A17**	**A19**	**A20**	**A21**	**A22**	**A23**
Mew gull	*Larus canus*						1		3						
Ring-billed gull	*Larus delawarensis*	223	180	121	258	174	26	857	993	597	1463	254	1137	3171	5197
Thayer's gull	*Larus thayeri*		9					2	273	104					
Western Gull	*Larus occidentalis*	887	400	2166	1625	1945	1445		532	1937		11	376	2	2261
Total		**126724**	**48690**	**19567**	**20587**	**17537**	**31347**	**16733**	**20353**	**17543**	**48820**	**1763**	**9613**	**21864**	**49354**

Appendix B-5. Monthly counts of waterbird species of the major foraging guilds in Eden Landing salt ponds of the South Bay subregion, San Francisco Bay estuary, from October 2002 through December 2003.

Species	2002			2003											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dabblers															
American coot		3		1	27	166	8							4	
American wigeon	8	62	30	668	582	426	52						7	7	5
Cinnamon teal					1			2							2
Gadwall		48			31	70	17	21	45	27	7	8	23	9	12
Green-winged teal	201		6	57	1	3	10					1			
Mallard	11	2	23		26	46	51	41	68	34	59	236	53	82	11
Northern pintail	33	11	12	11	23	12	28	10	11			5	267	116	27
Northern shoveler	1055	670	883	937	77	107	27	2	1			27	4150	2002	2335
Divers															
Bufflehead	5	40	287	2874	2488	1974	67	4	2	2			1	43	657
Canvasback			3	317	177					1					34
Clark's grebe		3			25	13	24	6		1	8		2	27	
Common goldeneye		45	45	46	162	364	40							37	88
Eared grebe	1062	771	604	2161	4068	2757	1640	420	19	9	17	130	457	1082	1468
Horned grebe					1										
Pied-billed grebe	77	42	44	20	3				1		3	23	26	61	89
Redhead				7											
Ring-necked duck				1											
Ruddy Duck	377	2421	3327	7150	12507	9285	1408	34	23	8			199	1320	2801
Scaup (lesser, greater)		341	900	2403	6668	5173	913	122	36	23	3	6	8	9	11
Surf Scoter			1	10	6	7									
Western grebe	38	49	75	57	66	49	20	36	11	9		6	11	43	8
Piscivores															
American white pelican	464	206	92	4			11	71	2	208	280	201	939	427	13

Species	2002			2003											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Black-crowned night heron	1	1	1	1			3	2	2	3	10	2	3		2
Belted Kingfisher	1	1											1		2
Black tern								3							
Brown pelican	44	18	23	3	1						16	61	52	237	
Caspian tern	25						14	1	28	33	27	1	48		
Common merganser															6
Double-crested cormorant	1862	423	251	26	13	10	15	11	225	334	770	1055	1871	3198	130
Elegant tern														10	
Forster's tern	522	127	148	33	1	1	192	366	396	306	156	229	319	816	44
Great blue heron	7	8	6	13	17	10	10	13	17	15	5	7	14	14	16
Great egret	113	36	104	21	7	18	9	6	6	14	11	38	29	206	80
Hooded merganser			2												
Least tern											29				
Red-breasted merganser			10	2	3	9	1	1	3			1		35	33
Snowy egret	149	101	179	31	4	10	17	17	13	63	40	40	113	146	44
Shallow Probers															
Black-bellied plover	1428	3012	3912	1462	3033	3816	1487	525	7		527	2104	401	1692	1323
Black turnstone	58		3			19									
Dunlin	5686	17827	25020	1556	3102	5633	7389	2436					1	20530	6960
Killdeer			2		3			2	3	4	3			6	
Least sandpiper	331	811	1321	935	198	392	205		2	31	888	2638	1400	10964	827
Least or Western sandpiper	5137														
Red knot						17	1	269						12	
Ruddy turnstone	9	71	23		1	21	8	8			3			11	24
Sanderling		22	11	8		9						1		2	1
Semipalmated plover	1	200	3				32	169		2	315	15	7	135	4

Species	2002			2003											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Snowy plover							2	28	24	66	12	20	11	11	
Western sandpiper	147	4635	5662	458	246	2921	2395	3402	2	3710	8874	14330	6710	16514	3409
Deep Probers															
Dowitcher (long-, short-billed)	1416	1474	1052	110		33	846	10		154	2	2	6	287	3
Greater yellowlegs	3	2	13	2	39	50		1		4	38	32	32	55	50
Long-billed curlew	59	1	1	26	1					15	1	120	62	122	244
Lesser yellowlegs		1				1					1	2	16	1	19
Marbled godwit	3	12	160	8	8		573	206	1	16	252	90	26	212	335
Whimbrel				2								1			
Willet	2048	745	1530	124	1121	1271	1371	362	81	1116	1638	1413	1288	1320	1272
Sweepers															
American avocet	480	1431	1322	1884	514	595	505	504	539	608	1044	3183	1908	1266	1328
Black-necked stilt	1142	726	1114	550		1	57	48	80	128	858	1305	2531	1048	263
Red phalarope															2
Red-necked phalarope								464	12	15	313	611	57	45	
Wilson's phalarope							44	2	120	501	74				
Other															
Bonaparte's gull		186	640	954	2809	760	552	7	6					442	131
Canada goose	26	99	7	202	122	168	91	64	4	17			4		12
California gull	9	8	64		273	102	24	36	977	736	5569	7466	2219	381	42
Gull spp.	725	225	54	37	10	2	30	17	4	1	1		49	163	4
Glaucous-winged gull			1		1									3	
Herring gull		23	45	69	45	44	22							13	31
Mew gull			30		20	85									
Ring-billed gull	54	308	361	75	38	218	59				3	47	24	478	203
Thayer's gull		3			2									11	

Species	2002			2003											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Western gull	16	2	59	4	3	17	8		1	2	2	8	7	72	3
Totals	**24833**	**37253**	**49466**	**25320**	**38574**	**36685**	**20278**	**9749**	**2772**	**8216**	**21859**	**35465**	**25352**	**65727**	**24408**

Appendix B-6. Monthly counts of waterbird species of the major foraging guilds in Eden Landing salt ponds of the South Bay subregion, San Francisco Bay estuary, from January 2004 through September 2004.

Species	2004								
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Dabblers									
American coot	17	50	67						
American wigeon	79	146	197	4					
Gadwall	3	122	16	24	40	34	26	54	49
Mallard	4	33	98	52	73	40	141	30	3
Northern pintail	1	4	17	8	3	2	6		
Northern shoveler	2546	423	14						101
Divers									
Bufflehead	35	20	58						
Canvasback	11		5					2	
Clark's grebe	234	81	16						
Common goldeneye	2134	2549	1632	1504	3	12	2	2	3
Eared grebe		1							
Horned grebe	13	7	5					3	1
Ring-necked duck	3171	3760	6449	626	1	6	1	3	
Ruddy Duck	285	1168	1289	522	14	3			
Scaup (lesser, greater)	1								
Surf Scoter	29	55	50	24	4	1			2
Western grebe	1259	452	354	6					
Piscivores									
American white pelican					91	177	297	295	474
Black-crowned night heron	1					6	7	4	2
Brown pelican							30	28	48
Caspian tern				25		2	20	5	16
Common merganser		19							

Double-crested cormorant	46	21	48	6	99	305	661	588	1105
Elegant tern									10
Forster's tern			9	23	236	629	464	513	601
Great blue heron	8	8	21		7	8	16	17	13
Great egret	17	12	13	1	10	15	52	63	113
Least tern							1	23	
Red-breasted merganser	17		13	1	1				
Snowy egret	9	4	11	5	19	48	238	360	134
Shallow Probers									
Black-bellied plover	1671	2665	2974	1053	183	71	360	472	938
Dunlin	2256	13253	10620	15525	11		4		30
Killdeer		4	9	2	1	3		1	7
Least sandpiper	1118	391	283	433	6		305	321	2033
Red knot				16	7		96	23	
Ruddy turnstone		59			2	7			
Sanderling	1	1							
Semipalmated plover	1	6	110	7	2		7	43	199
Snowy plover	3	6			7	17	11	33	6
Western sandpiper	8624	10586	10494	32752	8		7109	7825	11853
Deep Probers									
Dowitcher (long, short-billed)	6		1	436	4		765	201	69
Greater yellowlegs	45	28	45	257			10	14	41
Long-billed curlew	45	45	16	37	1		2	17	174
Lesser yellowlegs	1	7	1	1	1			2	5
Marbled godwit	158	801		194	38		55	490	168
Willet	433	1529	921	1066	42		737	1044	1458
Sweepers									
American avocet	203	1136	954	894	657	283	221	269	698
Black-necked stilt	613	708	840	25	129	44	378	282	338

Greater flamingo							1		
Red-necked phalarope								13	9
Wilson's phalarope								7	
Other									
Bonaparte's gull	158	10		648				1	
Canada goose	110	128	176	60	23	36	6	4	
California gull	49	52	140	114		132	99	405	918
Gull spp.	7	2	134		54	2	76		2
Glaucous-winged gull	11	1							
Herring gull	65	63	58				1		8
Ring-billed gull	73	123	93	9	4		24	113	142
Western gull	3	7	9	9	7				49
Totals	**25574**	**40546**	**38263**	**56369**	**1788**	**1883**	**12229**	**13570**	**21820**

Appendix B-7. Counts of waterbird species of the major foraging guilds in Eden Landing salt ponds of the South Bay subregion, San Francisco Bay estuary, from October 2002 through September 2004 (counts conducted monthly).

Species		Pond											
		E1	E2	E4	E5	E6	E6C	E7	E1C	E2C	E3C	E4C	E5C
Dabblers													
American coot	*Fulica americana*		4	3					3		277		12
American wigeon	*Anas americana*	4	26	109				92	4	2	332	2	15
Cinnamon teal	*Anas cyanoptera*										1		
Gadwall	*Anas strepera*	7	3	75	18	43	16	28	31	5	39	22	9
Green-winged teal	*Anas crecca*			5					125	10	121		
Mallard	*Anas platyrhynchos*	19	56	116	13	23	34	20	58	53	192	49	47
Northern pintail	*Anas acuta*	1	13	1	54	25	41	4	28	36	139	51	63
Northern shoveler	*Anas clypeata*	11	2	166	518	1023	210	46	1200	128	4303	2686	355
Divers													
Bufflehead	*Bucephala albeola*	65	13	46	162	260	130	15	58	7	247	61	58
Canvasback	*Aythya valisineria*	190	4										
Clark's grebe	*Aechmophorus clarkii*	23	91	6				1					
Common goldeneye	*Bucephala clangula*	279	98	25	69	17	7	10	31		50	13	40
Eared grebe	*Podiceps nigricollis*	212	531	284	2614	2472	673	123	3		517	37	4
Horned grebe	*Podiceps auritus*				1								
Pied-billed grebe	*Podilymbus podiceps*	71	69	81	15	46	1	102			1	2	
Redhead	*Aythya americana*							2					
Ring-necked duck	*Aythya collaris*		1										
Ruddy Duck	*Oxyura jamaicensis*	10872	13945	4855	656	883	222	3187	1533	16	302	825	1756
Scaup (lesser, greater)	*Aythya affinis, A. marila*	2587	1714	938	210	163	83	1544	372	3	293	25	74
Surf Scoter	*Melanitta perspicillata*	25											
Western grebe	*Aechmophorus occidentalis*	160	350	41	16	5	3	32			5	2	1
Piscivores													
American white pelican	*Pelecanus erythrorhynchos*	880	509	1044	30	29	14	284	165		123	176	40

Species		Pond											
		E1	E2	E4	E5	E6	E6C	E7	E1C	E2C	E3C	E4C	E5C
Black-crowned night heron	*Nycticorax nycticorax*	5	6	12				2	1				
Belted Kingfisher	*Ceryle alcyon*	2				1		1	1				
Brown pelican	*Pelecanus occidentalis*	187	312	52	6			4					
Caspian tern	*Sterna caspia*	57	15	4		1		32				21	
Common merganser	*Mergus merganser*	2	15	2	6								
Double-crested cormorant	*Phalacrocorax auritis*	3668	5747	796	288	479	7	1582			3	16	6
Elegant tern	*Sterna elegans*		10		5			5					
Forster's tern	*Sterna forsteri*	634	1336	534	428	380	8	907	77	1	14	318	3
Great blue heron	*Ardea herodias*	17	34	24	3	22	2	8	6		3	3	2
Great egret	*Casmerodius albus*	163	129	150	12	88	8	38	28	2	54	14	9
Hooded merganser	*Lophodytes cucullatus*		2										
Least tern	*Sterna antillarum*		20	3									
Red-breasted merganser	*Mergus serrator*	29	26	13	6	1		46					
Snowy egret	*Egretta thula*	226	213	225	55	57	21	59	72	1	95	19	11
Shallow Probers													
Black-bellied plover	*Pluvialis squatarola*	142	1735	713	42	108	2	683	5	1	924	9001	129
Dunlin	*Calidris alpina*		33	254		1069		261	2110	698	7327	9668	392
Killdeer	*Charadrius vociferous*			1			2	1	6	5	4	2	2
Least sandpiper	*Calidris minutilla*	311	164	21	278	845	231	138	1929	671	2519	672	1023
Least or Western sandpiper	*Calidris* spp.			2			4	3	60	54	140	26	
Ruddy turnstone	*Arenaria interpres*							1				1	
Sanderling	*Calidris alba*					1		1				2	
Semipalmated plover	*Charadrius semipalmatus*	4		3				3	196	9	68	15	11
Snowy plover	*Charadrius alexandrinus*			3					3		4		
Western sandpiper	*Calidris mauri*	130	23	586	47	2937	15	100	4654	1362	6149	5112	1762

Species		Pond											
		E1	E2	E4	E5	E6	E6C	E7	E1C	E2C	E3C	E4C	E5C
Deep Probers													
Dowitcher (long, short-billed)	*Limnodromus scolopaceus, L. griseus*	17	30			55	2	17	3079		433	1647	79
Greater yellowlegs	*Tringa melanoleuca*	2		5	8	171	13	1	62	24	54	65	34
Long-billed curlew	*Numenius americanus*	248				60			317		2	2	
Lesser yellowlegs	*Tringa flavipes*			5		21			4		5	18	2
Marbled godwit	*Limosa fedoa*	202	344			2	8		58	14	155	61	
Whimbrel	*Numenius phaeopus*		2							1			
Willet	*Catoptrophorus semipalmatus*	92	809	11	21	144	15	5	478	100	1238	508	46
Sweepers													
American avocet	*Recurvirostra americana*		19	28	47	1271	142	22	2770	476	3762	1251	601
Black-necked stilt	*Himantopus mexicanus*	3	2	8	26	450	2	10	1653	1213	3200	1357	150
Red-necked phalarope	*Phalaropus lobatus*			1							13	1	
Wilson's phalarope	*Phalaropus tricolor*					52			1				
Other													
Bonaparte's gull	*Larus philadephia*	102	554	732	10	356	5	146			200	105	296
Canada goose	*Branta canadensis*	12	105	23	19	42	25	41	37	56	481	58	58
California gull	*Larus californicus*	426	717	158	2079	3998	1848	522	23	307	1041	4053	59
Gull spp.	*Larus* spp.	253	155	60	50	196		22	1		181	153	2
Glaucous-winged gull	*Larus glaucescens*		3	2							3		
Herring gull	*Larus argentatus*	63	63	31	2	34	1	13	4	2	14	17	2
Mew gull	*Larus canus*					134		1					
Ring-billed gull	*Larus delawarensis*	21	181	10	111	401	3	58	7		913	17	4
Thayer's gull	*Larus thayeri*		3	3			6	2					
Western gull	*Larus occidentalis*	52	54	114	9	3		15	1		2	1	9
Totals		**22476**	**30290**	**12384**	**7934**	**18368**	**3806**	**10243**	**21254**	**5257**	**35943**	**38155**	**7170**

Appendix B-8. Counts of waterbird species of the major foraging guilds in Eden Landing salt ponds of the South Bay subregion, San Francisco Bay estuary, from October 2002 through September 2004 (counts conducted monthly).

Species		Pond									
		E10	E11	E12	E13	E14	E6A	E6B	E8	E8A	E9
Dabblers											
American coot	*Fulica americana*	29		15							
American wigeon	*Anas americana*	1563	123	1							
Cinnamon teal	*Anas cyanoptera*	2	2								
Gadwall	*Anas strepera*	142	213	12		4	10	4	4		1
Green-winged teal	*Anas crecca*	15						2			1
Mallard	*Anas platyrhynchos*	111	185		10	3	67	28	91	7	35
Northern pintail	*Anas acuta*	115	23		5	1			2	2	3
Northern shoveler	*Anas clypeata*	1307	835	594	1129	105	2		417	177	143
Divers											
Bufflehead	*Bucephala albeola*	769	36	40	77	2283	9	54	553	539	5026
Canvasback	*Aythya valisineria*	451									
Clark's grebe	*Aechmophorus clarkii*	4							2		
Common goldeneye	*Bucephala clangula*	47	4	7	4	115	2	3	169	63	105
Eared grebe	*Podiceps nigricollis*	427	31	279	693	843	32		2508	49	12158
Horned grebe	*Podiceps auritus*			1							
Pied-billed grebe	*Podilymbus podiceps*	27	2						1		
Redhead	*Aythya americana*	5									
Ruddy Duck	*Oxyura jamaicensis*	12685	1313	116	66	1409			28	2	206
Scaup (lesser, greater)	*Aythya affinis, A. marila*	2973	22	1569	2779	3451	13	41	65	341	637
Western grebe	*Aechmophorus occidentalis*	21	2	2		1					2
Piscivores											
American white pelican	*Pelecanus erythrorhynchos*	840	106						8		4
Black-crowned night heron	*Nycticorax nycticorax*	14	3			1	1	1	5		
Black tern	*Chlidonias niger*								3		

Species		Pond									
		E10	**E11**	**E12**	**E13**	**E14**	**E6A**	**E6B**	**E8**	**E8A**	**E9**
Caspian tern	*Sterna caspia*	111	1								3
Double-crested cormorant	*Phalacrocorax auritis*	425	11		3	1	3		37		1
Forster's tern	*Sterna forsteri*	899	56	3	32	20	3	1	223	29	225
Great blue heron	*Ardea herodias*	44	14	1	4	12	3	41	4	9	14
Great egret	*Casmerodius albus*	154	31	1	2	15	4	2	82	3	5
Least tern	*Sterna antillarum*	30									
Red-breasted merganser	*Mergus serrator*	9									
Snowy egret	*Egretta thula*	322	391	1	4	8	2		10	2	1
Shallow Probers											
Black-bellied plover	*Pluvialis squatarola*	597	442	1801	6485	684	186	185	1590	3252	6409
Black turnstone	*Arenaria melanocephala*				19	45					16
Dunlin	*Calidris alpina*	1	51	15625	11698	9507	4254	2254	5603	47394	19640
Killdeer	*Charadrius vociferous*		2	13	3		8	1			
Least sandpiper	*Calidris minutilla*	724	163	1031	4522	1795	1212	297	1990	4786	504
Least or Western sandpiper	*Calidris spp.*	7	25			3600		1	1150		65
Red knot	*Calidris canutus*	49	82	52	23	1			143	66	18
Ruddy turnstone	*Arenaria interpres*				122			1	9		113
Sanderling	*Calidris alba*			9			2	1	21	7	12
Semipalmated plover	*Charadrius semipalmatus*	50	34	326			61	390	3	85	
Snowy plover	*Charadrius alexandrinus*			58	8		11	91	57	12	8
Western sandpiper	*Calidris mauri*	15102	1125	5074	8059	2579	4608	3713	10877	55825	32823
Deep Probers											
Dowitcher (long-, short-billed)	*Limnodromus scolopaceus, L. griseus*	735	419	9	233		95		9	15	3
Greater yellowlegs	*Tringa melanoleuca*	19	7	9	5	3	132	25	102	15	5
Long-billed curlew	*Numenius americanus*	176					1		26	157	
Lesser yellowlegs	*Tringa flavipes*	1			1		1		1		

Species		**Pond**									
		E10	**E11**	**E12**	**E13**	**E14**	**E6A**	**E6B**	**E8**	**E8A**	**E9**
Marbled godwit	*Limosa fedoa*	417	218	8			10		1	2118	190
Willet	*Catoptrophorus semipalmatus*	3172	816	940	422	675	14	7	240	8260	5917
Sweepers											
American avocet	*Recurvirostra americana*	1292	1450	1195	653	1204	196	106	929	3945	1063
Black-necked stilt	*Himantopus mexicanus*	116	339	255	459	1840	17	4	679	633	792
Greater flamingo	*Phoenicopterus rubber*	1									
Red phalarope	*Phalaropus fulicaria*									1	1
Red-necked phalarope	*Phalaropus lobatus*		15	20		2		3	258	291	935
Wilson's phalarope	*Phalaropus tricolor*		215	2		142			13	52	271
Other											
Bonaparte's gull	*Larus philadephia*	1		969	992	1705	49	1	207	855	19
Canada goose	*Branta canadensis*	12	15		2	45	59	164	55	30	18
California gull	*Larus californicus*	598	331	86	177	311	207	1	353	495	2025
Gull spp.	*Larus* spp.	94	18	6	37		5	1	325	37	3
Glaucous-winged gull	*Larus glaucescens*	1								8	
Species		**B10**	**B11**	**B12**	**B13**	**B14**	**B6A**	**B6B**	**B8**	**B8A**	**B9**
Herring gull	*Larus argentatus*	34	11	7	15	11	70	11	5	57	20
Ring-billed gull	*Larus delawarensis*	78	91	185	30	77	106	1	130	20	5
Thayer's gull	*Larus thayeri*	1	1								
Western gull	*Larus occidentalis*	12			1			2	3	9	1
Totals		**46831**	**9274**	**30322**	**38774**	**32498**	**11455**	**7437**	**28991**	**129648**	**89446**

Appendix B-9. Monthly counts of waterbird species of the major foraging guilds in Ravenswood salt ponds R1-R5, RS2, RS5, and RSF2 of the South Bay subregion, San Francisco Bay estuary, from November 2002 through September 2004.

Species	2002		2003											
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dabblers														
Gadwall						4	2							
Mallard						7	5				8			
Northern pintail						3								
Northern shoveler			19											
Divers														
Bufflehead		4	168	32	139									
Common goldeneye		2	67	1689	260									
Eared grebe			64	244	150	13								1
Ruddy Duck			20	20										
Scaup (lesser, greater)			256	545	498	3	1							
Piscivores														
American white pelican							64		32	25	6	3		
Black-crowned night heron							36	5						
Black skimmer								2		1				
Brown pelican							1							
Caspian tern						2	19	3	4	2	17			
Double-crested cormorant	1	2	6	1	2	7	105		45	7	19	3		
Forster's tern						76	291	19	159	65	2			
Great blue heron	0		1	2	2		5	4				5	1	
Great egret	8	3	1	5	1	1	25	4	25	17		17	3	1
Least tern									42					
Snowy egret	4	6	1		1	3	61	18	2	10	4	12	7	

Species	2002		2003											
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Shallow Probers														
Black-bellied plover				7		245			64	73			3	117
Dunlin	8462	14723	349	7912	3324	14312				1			1601	1157
Killdeer					2	6	1	1			5	6	1	48
Least sandpiper	235	1060	120	677	1665	1647			126	426	378	296	1682	1098
Ruddy turnstone						1								
Sanderling			2	47										
Semipalmated plover	255	134	103	3256	588	380	57	79	80	49	329	3	757	1464
Semipalmated sandpiper							1							
Snowy plover	0	4	5	7		25	58	3	14	5			18	9
Western sandpiper	3419	12176	158	6411	13334	56768	10	3	301	593	3695	239	1347	1603
Deep Probers														
Dowitcher (long-, short-billed)		56	72	243		2454			50				103	
Greater yellowlegs			1	1	1	6	1						23	1
Long-billed curlew	54	55	1	71					45	35			62	72
Lesser yellowlegs				1						1			4	
Marbled godwit	15	53		2					13	64	1		1	
Whimbrel		4		2				2		1				
Willet	575	372	71	690	1036	40			104	403		145	2	
Sweepers														
American avocet	40	12	91	895	406	97	96	45	2			6	43	
Black-necked stilt			199	677	698	72	62	17	1				25	
Red-necked phalarope						475	9			2	5			
Wilson's phalarope										8	31			
Other														
Bonaparte's gull					27									

Species	2002		2003											
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Canada goose		10	4	8	29	3	9							12
California gull		14		395	738		246	186	3	45	142	67	2	
Gull spp.	67	1		1421			164			1				1
Glaucous-winged gull				2										
Herring gull	1	6	14	124										1
Ring-billed gull		175	207		45		23		39	2		28	104	70
Thayer's gull													1	
Western gull			23		10				2	3	9			
Totals	**13136**	**28872**	**2023**	**25387**	**22956**	**76650**	**1352**	**391**	**1153**	**1839**	**4651**	**830**	**5790**	**5655**

Appendix B-10. Monthly counts of waterbird species of the major foraging guilds in Ravenswood salt ponds R1-R5, RS2, RS5, and RSF2 of the South Bay subregion, San Francisco Bay estuary, from January 2004 through September 2004.

Species	2004								
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Dabblers									
Gadwall							1		
Mallard		5			3	1			
Northern pintail				2					
Northern shoveler		93	6						
Divers									
Bufflehead	11	27	21						
Common goldeneye	5	169	34						
Eared grebe	8	65	18						
Scaup (lesser, greater)		257	497						
Piscivores									
American white pelican							4		
Black skimmer								3	
Caspian tern				2	1	2			
Forster's tern				32	11	14	56		7
Great egret	1			1					1
Least tern							110		
Snowy egret				1	1	2			
Shallow Probers									
Black-bellied plover	3			182	27	14		196	6
Dunlin	871	1898	10	5735					
Killdeer	34	12		1		3	2	3	5
Least sandpiper	30	132	16	169			18	294	711
Semipalmated plover	415	598	208	431			43	18	34
Snowy plover	72	3		8	6	11	12	3	

Species	2004								
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**
Stilt sandpiper								1	
Western sandpiper	701	7916	5520	68358	3		4968	442	3094
Deep Probers									
Dowitcher (long, short-billed)		163		331				13	
Greater yellowlegs		2	6	9				23	16
Long-billed curlew		3					49	29	69
Lesser yellowlegs		1							
Marbled godwit							100	42	21
Whimbrel							1		
Willet		879	835	777			574	114	800
Sweepers									
American avocet	5	373	378	100	201	136	205	343	523
Black-necked stilt	60	279	463	29	17	27	275	75	664
Red-necked phalarope				20	1		133	2251	1638
Wilson's phalarope								230	185
Other									
Canada goose	7		5	16	2				
California gull		46	477			1		27	54
Gull spp.	1	18	1	1			67		
Glaucous-winged gull		1							
Herring gull	35	395	226						
Ring-billed gull	44	59	63						76
Totals	**2303**	**13394**	**8784**	**76205**	**273**	**211**	**6618**	**4107**	**7904**

Appendix B-11. Counts of waterbird species of the major foraging guilds in salt ponds in the Ravenswood complex of the South Bay subregion, San Francisco Bay estuary, from November 2002 through September 2004 (counts conducted monthly).

Species		Pond							
		R1	R2	R3	R4	R5	RS2	RS5	RSF2
Dabblers									
Gadwall	*Anas strepera*	7							
Mallard	*Anas platyrhynchos*	24	3						2
Northern pintail	*Anas acuta*	5							
Northern shoveler	*Anas clypeata*	2	71		2			43	
Divers									
Bufflehead	*Bucephala albeola*	100	87		100				115
Common goldeneye	*Bucephala clangula*	4	222		1951	4		16	29
Eared grebe	*Podiceps nigricollis*	10	73	8	471				1
Ruddy Duck	*Oxyura jamaicensis*	20							20
Scaup (lesser, greater)	*Aythya affinis, A. marila*	44	1138		579	173		71	52
Piscivores									
American white pelican	*Pelecanus erythrorhynchos*	134							
Black-crowned night heron	*Nycticorax nycticorax*	41							
Black skimmer	*Rynchops niger*	6							
Brown pelican	*Pelecanus occidentalis*	1							
Caspian tern	*Sterna caspia*	52							
Double-crested cormorant	*Phalacrocorax auritis*	198							
Forster's tern	*Sterna forsteri*	732							
Great blue heron	*Ardea herodias*	20							
Great egret	*Casmerodius albus*	109		2		1		1	1
Least tern	*Sterna antillarum*	152							
Snowy egret	*Egretta thula*	131		1				1	
Shallow Probers									
Black-bellied plover	*Pluvialis squatarola*	565	8	180	3	3			178
Dunlin	*Calidris alpina*	40112	2812	1214	6857	40			9320
Killdeer	*Charadrius vociferous*	3	4	70		35	1	1	16
Least sandpiper	*Calidris minutilla*	6312	486	1026	26	71		3	2856
Ruddy turnstone	*Arenaria interpres*		1						
Sanderling	*Calidris alba*	47			2				

Species		Pond							
		R1	**R2**	**R3**	**R4**	**R5**	**RS2**	**RS5**	**RSF2**
Semipalmated plover	*Charadrius semipalmatus*	6322	394	1057	1	56	43		1408
Semipalmated sandpiper	*Calidris pusilla*	1							
Snowy plover	*Charadrius alexandrinus*	152	3	3	2	13	1		89
Stilt sandpiper	*Calidris himantopus*	1							
Western sandpiper	*Calidris mauri*	87693	10851	15028	20098	587	45	5	56752
Deep Probers									
Dowitcher (long, short-billed)	*Limnodromus scolopaceus, L. griseus*	656	2		53	57		270	2447
Greater yellowlegs	*Tringa melanoleuca*	11				3		68	8
Long-billed curlew	*Numenius americanus*	471		71		3			
Lesser yellowlegs	*Tringa flavipes*	1				1		4	1
Marbled godwit	*Limosa fedoa*	309		2				1	
Whimbrel	*Numenius phaeopus*	10							
Willet	*Catoptrophorus semipalmatus*	3781	289	1113	1241	446		63	484
Sweepers									
American avocet	*Recurvirostra americana*	1727	149	692	567	376		376	110
Black-necked stilt	*Himantopus mexicanus*	1088	73	337	118	652		591	781
Red-necked phalarope	*Phalaropus lobatus*	4525							9
Wilson's phalarope	*Phalaropus tricolor*	423						31	
Other									
Bonaparte's gull	*Larus philadephia*				27				
Canada goose	*Branta Canadensis*	10	1	32		25		37	
California gull	*Larus californicus*	1180	28	691	103	113		220	108
Gull spp.	*Larus* spp.	246		8	1391			56	42
Glaucous-winged gull	*Larus glaucescens*			2					1
Herring gull	*Larus argentatus*	472		98	131	26		7	68
Ring-billed gull	*Larus delawarensis*	116		215		1		533	70
Thayer's gull	*Larus thayeri*	1							

Species		Pond							
		R1	**R2**	**R3**	**R4**	**R5**	**RS2**	**RS5**	**RSF2**
Western gull	*Larus occidentalis*	47							
Totals		**158074**	**16695**	**21850**	**33723**	**2686**	**90**	**2398**	**74968**