MARSH PLANT ASSOCIATIONS OF SOUTH SAN FRANCISCO BAY: 2000 COMPARATIVE STUDY

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January 31, 2001 Project No. 477-22

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EXECUTIVE SUMMARY

This study is a continuation of a long-term monitoring program designed to detect changes in habitat types within the estuarine marshes of South San Francisco Bay. Additionally, this study evaluates the possible contribution of the freshwater discharge from the San Jose/Santa Clara WPCP on the distribution of these habitat types. To determine the distribution of habitat types in the South Bay Marshes, the study area was subdivided into three zones: the upper segments, the transition segments and the lower segments. To track the changes that could potentially be caused by anthropogenic influences instead of environmental influences, a Reference Area (Alviso Slough) was also mapped. Vegetation mapping within the Main Study and Reference Areas commenced in 1989 and subsequent mapping has occurred in 1991, 1994, 1995, 1996, 1997, 1998 and 1999.

The 2000 plant association mapping was done on digital orthos images created from rectified color infrared aerial photography. All vegetation mapping was done by plant biologists in the field and spot-checked by senior biologists. The vegetation maps were digitized and converted to a Geographic Information Systems (GIS) format. Acreage calculations by plant associations, dominant species and habitat type were done in GIS and maps were produced. Comparisons were made between the 2000 mapping and previous years' mapping from both the GIS data and the original data.

Comparison between years has shown that the surface area of total marsh and the distribution of marsh habitat types with South San Francisco Bay marshes are dynamic. Baseline vegetation mapping of the South San Francisco Bay study area was conducted in 1989 (H. T. Harvey & Associates 1990a). Subsequent mapping studies were conducted in 1991, 1994, 1995, 1996, 1997, 1998 and 1999 which documented changes in the distribution and aerial extent of salt, brackish and freshwater marsh (CH2MHill 1991; H.T. Harvey & Associates 1994, 1995, 1996, 1997, 1998, 1999). From 1989 to 2000, new marsh formation (salt, brackish and freshwater marsh habitats) has occurred in both the Main Study Area (+173.5 acres) and the Reference Area (+48.9 acres). In the Main Study Area, new marsh formation occurred primarily in the Lower (near the mouth of Coyote Creek) and Transition Reaches. There has been little change in total marsh area in the Upper Reach during the past 11 years. However, from 1999 to 2000, there was an overall loss in marsh habitat in both the Main Study Area (-28.7 acres) and the Reference Area (-3.8 acres). Although there does appear to be some loss of acreage along marsh edges, this loss accounts for less than 1% of the total marsh area. An unknown portion of this loss can be attributed to the small degree of error inherent in the mapping process, such as; shifts in the mylar during field mapping, shrinkage of the mylars due to temperature differences, or error associated with the width of the pen used for field mapping.

Overall, approximately 117 acres of salt marsh have converted to less saline habitat types within the Main Study Area between 1989 and 2000. This is about ten (10) acres less than was reported in 1999. The 117 acres of converted salt marsh represents 16% of the total salt marsh acreage present in the Main Study Area in 1989. The Reference Area, however, has had approximately 21% (16 acres) of salt marsh converted to less saline habitat types during that same period. The majority of this conversion has taken place between 1996 and 1999. The salt marsh habitat conversion during the past eleven years is primarily attributed to losses of pickleweed and cordgrass dominated associations and increases in alkali bulrush and peppergrass associations. In the Main Study Area, the majority of this conversion has occurred in the transition segments where over 70 acres of salt marsh habitat has become brackish marsh habitat during the past eleven years.

There has been little net change in the total salt marsh area and in the proportion of salt marsh within the Main Study Area from 1989 to 2000. This apparent stability occurred because salt marsh habitat converted to other habitat types was balanced by creation of salt marsh habitat via new marsh formation. Comparison between years has shown that the distribution of plant associations within the South San Francisco Bay marshes is dynamic. The entire study area has become less saline during the past ten years. Much of that change has occurred since 1996; that was the first year freshwater marsh habitats were mapped within the Main Study Area and the Reference Area.

The majority of the conversions of salt marsh habitats within South San Francisco Bay are likely caused by large-scale influences that are affecting the entire system. This includes both anthropogenic and environmental factors. The impact from the WPCP can only be determined by a study that includes both physical and biological variables that could be influenced by freshwater flows. The ongoing collection of physical data (which began in August 1999) concurrent with this study will aid in determining the relative influences of environmental factors and anthropogenic factors to changes in marsh type.

INTRODUCTION

This report presents the results of vegetation mapping conducted in September and October 2000 in the South San Francisco Bay (South Bay) study area (Figure 1). The current study is a continuation of a long-term monitoring program designed to detect changes in the surface area and distribution of salt, brackish and freshwater marsh habitat types. An underlying objective of the long-term monitoring program is to evaluate the relative effect of freshwater discharge from the San Jose/Santa Clara Water Pollution Control Plant (WPCP) on the distribution and aerial extent of these habitat types.

The South Bay Marsh study area was subdivided into 24 mapping segments in the 1989 base study. Furthermore, the Alviso Slough Reference Reach was subdivided into 4 mapping segments. This was done to aid in determining specific locations of vegetation change. For the purpose of data analysis and to better summarize vegetation change, the mapping segments within the study area were organized into four reaches (Upper Reach segments, Transition Reach segments, Lower Reach segments and Alviso Slough Reference Reach) (Figure 2). The Upper, Transition and Lower Reach segments combined are referred to as the Main Study Area and are comprised of the original 24 mapping segments. The Alviso Slough Reference Reach comprises 4 mapping segments established in the 1989 study.

Baseline vegetation mapping of the South San Francisco Bay study area was conducted in 1989 (H. T. Harvey & Associates 1990a). Subsequent mapping studies were conducted in 1991, 1994, 1995, 1996, 1997, 1998 and 1999 which documented changes in the distribution and aerial extent of salt, brackish and freshwater marsh (CH2MHill 1991; H.T. Harvey & Associates 1994, 1995, 1996, 1997, 1998, 1999). Comparison between years has shown that the distribution of plant associations within the South San Francisco Bay marshes is dynamic; the dominant plant species are adapted to respond rapidly to environmental changes. The 1999 study found that the surface area of total marsh and the distribution of marsh habitat types within the South Bay marshes are dynamic through time. New marsh formation (salt, brackish and freshwater marsh habitats) has occurred in both the Main Study Area (+202.02 acres) and the Reference Area (+52.78 acres). In the Main Study Area, new marsh formation occurred primarily in the Lower Reach (near the mouth of Coyote Creek) and Transition Reach. The 1999 report found that there has been little change in total marsh area in the Upper Reach during the previous 10 years.

The previous report found that approximately 127 acres of salt marsh had converted to less saline habitat types within the Main Study Area between 1989 and 1999 (H.T. Harvey & Associates 1999). The 127 acres of converted salt marsh represented 17% of the total salt marsh acreage present in the Main Study Area in 1989. Similarly, in the Reference Area approximately 16% (12 acres) of the total salt marsh area present in 1989 had converted to less saline habitat types during that same period. The majority of this conversion occurred between 1996 and 1999. Most of the salt marsh habitat conversion during the previous ten years is attributed to losses of pickleweed and cordgrass dominated associations and increases in alkali bulrush and peppergrass associations. In the Main Study Area, the majority of this conversion had occurred in the transition segments where nearly 100 acres of salt marsh habitat became brackish marsh habitat between 1989 and 1999.

Pickleweed (*Salicornia virginica*) dominated salt marsh typically comprises a diverse assemblage of mid-marsh salt tolerant species with pickleweed exhibiting the highest average percent cover. Pickleweed dominated salt marsh provides habitat for a unique assemblage of animal species including the federally and state-endangered salt marsh harvest mouse (*Reithrodontomys raviventris raviventris)*. Therefore, it is important to determine the area of change annually as well as to understand the factors responsible for the observed conversion of salt marsh to brackish marsh. Furthermore, it is important to understand to what extent this conversion is caused by natural, region-wide environmental change versus anthropogenic changes such as increases in freshwater discharge from the San Jose/Santa Clara WPCP and dry-weather releases from local reservoirs.

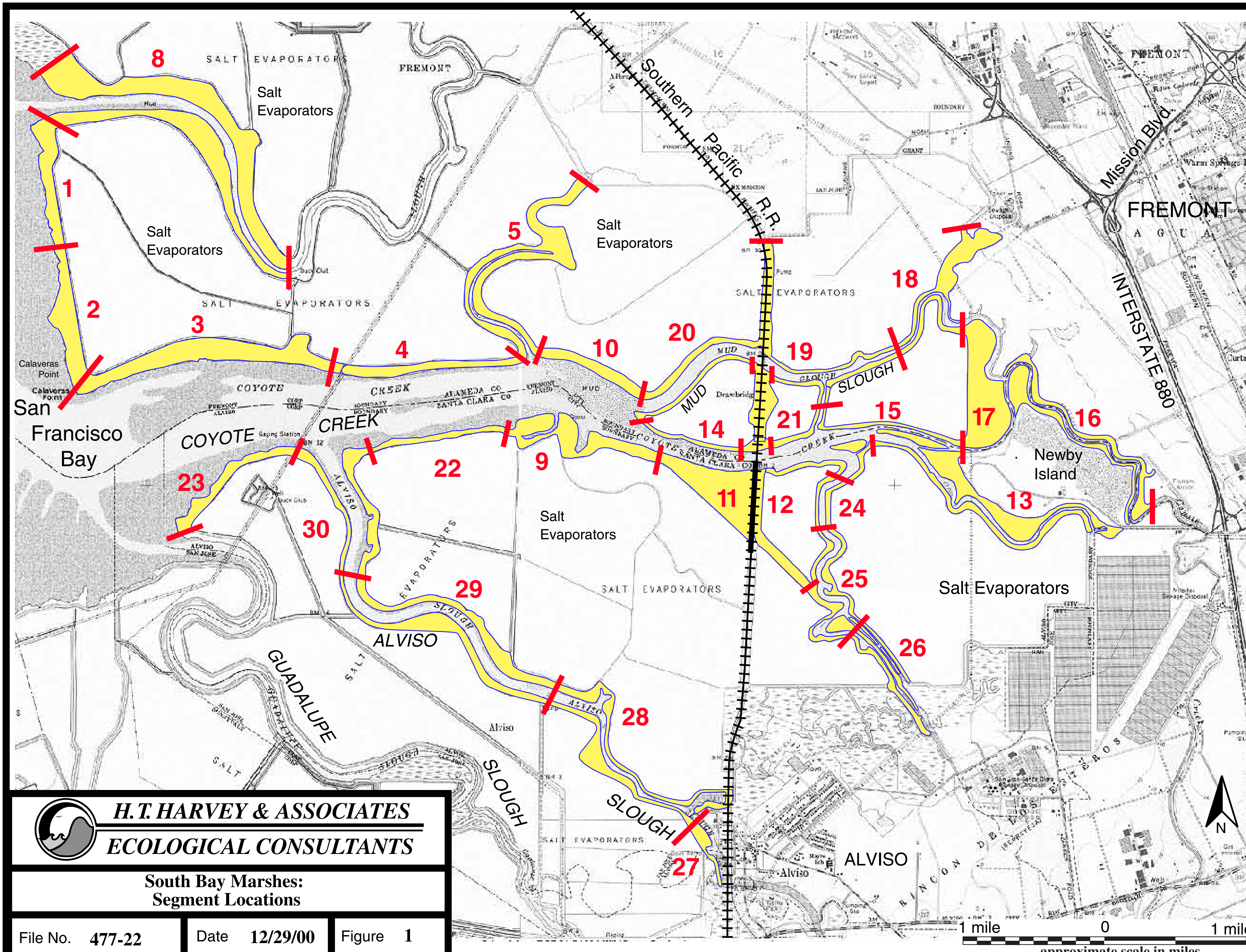
A number of variables have been shown to be important in controlling the distribution of plant species in coastal marshes. Interstitial soil salinity is one of the important variables correlated with vegetation change (Callaway and Sabraw 1994, Allison 1992, Callaway et al. 1989, Zedler 1983, 1986). For example, conversion of a pickleweed-dominated salt marsh to a cattail (*Typha dominguensis*)-dominated freshwater marsh was observed in the San Diego River marsh when reservoir discharges of freshwater were prolonged into summer; well beyond the normal rainy season (Zedler 1983). In this case study, prolonged freshwater discharge and increases in the depth and duration of inundation caused mortality of pickleweed and decreased soil salinities allowing cattail germination and growth (Zedler 1983).

However, numerous other factors have also been found to control marsh species composition including: depth and duration of flooding over the marsh surface (Webb and Mendelssohn 1996, Webb et al. 1995, Pennings and Callaway 1992, Mendelssohn and McKee 1988), accumulation of phytotoxins such as hydrogen sulfide in marsh soils (Webb and Mendelssohn 1996, Webb et al. 1995, Koch and Mendelssohn 1989, DeLaune et al. 1983, King et al. 1982), interstitial nutrient concentrations (Koch et al. 1990, Bradley and Morris 1980, Koch and Mendelssohn 1989, Morris 1980) and soil mineral and organic matter content (Nyman et al. 1990, DeLaune et al. 1979). All of these variables can be affected by both natural and man-induced environment changes such as changes in precipitation, sea level and anthropogenic (potentially nutrient-rich) freshwater discharges. Increased flooding frequency due to sea level rise, for example, was implicated as the causal agent of plant association changes in a tidal marsh in the northeastern United States (Warren 1993).

Interspecific competition may be another variable that can explain why species with similar environmental tolerances exhibit distinct zonation. Many studies of plant competition in salt marsh environments have shown that the species with the greater stress tolerance has lower competitive ability. Therefore it is likely that stress (e.g. salt stress) tolerance and competitive ability are inversely related (Grace and Wetzel 1981, Zedler 1982, Bertness 1991). For example, Zedler (1982) found that competitive interaction does occur in salt marshes and concluded that pickleweed does compete with cordgrass for light and to some extent, nutrients.

Without empirical observations of the factors most likely to cause vegetation change within the study area (e.g. delta outflow, surface water and soil salinity, Coyote Creek flows) it has not been possible to definitively evaluate the relative effect of WPCP discharges on observed vegetation changes. However, proportionate changes in overall marsh acreage and marsh types have occurred in both the Main Study Area and the Reference Reach (Alviso Slough). The Reference Reach is not affected by WPCP discharges (H. T. Harvey & Associates 2000); this may indicate that large-scale, regional environmental changes are likely controlling the recently observed conversion of pickleweed-dominated salt marsh to brackish marsh in the Main Study Area. Specifically, annual precipitation exceeded the average from 1994 - 1998 (National Weather Service, Western Regional Climate Center) with the 1997 – 1998 El Nino rains (rainfall year 7/97 – 6/98) producing the third highest rainfall year on record since 1874 (28.89 inches, San Jose NWS substation at the civic center). Furthermore, increased freshwater flows from the Sacramento-San Joaquin Delta have been shown to significantly decrease salinities and increase the depth of flooding baywide (Dettinger et al. 1995, Peterson et al. 1995). Therefore, decreased salinity in the waters of the entire Bay and increased average tidal elevation associated with successive years of above average rainfall could be factors affecting changes in the South Bay marshes. Without concrete data regarding all of the factors above, the relative contribution of each is speculative.

Monitoring of surface water levels and salinity, soil bulk density, interstitial salinity and pH and flow rates from Coyote Creek and the Guadalupe River in combination with predicted tides for the South Bay and Delta Outflows will provide much of the information necessary to determine the relative effects of the discharge from the WPCP on observed vegetation changes. The addition of this data collection to the ongoing long-term vegetation monitoring has been presented in an earlier report (H. T. Harvey & Associates 2000) and will again be provided in 2001. The 2000 results indicate that the influence of freshwater flows does not extend into the lower reach segments of the study area and changes in salinity (likely from all sources of freshwater flows) are similar in the reference area as in the upper and transition reaches. Correlations in water levels, salinities and flows were not strong making conclusive interpretations difficult from only one year of data. Areas mapped as salt marsh habitat in the 1999 study had the highest interstitial salinities, areas mapped as brackish marsh habitat had intermediate interstitial salinities while freshwater marsh habitats had low interstitial salinities, and alkali bulrush distribution does not appear to be directly related to interstitial salinities (H.T. Harvey & Associates 2000).



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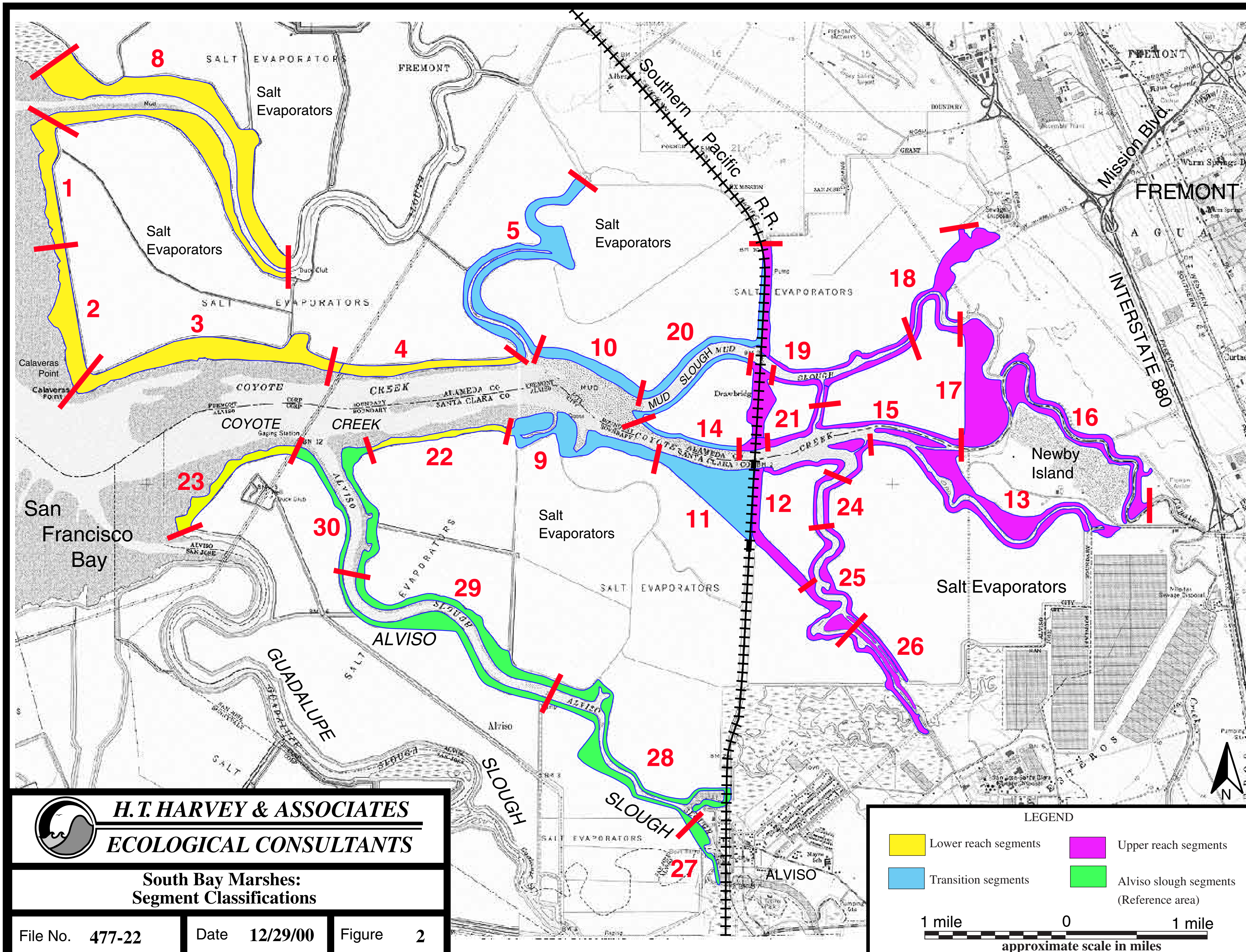
South Bay Marshes:
Segment Locations

File No. 477-22	Date 12/29/00	Figure 1



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South Bay Marshes:
Segment Classifications

File No. 477-22 | Date 12/29/00 | Figure 2

SURVEY METHODS

STUDY AREA

For the purposes of data collection and analysis the study area was divided into 28 segments as defined in the 1989 study (H. T. Harvey & Associates 1990a; Figure 1). The study area was then divided into four reaches (Upper Reach segments, Transition Reach segments, Lower Reach segments, and Reference Reach) to provide a more easily comprehensible method of analyzing the data and presenting the results (Figure 2). The Upper (approximately 440 acres), Transition (approximately 391 acres), and Lower Reach (approximately 703 acres) segments, referred to as the Main Study Area are located within the Coyote Creek watershed and include Segments 1-5 and 8-26 (Figure 1). Segments 27-30 (Reference Area) are located along the Lower Reach segments of the Guadalupe River or Alviso Slough (Figure 1). These segments comprise a Reference Area (approximately 225 acres) for documenting vegetation changes in a watershed not affected by the discharge of treated wastewater. The name and number of individual segments are listed in Table 1. These names were chosen for prominent geographic features displayed in Figure 1.

AERIAL PHOTOGRAPHY AND ORTHORECTIFICATION

The subconsultant responsible for aerial photography acquisition and digital imagery production, Hammon, Jenson, Wallen & Associates (HJW), took color-infrared aerial (CIR) photographs of the entire study area. Color-infrared aerial photographs were taken on June 30, 2000. Photographs were taken from an altitude of 8500 feet using a 6-inch camera lens. The flight was scheduled during negative tidal elevation and 30 to 45 degree solar altitude.

This was the second year of this long-term study that the aerial photographs were orthorectified. The photographs were orthorectified to remove any distortion of the scale across the image caused by various factors including curvature of the earth's surface, topographic changes, and tilt of the camera lens. The use of orthorectified photographs adds greater accuracy to the estimation of polygon areas on the vegetation map. However, area calculations between previous year's data and the 1999 and 2000 data will be influenced by this change in methodology.

The ortho processing procedure involved several consistent production steps, each including important inspections. First the film diapositive was scanned and thereby converted into a computer rasterized image. Scanning diapositives were made from the photography prior to any editing or other handling of the film. These diapositives were placed in individual sleeves to be kept free of dust, scratches, and any other blemishing agents. HJW maintains an environmentally controlled clean room for performing all photo scans to help eliminate airborne dust. The diapositives were scanned on a high precision Vexcel VS4000 scanner at the aperture of 25 microns. No pixels were resampled to convert to a finer resolution.

To correct an aerial photo for distortion caused by terrain; a digital terrain model (DTM) must be included in the ortho processing. HJW produced a DTM, not only capable of accurately generating the orthophotos, but sufficient for generating the digital elevation model (DEM) as well. Once scanned, HJW used OrthoView^{TM} software to orthorectify the images and orient them into the California State Plane Coordinate System through the sensor orientation process. Control from the aerotriangulation and ground survey data from existing control points in HJW's database was used to tie the digital images to real world coordinates. The DTM collected from the stereo photography was used during the digital orthorectification process to adjust each image pixel into its correct position. HJW used a cubic convolution algorithm to perform the ortho processing. This technique provides a much more accurate solution than nearest neighbor methods.

Each image was visually checked and radiometrically enhanced if needed. Neighboring images were viewed and if problems were detected, they were featured, or blended, along their edges to reduce radiometric differences. Where two adjoining images contain water (i.e., without land features) at the junction, radiometric differences were not removed. Sun angles on water can result in severe tonal discontinuities that are quite labor intensive to repair. All digital orthophotographs were visually compared with the original unrectified image to verify radiometric accuracy.

VEGETATION ASSOCIATION MAPPING AND AREA CALCULATIONS

Field surveys and analysis of vegetation followed a protocol that began with mapping plant associations (comprised of either a single dominant individual plant or two dominant plants) onto clear acetate overlays that were placed directly over the digital images of the orthorectified CIR photos. These associations were subsequently assigned to one of three marsh types (i.e. salt marsh, brackish marsh or freshwater marsh) based upon the relative salinity tolerance of these species following the protocol established in the baseline study (H. T. Harvey & Associates 1990a). In order to facilitate comparison of results between monitoring years, vegetation associations were assigned to dominant species categories (as defined below). Dominant species categories, marsh types and vegetation associations for 1989, 1999 and 2000 are presented in Table 2.

Topographic features, marsh boundaries, and tentative vegetation associations (based on color signatures) were mapped in the office prior to field visits. Extensive ground-truthing of the preliminary mapping was then conducted during site visits to the entire Study Area conducted from 7 September to 5 October 2000. Marsh vegetation was observed primarily from areas directly adjacent to the marshes in order to maintain consistency with the method employed in previous years. Marshes were, therefore, observed primarily from levee roadways, railroad beds, unimproved salt pond levees and Pacific Gas and Electric (PG&E) walkways. Only when necessary, vegetation associations were verified by walking in those marshes areas that were not clearly visible from adjacent levees and upland areas.

The field vegetation maps (acetate overlays) were then scanned and electronically digitized by Geographic Computer Technologies. The maps were then linked to the digital orthos images. Plant association acreages and color-coded figures for the entire Study Area were generated by GIS systems Microstation and ARCVIEW.

Access to the Study Area was obtained from the USFWS San Francisco Bay National Wildlife Refuge (Ms. Joy Albertson 510.792.0222; Special Use Permit Number 78109) and Cargill Salt Division, Newark, CA., (Mr. Chuck Taylor 510.797.1820; License Agreement 2001.009:98C).

Table 1. Segment Names and Numbers.

Segment Number	Segment Name
1	Calaveras Point, N
2	Calaveras Point, S
3	Calaveras Point, EI
4	Calaveras Point, EII
5	Albrae
8	Mowry Slough, Lower
9	Goose Point
10	Mud Slough, Lower W
11	Triangle
12	Coyote Creek, Mid S
13	Coyote Creek, Lower N
14	Coyote Creek, Lower N
15	Coyote Creek, Mid N
16	Coyote Creek, Upper
17	Warm Springs
18	Mud Slough, Upper
19	Mud Slough, Mid
20	Mud Slough, Lower E
21	Drawbridge
22	Strip
23	Knapp
24	Artesian Slough, Upper
25	Artesian Slough, Lower
26	Outfall
27	Alviso Slough, Gold St.
28	Alviso Slough, Upper
29	Alviso Slough, Middle
30	Alviso Slough, Lower

Table 2. Dominant Species Categories, Marsh Type, and Vegetation Associations for 1989, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY	HABITAT TYPE	VEGETATION ASSOCIATIONS		
		1989	1999	2000
Cordgrass	Salt	Cordgrass	Cordgrass	Cordgrass
				Cordgrass/Spearscale
			Cordgrass/Alkali Bulrush	Cordgrass/Alkali Bulrush
			Cordgrass/Pickleweed	Cordgrass/Pickleweed
				Cordgrass/Saltgrass
Pickleweed	Salt	Pickleweed	Pickleweed	Pickleweed
		Pickleweed, Alkali Heath, Fat Hen	Pickleweed/Spearscale	Pickleweed/Spearscale
			Pickleweed/Cordgrass	Pickleweed/Cordgrass
			Pickleweed/Peppergrass	Pickleweed/Peppergrass
			Pickleweed/Alkali Bulrush	Pickleweed/Alkali Bulrush
			Pickleweed/Saltgrass	Pickleweed/Saltgrass
			Pickleweed/Gumplant	Pickleweed/Gumplant
			Pickleweed/Alkali Heath	Pickleweed/Alkali Heath
Pickleweed-Cordgrass Mix	Salt	Cordgrass, Pickleweed, with or without Alkali Heath	Pickleweed-Cordgrass Mix	Pickleweed-Cordgrass Mix
Alkali Heath	Salt	•	Alkali Heath	Alkali Heath
				Alkali Heath/Alkali Bulrush
				Alkali Heath/Peppergrass
				Alkali Heath/Spearscale
Gumplant	Salt	•	Gumplant	Gumplant
			Gumplant/Cordgrass	Gumplant/Cordgrass
			Gumplant/Pickleweed	Gumplant/Pickleweed
			Gumplant/Peppergrass	Gumplant/Peppergrass
Saltgrass	Salt	•	Saltgrass	Saltgrass
			Saltgrass/Pickleweed	Saltgrass/Pickleweed
Saltgrass-Gumplant Mix	Salt	•	•	Saltgrass-Gumplant Mix
Jaumea	Salt	•	Jaumea	Jaumea
			Jaumea/Gumplant	
Peripheral Halophytes	Salt	Fat Hen, Alkali Heath	Peripheral Halophytes	Peripheral Halophytes

Table 2. Dominant Species Categories, Marsh Type, and Vegetation Associations for 1989, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY	HABITAT TYPE	VEGETATION ASSOCIATIONS		
		1989	1999	2000
				Peripheral Halophytes/Peppergrass
				Peripheral Halophytes/Upland Species
				Russian Thistle
				Russian Thistle/Saltgrass
Alkali Bulrush	Brackish	Alkali Bulrush	Alkali Bulrush	Alkali Bulrush
			Alkali Bulrush/Pickleweed	Alkali Bulrush/Pickleweed
			Alkali Bulrush/Peppergrass	Alkali Bulrush/Peppergrass
			Alkali Bulrush/Spearscale	Alkali Bulrush/Spearscale
			Alkali Bulrush/Cordgrass	Alkali Bulrush/Cordgrass
			Alkali Bulrush/California Bulrush	Alkali Bulrush/California Bulrush
			Alkali Bulrush/Cattail	Alkali Bulrush/Cattail
Peppergrass	Brackish	Peppergrass	Peppergrass	Peppergrass
			Peppergrass/Pickleweed	Peppergrass/Pickleweed
			Peppergrass/Alkali Bulrush	Peppergrass/Alkali Bulrush
			Peppergrass/Spearscale	Peppergrass/Spearscale
			Peppergrass/Peripheral Halophytes	Peppergrass/Peripheral Halophytes
			Peppergrass/California Bulrush	Peppergrass/California Bulrush
				Peppergrass/Upland Species
Spearscale	Brackish	•	Spearscale	Spearscale
				Spearscale/Pickleweed
			Spearscale/Alkali Bulrush	Spearscale/lkali Bulrush
			Spearscale/Peppergrass	Spearscale/Peppergrass
				Spearscale/Peripheral Halophytes
California Bulrush	Fresh	•	California Bulrush	California Bulrush
			California Bulrush/Knotweed	California Bulrush/Knotweed
			California Bulrush/Cattail	California Bulrush/Cattail
			California Bulrush/Alkali Bulrush	California Bulrush/Alkali Bulrush
				California Bulrush/Peppergrass
Cattail	Fresh	•	Cattail	Cattail
			Cattail/California Bulrush	Cattail/California Bulrush
			Cattail/Alkali Bulrush	Cattail/Alkali Bulrush

Table 2. Dominant Species Categories, Marsh Type, and Vegetation Associations for 1989, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY	HABITAT TYPE	VEGETATION ASSOCIATIONS		
		1989	1999	2000
Knotweed	Fresh	•	Knotweed Knotweed/California Bulrush	Knotweed Knotweed/California Bulrush
Giant Reed	Fresh	•	•	Giant Reed

• Not a Dominant Species Category in Analysis Year.

VEGETATION ASSOCIATION CATEGORIZATION METHODS

Any species that occurred as a dominant, co-dominant or sub-dominant in any portion of the study area was mapped. For the purposes of this study a dominant species had a percent cover of 51-100%, co-dominant species have roughly equal percent coverage, and sub-dominant species have between 15 and 49 percent cover.

Each species was then assigned to a vegetation association comprised of one dominant, a dominant and subdominant, or two or more co-dominant species. The three types of vegetation associations are described below:

Dominant - An area that consists of one dominant species that comprises approximately 85-100% of the cover is named solely for that species alone, so that the vegetation association called Pickleweed consists of from 85-100% Pickleweed and of less than 15% of other unspecified species.

Dominant/sub-dominant - If one species comprises between approximately 51-85% of the cover in a particular area, and another species comprises 15-49% cover in that same area, then this is dominant/sub-dominant vegetation association. The association is named for both species, with the more abundant species listed first. The category called Pickleweed/Alkali bulrush could therefore consist of from 51-85% cover of Pickleweed and 15-49% cover of Alkali bulrush.

Co-dominant - Two co-dominant associations were identified: Pickleweed-Cordgrass (*Spartina foliosa*) Mix and Saltgrass (*Distichlis spicata*)-Gumplant (*Grindelia* sp.) Mix. The species mixes represent an approximately equal amount of each species.

The upland species category consists of species not commonly found within salt marsh habitats. These include ruderal species such black mustard (*Brassica nigra*), ripgut grass (*Bromus diandrus*), bristly ox-tongue (*Picris echioides*), sweet fennel (*Foeniculum vulgare*), and coyote brush (*Baccharis pilularis*) as well as tree species such as California box elder (*Acer negundo ssp. californica*), California black walnut (*Juglans californica* var. *hindsii*) and Fremont cottonwood (*Populus fremontii*). The peripheral halophyte category consists of a patchwork of species that occur along salt marsh edges, adjacent to levees. This mixture includes pickleweed and various peripheral halophyte species such as alkali heath (*Frankenia salina*), Australian salt bush (*Atriplex semibaccata*) and slender-leaved iceplant (*Mesembryanthemum nodiflorum*).

Plant species associations were summarized into 15 dominant species categories (e.g. alkali bulrush/peppergrass association is an alkali bulrush dominant species category). These dominant species categories were then assigned to one of four habitat types: salt marsh, brackish marsh, freshwater marsh and upland. A number of assumptions about grouping dominant species into appropriate habitat types were made. These include:

- Relative salt tolerance of dominant plant species;
- Edaphic characteristics of the South Bay Marshes that may control plant species distribution;
- Historic relationships within this study, and;
- Relationships between dominant plant species and wildlife use.

Certain plant species for which salinity tolerance data is lacking (e.g. spearscale and peppergrass) were categorized into habitat types based on relative location in the marsh plain or known wildlife use. This assumption and the potential uncertainties related to assigning plant species to habitat type categories has been understood throughout the study period and was stated in the 1989 (baseline) study (H. T. Harvey & Associates 1990a). The habitat classification scheme first used in the baseline study is carried through to this study to maintain comparable data.

AREA COMPARISONS

Analysis of potential marsh conversion within the Main Study and Reference Areas involved a multi-step process that began at a total marsh area level and proceeded to a more specific, segment-level analysis. The first task involved comparing the relative acreage change in marsh type and dominant species categories between years. The current years results are compared to analysis year 1989. When a significant shift in marsh acreage occurred, the dominant species categories responsible for that shift were also identified.

In order to identify where significant acreage changes had occurred, the marsh was divided into four areas based upon segment location: Upper, Transition, Lower and Reference (Alviso Slough) (Figure 2). The Upper and Lower segments are upstream and downstream from the Transition segments, respectively. The Transition Segments include: 5, 9, 10, 11, 14 and 20. Upper Segments include: 12, 13, 15, 16, 17, 18, 19, 21, 24, 25 and 26. Lower Segments include: 1, 2, 3, 4, 8, 22 and 23. The Reference Area includes Segments 27, 28, 29 and 30.

A comparison of marsh habitat acreage data from all years (1989, 1991, 1994, 1996, 1997, 1998, 1999 and 2000) by location (reach) was also conducted to compare trends between reaches. The final step in the analysis overlaid the original data from previous years' mapping onto 2000 data to determine, with confidence, the location and size of change in marsh area and habitat type.

Dominant species and habitat maps were produced for each of the four segment locations. The maps were produced from an ArcView database and the full mapping for all segments by plant species association is available electronically.

RESULTS

GENERAL SPECIES DISTRIBUTION, DOMINANT SPECIES CATEGORY AND HABITAT ACREAGES FOR 2000

Main Study Area

Information is presented below by dominant species categories (a distillation of vegetation associations) and by habitat types. The spatial distribution of dominant plant species and habitat types are presented in Appendix A for each of the three segment locations within the Main Study Area (figure scales vary). Acreages of habitat types and associated dominant plant species for the Main Study Area are shown in Table 3 and Figure 3. The dominant plant species within the Main Study Area are alkali bulrush and pickleweed, each comprising just under 600 acres (Table 3). The total acreage of salt marsh habitat and brackish marsh habitat within the Main Study Area is nearly equal.

The Upper Reach segments (Figure 2) consist primarily of brackish marsh associations dominated by either pure stands or mixtures of alkali bulrush and peppergrass (*Lepidium latifolium*). The Lower Reach segments (nearest San Francisco Bay, Figure 2) are comprised primarily of single-species stands or mixtures of the salt marsh plant species dominated by pickleweed and cordgrass. Although cordgrass and pickleweed are most abundant in the Lower Reach segments, both occur at low abundance even in the furthest upstream segments (although sometimes in patches too small to map). Conversely, peppergrass is most abundant in the Upper Reach segments, but is found throughout most of the Main Study Area (Appendix A).

Alkali bulrush occurs throughout the Main Study Area and is the dominant plant species of brackish marsh associations in South San Francisco Bay. Each year, alkali bulrush has been mapped further downstream (closer to San Francisco Bay). The furthest downstream patches of alkali bulrush were observed within Segments 3 and 22 (Lower Reach).

The Transition Reach, intermediate to the furthest upstream and downstream reaches, supported significant amounts of both salt and brackish species, which sometimes occurred in mixed associations (both brackish and salt marsh plant species).

Table 3. Summary of Acreages of the Main Study Area by dominant species categories for each habitat type for 2000.

Dominant Species Category	**2000**
Salt Marsh Categories	
Cordgrass	95.22
Pickleweed	595.59
Pickleweed-Cordgrass Mix	2.01
Saltgrass	10.26
Alkali Heath	1.43
Gumplant	38.36
Peripheral Halophytes	34.33
Misc. Others	1.17
Sub-Total	**778.37**
Brackish Marsh Categories	
Alkali Bulrush	584.91
Peppergrass	145.85
Spearscale	8.97
Misc. Others	0.00
Sub-Total	**739.79**
Freshwater Marsh Categories	
California Bulrush	67.51
Cattail	6.87
Misc. Others	0.05
Sub-Total	**74.43**
TOTAL	**1592.59**

Note: Upland habitat (28.2 acres in the Main Study Area) has not been included.

Figure 3. Dominant Species Categories of the Main Study Area by Habitat Type, 2000.

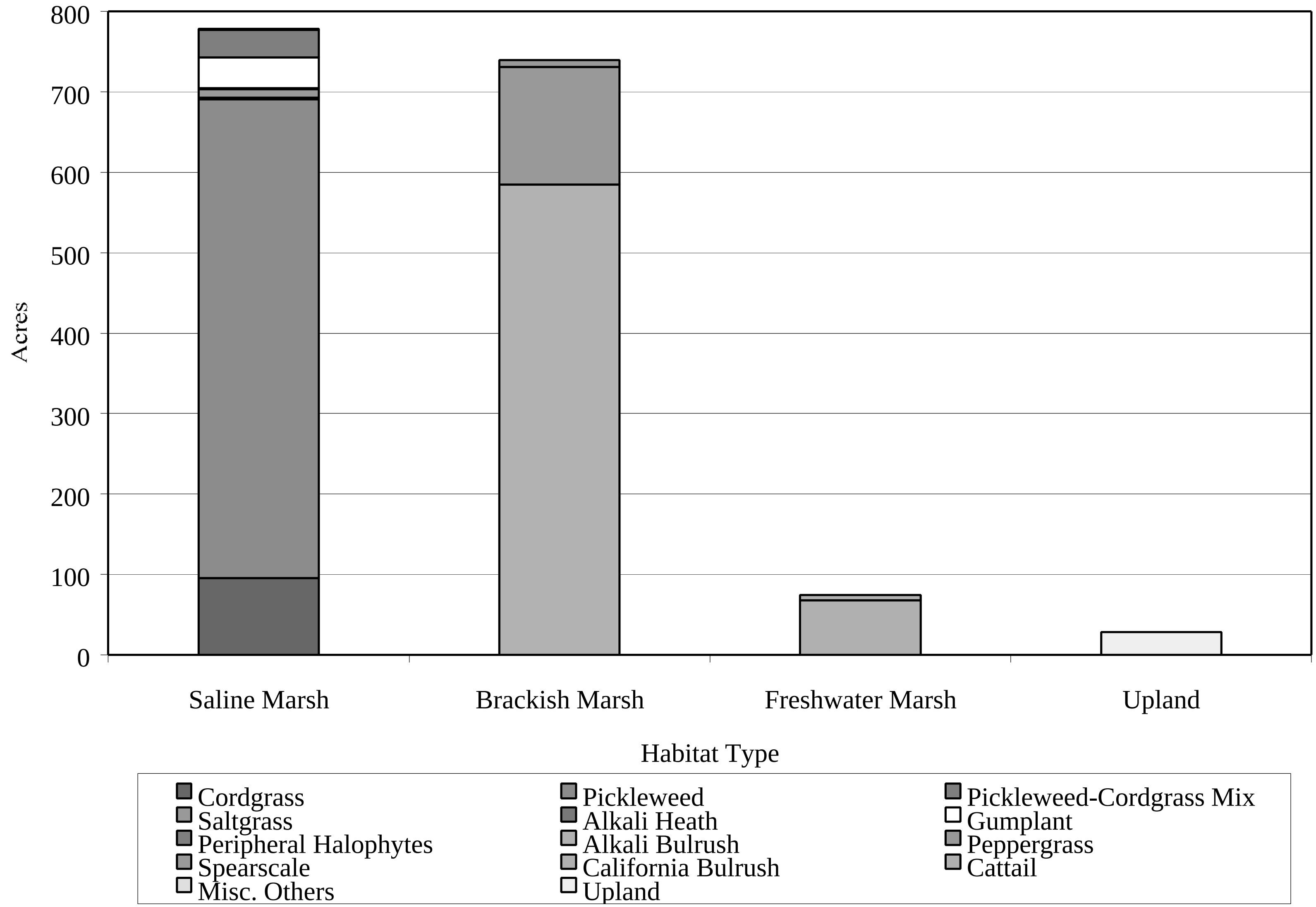
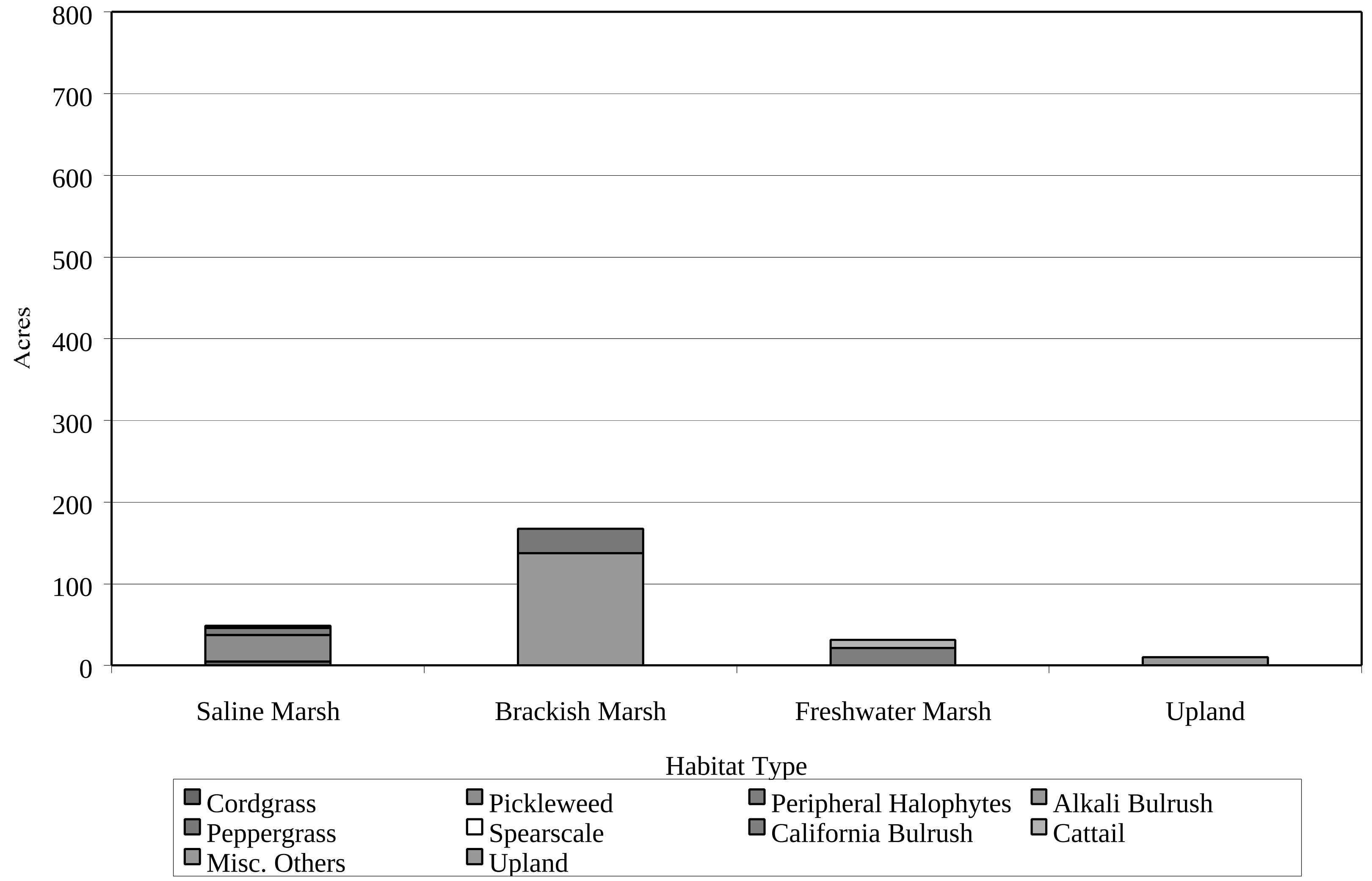


Figure 4. Dominant Species Categories of the Reference Area by Habitat Type, 2000.



Reference Area (Alviso Slough)

The spatial distribution of dominant plant species and habitat types in the Reference Area are presented in Appendix A. The 2000 plant association acreages for Alviso Slough are presented in Table 4. Plant species within Alviso Slough have a general distribution similar to the Main Study Area in terms of a progression from freshwater to brackish and salt marsh species extending from upstream to the confluence with Coyote Creek. Acreage of habitat types and associated dominant plant species are shown in Figure 4. Alkali Bulrush is the dominant plant species within the Reference Area and brackish marsh habitat comprises over three times the area of salt marsh habitat.

Brackish marsh associations occur throughout Alviso Slough. Patches of alkali bulrush were observed as far downstream as Segment 30 (near the confluence with Coyote Creek). Aside from a trace amount, peppergrass was not observed further downstream than Segment 29. Freshwater marsh associations are concentrated in the upstream portions of the slough and salt marsh associations dominate the downstream areas.

Table 4. Summary of Acreages of the Reference Area (Alviso Slough) by dominant species categories for each habitat type for 2000.

Dominant Species Category	2000
Salt Marsh Categories	
Cordgrass	4.99
Pickleweed	32.21
Peripheral Halophytes	8.70
Misc. Others	2.61
Sub-Total	**48.51**
Brackish Marsh Categories	
Alkali Bulrush	137.43
Peppergrass	29.95
Spearscale	0.07
Misc. Others	0.00
Sub-Total	**167.45**
Freshwater Marsh Categories	
California Bulrush	21.31
Cattail	10.24
Misc. Others	0.09
Sub-Total	**31.64**
TOTAL	**247.60**

Note: Upland area (10.4 acres in the Reference Area) has not been included.

Summary

Brackish marsh plant associations dominated the upper and transition reaches of the main study area as well as the reference reach. Only the lower reach segments remain primarily dominated by salt marsh plant species. From 1999 to 2000, there was an overall loss in marsh habitat in both the Main Study Area (-28.7 acres) and the Reference Area (-3.8 acres). Although there does appear to be some loss of acreage along marsh edges, this loss accounts for less than 1% of the total marsh area. An unknown portion of this loss can be attributed to the small degree of error (±1%) inherent in the mapping process, such as; shifts in the mylar during field mapping, shrinkage of the mylars due to temperature differences, or error associated with the width of the pen used for field mapping.

TEMPORAL AND SPATIAL CHANGES IN MARSH HABITAT ACREAGES FROM 1989 THROUGH 2000

This comparison does not include data from segments 24, 25 and 26 of the Main Study Area and segment 27 of the Reference Area since they were not mapped in 1989. Additionally, the Reference Area was not mapped in 1994, therefore only data from the Main Study Area in 1994 is included in the evaluation.

New Marsh Formation (Salt, Brackish, and Freshwater Marsh Combined)

The surface area of marsh habitat has increased by 173.3 acres between 1989 and 2000 within the Main Study Area (Upper, Transition and Lower Reaches Combined) (Table 5). During the same period, 75.4 acres of new marsh has formed in the Reference Area (Table 6). This equates to a 13% increase in marsh acreage in the Main Study Area and a 44% increase in marsh acreage in the Reference Area between 1989 and 2000.

Marsh area remained relatively stable from 1989 to 1996 in the Main Study Area (Figure 5). The formation of new marsh habitat in the Main Study Area has occurred primarily between 1996 and 1999 in the Lower Reach and between 1996 and 1998 in the Transition Reach (Figure 5). Gains in marsh area during these respective periods were greatest in the Lower Reach (151.7 acres), while 49.5 acres of new marsh formation has occurred in the Transition Reach. The majority of new marsh formation has occurred in the Lower Reach along the north side of Coyote Creek, immediately upstream of Calaveras Point. Marsh area has increased steadily in the Lower Reach from 1996 through 1999 however a slight decrease occurred between 1999 and 2000 (Figure 5). In contrast, in the Transition Reach marsh area increased in 1997 and 1998 but decreased slightly in 1999 and 2000 (Figure 5). Compared to the lower and Transition Reaches, the surface area of marsh in the Upper Reach has remained relatively stable throughout this 11 year study (Figure 5).

A trend of increasing marsh area is apparent from 1989 through 1999 in the Reference Area (Figure 5). However, a slight decrease in total marsh acreage occurred between 1999 and 2000.

Changes in Surface Area of Salt, Brackish, and Freshwater Marsh Habitats

Salt Marsh. Figures 6, 7 and 8 present the surface area of salt, brackish and freshwater marsh habitats by year and location (reach). Salt marsh area decreased in the Transition Reach from 1989 through 2000; the rate of decrease in salt marsh area was greatest between 1989 and 1994 (Figure 6). Conversely, salt marsh area increased in the Lower Reach from 1989 through 2000 with most of the increase occurring between 1996 and 1999. Much of this increase was due to new marsh formation along the north side of Coyote Creek within segments 3 and 4. Despite these changes, there has been little net change in salt marsh habitat area from 1989 to 2000 (+7.5 acres) within the Main Study Area (Table 5). The net stability of salt marsh area within the Main Study Area was due to gains from new marsh formation in the Lower Reach balancing losses in the Transition Reach (due to conversion) (Figure 6).

Table 5. Summary of Acreages of the Main Study Area by dominant species categories for each habitat type for 1989 and 2000*.

Dominant Species Category	1989	2000	Change	Percent Change
Salt Marsh Categories				
Cordgrass	70.7	95.1	24.4	34.5%
Pickleweed	499.0	594.2	95.2	19.1%
Pickleweed-Cordgrass Mix	171.6	2.0	-169.6	98.8%
Alkali Heath**	0.0	1.4	1.4	-
Gumplant**	0.0	38.4	38.4	-
Peripheral Halophytes	27.0	33.5	6.5	24.1%
Misc Others	0.0	11.2	11.2	-
Sub-Total	***768.3***	***775.8***	***7.5***	***1.0%***
Brackish Marsh Categories				
Alkali Bulrush	493.4	575.7	82.3	16.7%
Peppergrass	70.9	130.8	59.9	84.5%
Spearscale**	0.0	8.9	8.9	-
Misc. Others	0.0	0.0	0.0	-
Sub-Total	***564.3***	***715.4***	***151.1***	***26.8%***
Freshwater Marsh Categories				
California Bulrush	0.0	10.1	10.1	-
Cattail	0.0	4.6	4.6	-
Misc. Others	0.0	0.0	0.0	-
Sub-Total	***0.0***	***14.7***	***14.7***	***-***
TOTAL	**1332.6**	**1505.9**	**173.3**	**13.0%**

* Comparison consists of segments 1-5, 8-23 only since segments 24-26 were not mapped in 1989

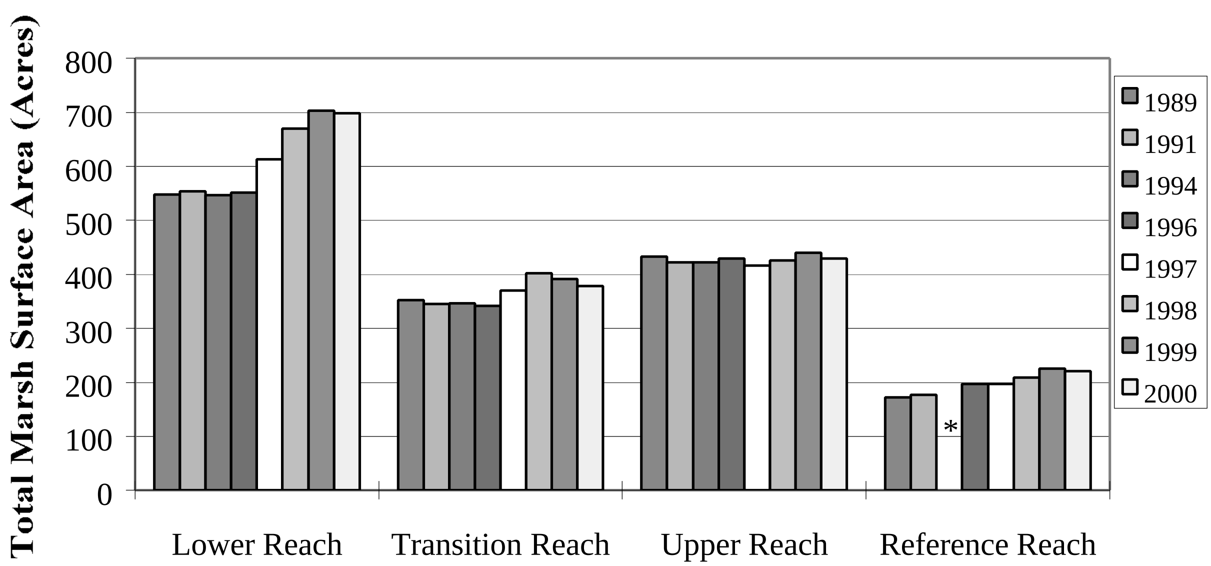
** Not a dominant species category in 1989

Table 6. Summary of Acreages of the Reference Area (Alviso Slough) by dominant species categories for each habitat type for 1989 and 2000.*

Dominant Species Category	1989	2000	Change	Percent Change
Salt Marsh Categories				
Cordgrass	27.9	5.0	-22.9	82.1%
Pickleweed	46.8	32.2	-14.6	31.2%
Peripheral Halophytes	2.6	8.7	6.1	234.6%
Misc. Others	0.0	2.6	2.6	-
Sub-Total	***77.3***	***48.5***	***-28.8***	***37.3%***
Brackish Marsh Categories				
Alkali Bulrush	77.1	137.4	60.3	78.2%
Peppergrass	17.6	30.0	12.4	70.5%
Spearscale**	0.0	0.1	0.1	-
Misc. Others	0.0	0.0	0.0	-
Sub-Total	***94.7***	***167.5***	***72.8***	***76.9%***
Freshwater Marsh Categories				
California Bulrush	0.2	21.3	21.1	10,550%
Cattail	0.0	10.2	10.2	-
Misc. Others	0.0	0.1	0.1	-
Sub-Total	***0.2***	***31.6***	***31.4***	***15,700%***
TOTAL	**172.2**	**247.6**	**75.4**	**43.8%**

* Comparison consists of segments 27-30.
** Not a dominant species category in 1989.

Figure 5. Total Marsh Acreage Comparison From 1989 to 2000 by Reach



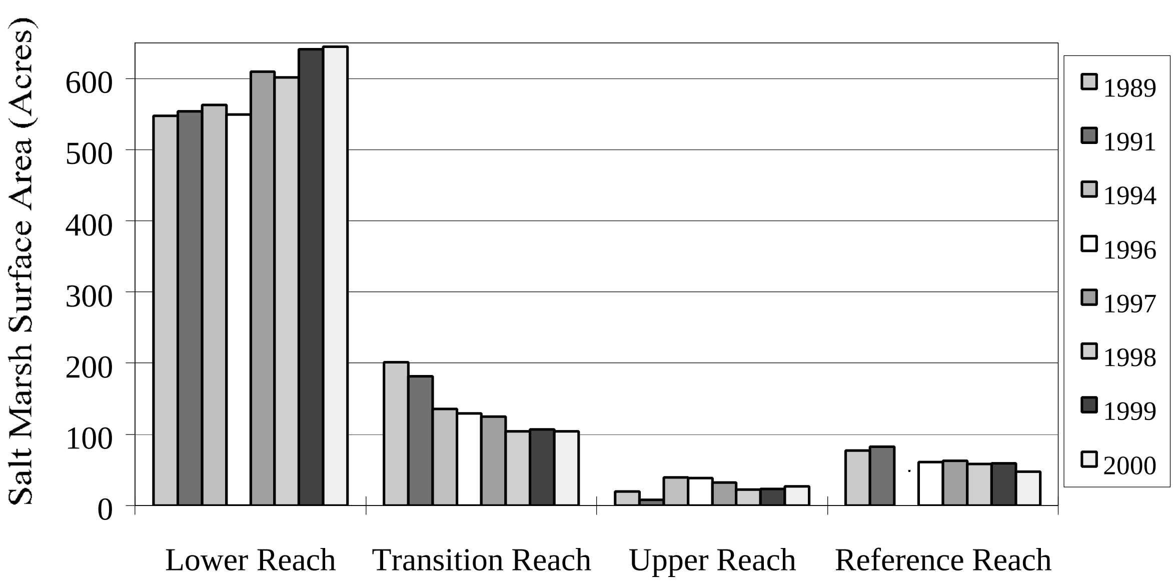
***No data collected in 1994 within Reference Area.**

A relatively large loss of salt marsh habitat has occurred in the Reference Area between 1989 and 2000 (Table 6). In contrast to the Main Study Area this loss was not compensated for by new salt marsh formation. Approximately 28.8 acres of salt marsh (37% of the total) has been lost during the study period and is comprises losses in both pickleweed and cordgrass dominated categories. Similar to the pattern in the Transition Reach, the majority of salt marsh decline in the Reference Reach occurred early in the study period between 1991 and 1996 (Figure 6), including a slight decline in 2000.

Brackish and Freshwater Marsh. Overall large gains in brackish marsh area have occurred in both the Main Study Area and in the Reference Area between 1989 and 2000 (Tables 5 and 6). During this period, brackish marsh increased by 151.1 acres (27% increase) and 72.8 acres (77% increase) in the Main Study and Reference Areas, respectively (Tables 5 and 6). This is due mostly to marsh conversion (from salt to brackish) but some new marsh has formed as brackish marsh. Furthermore, freshwater marsh has increased in the Main Study and Reference Areas during the past 11 years (Tables 5 and 6).

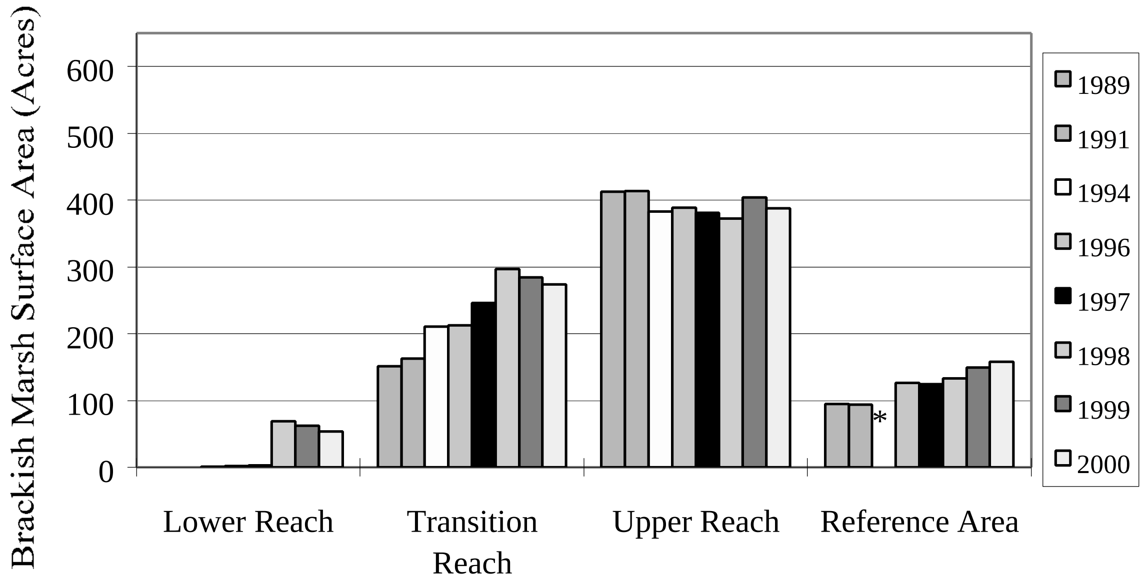
In the Main Study Area, gains in brackish marsh have occurred in the Lower and Transition Reaches while brackish marsh has decreased slightly in the Upper Reach (Figure 7). Expansion of brackish marsh area occurred primarily between 1997 and 1998 in the Lower Reach and from 1991 through 1998 in the Transition Reach (Figure 7). The Reference Area exhibited a steady trend of increasing brackish marsh area from 1991 through 2000 (Figure 7). Increases in freshwater marsh habitat have only occurred in the Upper Reach and Reference Area (Figure 8).

Figure 6. Salt Marsh Acreage Comparison From 1989 to 2000, by Reach.



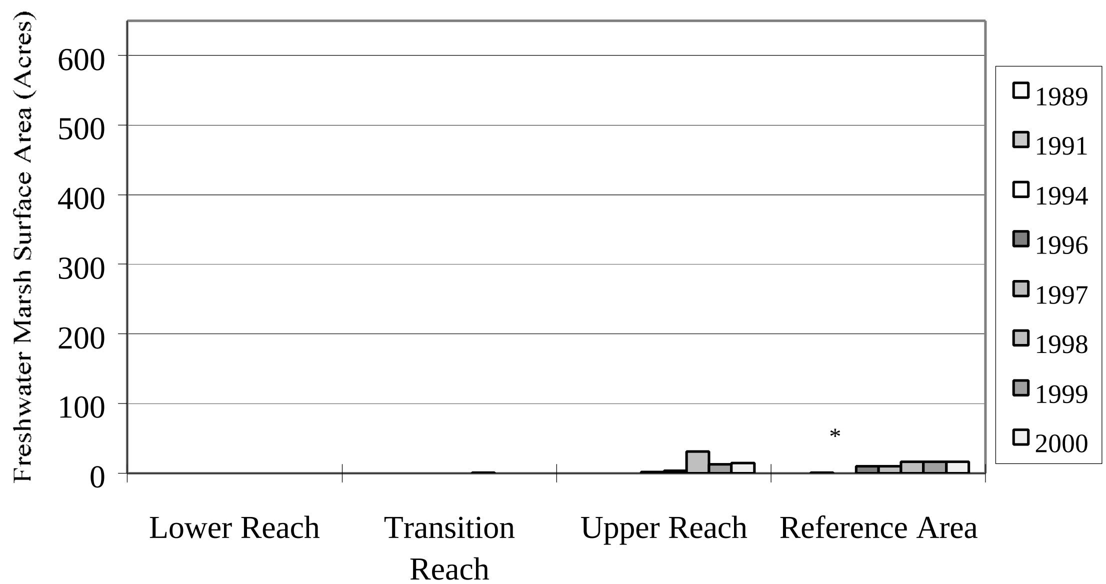
***No data collected in 1994 within Reference Area.**

Figure 7. Brackish Marsh Acreage Comparison From 1989 to 2000, by Reach.



***No data collected in 1994 within Reference Area.**

Figure 8. Freshwater Marsh Acreage Comparison From 1989 to 2000, by Reach.



***No data collected in 1994 within Reference Area.**

Temporal Changes in Proportional Area of Salt and Brackish Marsh Between the Main Study and Reference Areas

The proportion of salt marsh and brackish marsh area relative to total marsh area was compared between the Main Study and Reference Areas from 1989 through 2000 (Figures 9 and 10). This analysis was performed to control for the difference in size between the Main Study and Reference Areas. The percentage of salt marsh in the Main Study Area remained relatively stable from 1989 through 1997 with a slight decline between 1997 and 1998 (Figure 9). The decline in the percentage of salt marsh was greater in the Reference Area compared to the Main Study Area (Figure 9). The majority of this decline occurred between 1991 and 1996 and between 1999 and 2000 in the Reference Area.

Similar to the pattern for salt marsh habitat, the percentage of brackish marsh has been relatively stable in the Main Study Area (Figure 10). Within the Main Study Area, slight increases in the proportion of brackish marsh were observed between 1989 and 1991 and between 1997 and 1998 (Figure 10). A slight decrease occurred between 1999 and 2000 (Figure 10). A larger increase in the percentage of brackish marsh was observed in the Reference Area compared to the Main Study Area (Figure 10). This increase in the proportion of brackish marsh area to total marsh area in the Reference Area occurred primarily between 1991 and 1996 and between 1999 and 2000 (Figure 10) during the same time that the percentage of salt marsh declined (Figure 9).

Figure 9. Temporal Comparison of the Proportion of Salt Marsh Area Between the Main Study and Reference Areas

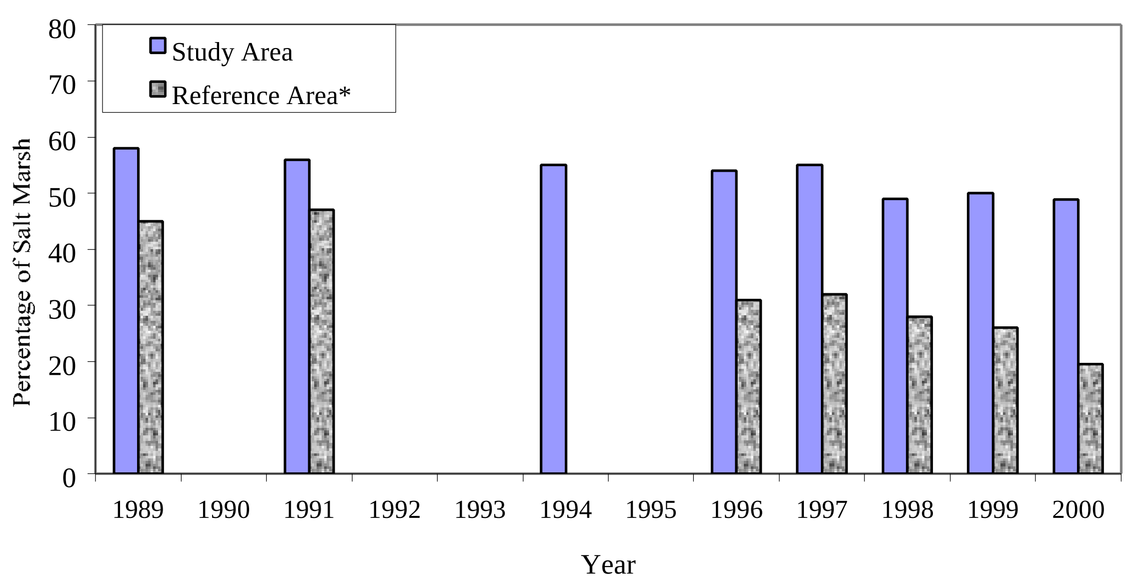
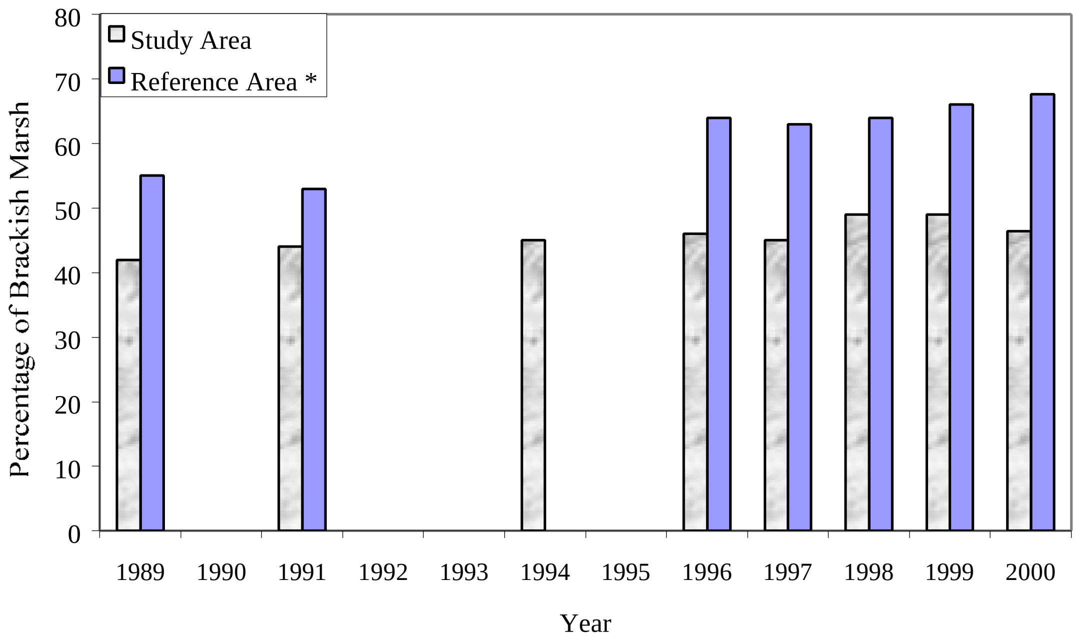


Figure 10. Temporal Comparison of the Proportion of Brackish Marsh Area Between the Main Study and Reference Areas



***No data collected in 1994 within Reference Area**.

Habitat Type Conversion

Detailed comparisons of the original overlays were conducted to isolate specific areas of major habitat change. Table 7 provides a summary of the segment locations and detailed explanation of significant shifts in acreage by marsh type and/or total marsh area from 1989 to 2000. This table differs from Tables 5 and 6, in that the previous tables compare the area of habitats as reported in 1989. However, without the benefit of orthorectified photography in 1989, distortions exist (see Methods section) that may skew the acreage of the mapped polygons. Therefore, the area calculations in Table 7 were derived from interpretation of changes in habitat characteristics based on a manual segment-by-segment evaluation.

A total of 117 acres of salt marsh habitat (16% of the total) has converted to brackish marsh habitat from 1989 to 2000 in the Main Study Area. During the same period, 16 acres (21% of the total) of salt marsh habitat has converted to brackish marsh in the Reference Area. The remaining change indicated by the GIS data could not be accounted for through detailed analysis of the original data. That difference can be accounted for in minor changes within segments and mapping associated errors.

Table 7. Detailed Evaluation of Changes in Acreage for Segment Locations by Habitat Type and for Total Marsh, 1989 to 2000.

Segment Location	Change in SM acreage	Change in BM acreage	Change in FM acreage	Change in TM acreage	Evaluation Results
Lower	97.47	53.95	0.00	151.42	Increase in TM acreage is due to approximately 102 acres of new marsh formation in segments 3 and 4. This increased marsh area has formed as both SM and BM habitat which, in part, accounts for the increase in these habitat types. Approximately 41 acres of SM has converted to BM during the past 11 years. The remaining change is due to mapping error (between 1989 and 2000). **Net SM conversion: 41 acres.**
Transition	-96.75	122.41	0.03	25.69	Approximately 9 acres of the total marsh acreage increase is due to new marsh formation. Approximately 73 acres of salt marsh has converted to BM. The remaining change is due to mapping error (between 1989 and 2000). **Net SM conversion: 73 acres.**
Upper	6.95	-25.36	14.77	-3.64	The increase in TM acreage is due to approximately 1 acre of new marsh formation, primarily in FM habitat. Approximately 3 acres of SM has converted to BM while approximately 13 acres of BM has converted to FM. The remaining change is due to mapping error (between 1989 and 2000). **Net SM conversion: 3 acres.**
Reference	-29.99	63.12	15.80	48.93	Approximately 11 acres of new marsh formation has occurred during the past 11 years. This marsh has formed primarily as BM and FM habitats. Approximately 16 acres of SM has converted to BM. The remaining change is due to mapping error (between 1989 and 2000). **Net SM conversion: 16 acres.**

Total SM Conversion Within Main Study Area= 117 acres (16% of total SM acreage in 1989).
Total SM Conversion Within Reference Area = 16 acres (21% of total SM acreage in 1989).
SM = Salt Marsh Habitat
BM = Brackish Marsh Habitat
FM = Freshwater Marsh Habitat
TM = Total Marsh Area

DISCUSSION

There has been an apparent increase of approximately 173.3 acres of overall marsh area mapped since 1989 in the Main Study Area. The majority of this increase is apparently due to sediment accretion along slough and river channels and subsequent vegetation colonization to form new marsh area. Some portion of the overall increase in marsh area can be attributed to differences in mapping methodology between years and errors associated with previous years' photography that is not orthorectified.

The majority of new marsh formation continues to occur at Calaveras Point (Segments 2, 3 and 4) located at the mouth of Coyote Creek. Segment 3 alone has increased 4 acres during the past year and has grown in size from 173 acres in 1989 to 283 acres in 2000 (a 64% increase). It appears that substantial sedimentation along Coyote Creek has raised the elevations to a level that will support the growth of emergent plant species. This newly formed mud flat continues to be colonized by alkali bulrush and a mixture of cordgrass and annual pickleweed (*Salicornia europaea*).

Within the Main Study Area from 1989 to 2000, losses in salt marsh habitat from conversion to other habitat types were balanced by increases in salt marsh habitat via new marsh formation. The majority of salt marsh habitat conversion during the past eleven years is attributed to losses of pickleweed and cordgrass dominated associations and increases in alkali bulrush and peppergrass associations. Furthermore, the majority of this conversion has occurred in the transition segments where nearly 100 acres of salt marsh habitat has become brackish marsh habitat during the past ten years. Conversely during the past year, over 3 acres of salt marsh conversion has occurred within the lower reach segments. Much of the conversion that has occurred during the past two years has been in an area disjoint from brackish marsh habitat within the transition segments; prior to 1998 most of the conversion was occurring farther upstream.

The only segments where salt marsh conversion has not occurred during the last 11 years are those segments located immediately adjacent to San Francisco Bay (Segments 1, 2 and 8). These marshes are likely outside of the immediate influence of Coyote Creek and Alviso Slough flows but are instead influenced directly by San Francisco Bay hydrology. The lack of salt marsh conversion adjacent to San Francisco Bay within the Study Area may indicate that the factors affecting marsh conversion are limited to the Coyote Creek and Alviso Slough reaches.

Historically, the channel-side vegetation in the transition segments may have been dominated by brackish (alkali bulrush) and freshwater species (tules), based on observations dating as far back as the mid-1800s (SFEI 1999). Salt marsh habitat dominated by pickleweed and saltgrass occurred inland of the channel-side vegetation (SFEI 1999). Those areas that were historically salt marsh have likely been converted to salt ponds. Many of the existing marshes, located between the levees of the salt ponds and the channels, 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 (SFEI 1999). 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 the restriction of local freshwater inputs and landscape-scale changes such as salt pond construction.

The entire study area is becoming less saline. No freshwater marsh habitat was mapped prior to 1996 in the Main Study Area or Alviso Slough (except in Segments 25 to 27, which are not part of the 10-year analysis) but now accounts for approximately 31 acres within the study area (2 acres more than last year). However, the majority of the freshwater marsh observed on site is in those segments (25 to 27) that are excluded from the comparisons to the 1989 data, as these areas were not mapped until later years. In 2000, Segments 25, 26 and 27 (the most upstream reaches of Alviso and Artesian Sloughs) contain an additional 75 acres of freshwater marsh.

Newly forming freshwater marsh habitat in both the Reference Area and the Main Study Area indicates that freshwater influences are affecting all marshes in the vicinity. Additionally, the net salt marsh acreage within the Main Study Area has been relatively stable during this period of increased freshwater impacts. The stability in salt marsh acreage during a period when salt marsh conversion is predominant is due to a simultaneous increase in new salt marsh via marsh formation and a concurrent conversion of salt marsh to brackish marsh habitat.

Between 1989 and 1999, the relative change in habitat types through time was similar between the Main Study Area and Reference Area although the rate of new marsh formation in the Main Study Area had exceeded that of the Reference Area. This indicates that much of the conversion of salt marsh habitats within the South San Francisco Bay area was likely driven by large-scale influences (both environmental and anthropogenic) that were affecting the entire system. However, the 2000 vegetation data shows a slight reversal of this trend, as the Main Study Area showed a gain in salt marsh acreage while the reference area showed a loss of total salt marsh acreage. This trend seems to further highlight the influence of multiple factors affecting changes in marsh vegetation communities in South San Francisco Bay. Additional improvements in the base materials (e.g. 1989 data rectification) used to conduct the vegetation mapping would allow future datasets to be more accurate and better reflect real changes in the South Bay Marshes.

The impact from the WPCP plant can only be determined from a study that includes both physical and biological variables that could be influenced by the freshwater flows. To better understand the causes of habitat conversion, monitoring of water levels, salinities and selected edaphic characteristics began in August 1999 (H.T. Harvey 2000). The mean salinities at the three continuous sampling locations, Alviso Slough, the Railroad Bridge and the Channel Marker, were 4.31, 4.01 and 13.34 ppt, respectively. These early results of this study indicate that the influence of freshwater flows does not extend into the lower reach segments of the study area and changes in salinity (likely from all sources of freshwater flows) are similar in the reference area as in the upper and transition reaches. The surface water results indicate that the physical conditions at the Railroad Bridge station within the Main Study Area (Transition Zone) is not significantly different from the Alviso Slough station within the Reference Area. The Channel Marker station (Lower Zone) 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.

Areas mapped as salt marsh habitat in the 1999 study had the highest interstitial salinities, areas mapped as brackish marsh habitat had intermediate interstitial salinities while freshwater marsh habitats had low interstitial salinities (H.T. Harvey 2000). The reference area had mean interstitial salinities most similar to the Upper Zone of the Main Study Area. The Transition and Lower Zones had much higher mean interstitial salinities than the Reference Area. This indicates that similar freshwater flows influence the Reference Area and the Upper Zone of the Main Study Area.

Alkali bulrush distribution does not appear to be directly related to interstitial salinities. However its distribution may be related to the depth and duration of flooding over the marsh surface, phytotoxins, disturbance and interspecific competition. Alkali bulrush was found growing and thriving as the dominant plant species in locations where the interstitial salinities were as low as 1.1 ppt (freshwater marsh) and as high as 51 ppt (salt marsh). No other dominant plant species in the South San Francisco Bay marshes was found within this broad range of salinities. Additional data collected since that initial report on edaphic characteristics (H.T. Harvey 2000) will be compiled and analyzed in conjunction with the vegetation and habitat mapping included in this report.

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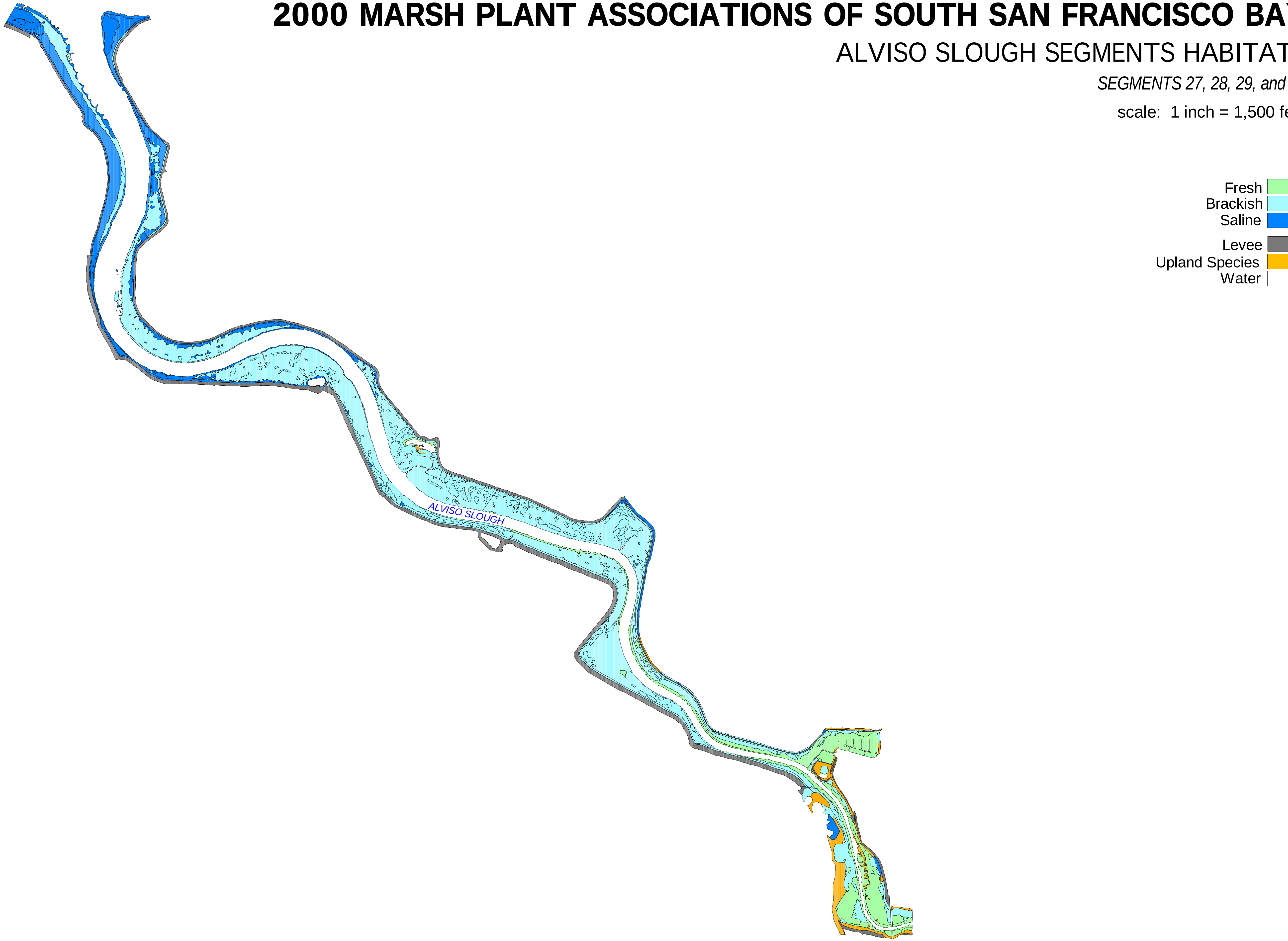
APPENDIX A.
SOUTH BAY MARSHES:
1999 VEGETATION MAPS

2000 MARSH PLANT ASSOCIATIONS OF SOUTH SAN FRANCISCO BAY

ALVISO SLOUGH SEGMENTS HABITATS

SEGMENTS 27, 28, 29, and 30

scale: 1 inch = 1,500 feet



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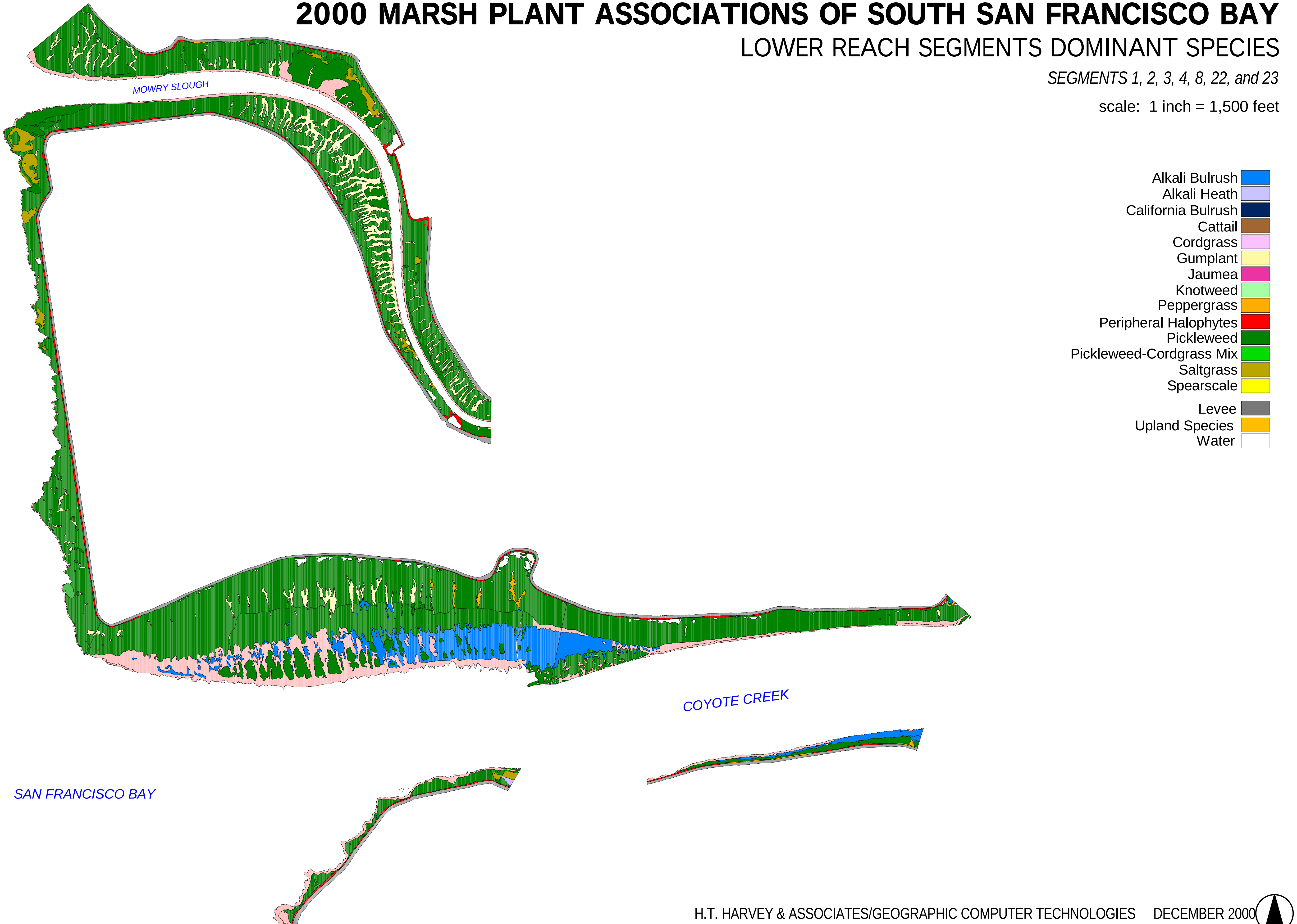
2000 MARSH PLANT ASSOCIATIONS OF SOUTH SAN FRANCISCO BAY

LOWER REACH SEGMENTS DOMINANT SPECIES

SEGMENTS 1, 2, 3, 4, 8, 22, and 23

scale: 1 inch = 1,500 feet



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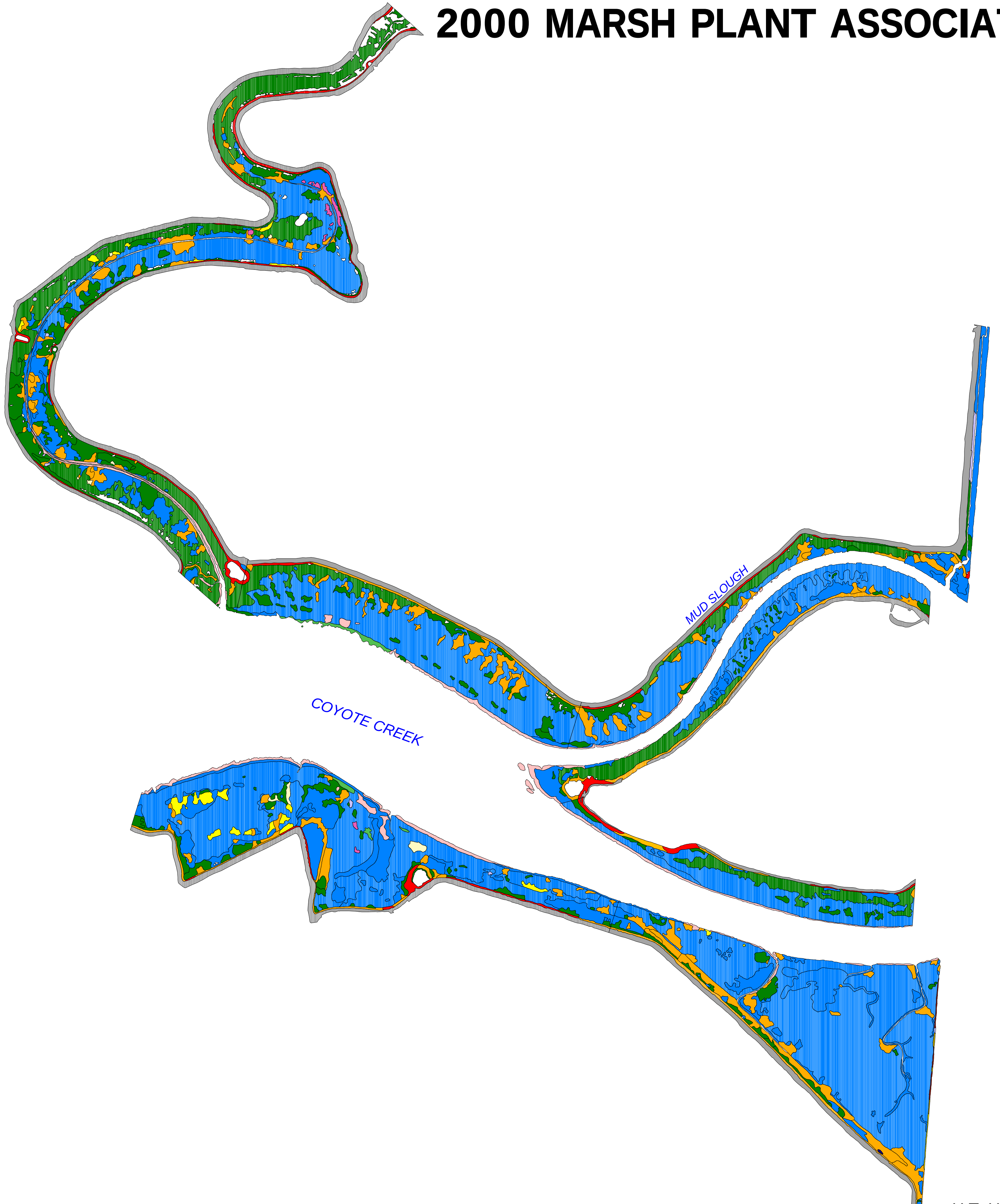
2000 MARSH PLANT ASSOCIATIONS OF SOUTH SAN FRANCISCO BAY

TRANSITION SEGMENTS DOMINANT SPECIES

SEGMENTS 5, 9, 10, 11, 14, and 20

scale: 1 inch = 1,200 feet



Alkali Bulrush
Alkali Heath
California Bulrush
Cattail
Cordgrass
Gumplant
Jaumea
Knotweed
Peppergrass
Peripheral Halophytes
Pickleweed
Pickleweed-Cordgrass Mix
Saltgrass
Spearscale
Levee
Upland Species
Water

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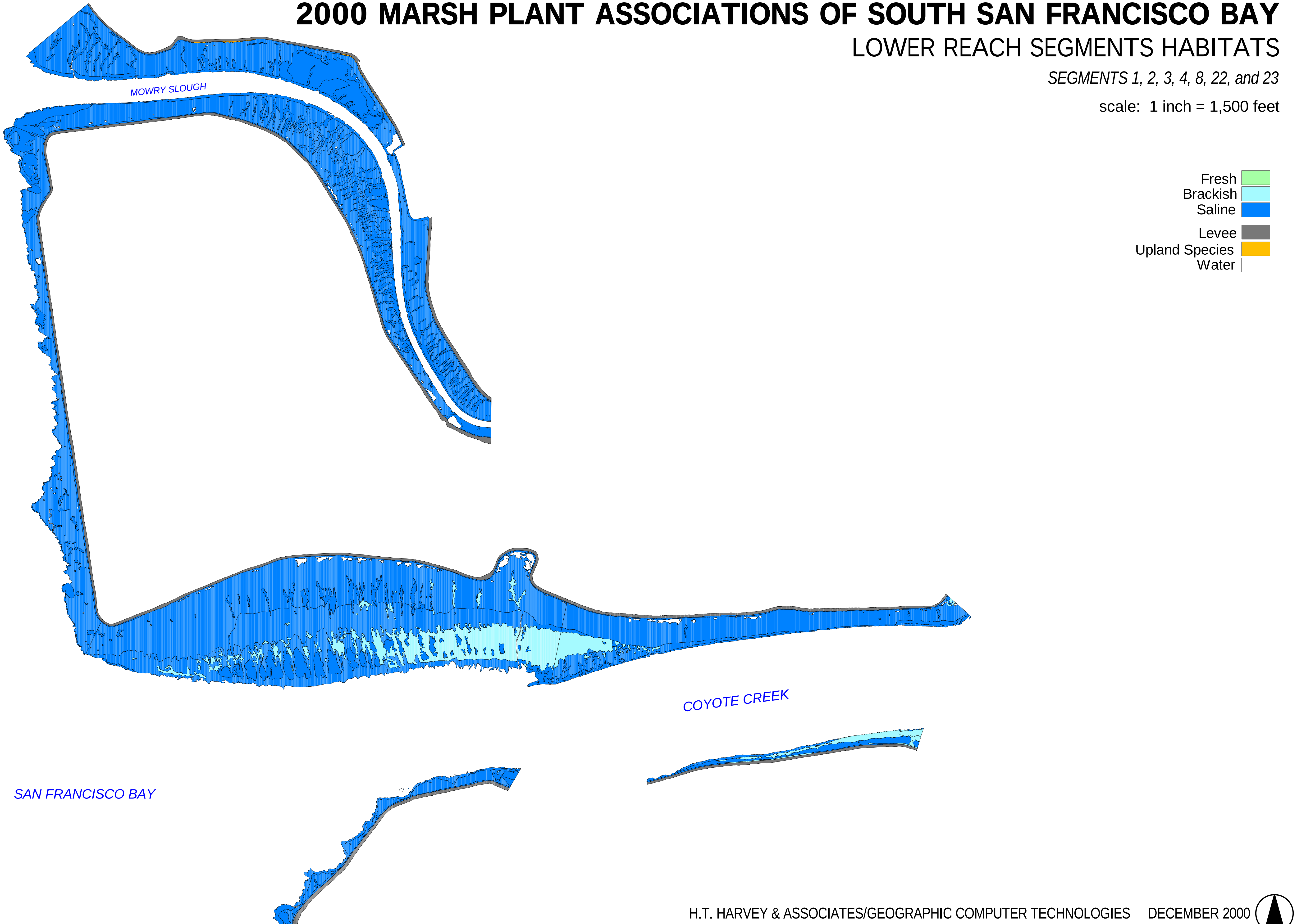
2000 MARSH PLANT ASSOCIATIONS OF SOUTH SAN FRANCISCO BAY

LOWER REACH SEGMENTS HABITATS

SEGMENTS 1, 2, 3, 4, 8, 22, and 23

scale: 1 inch = 1,500 feet



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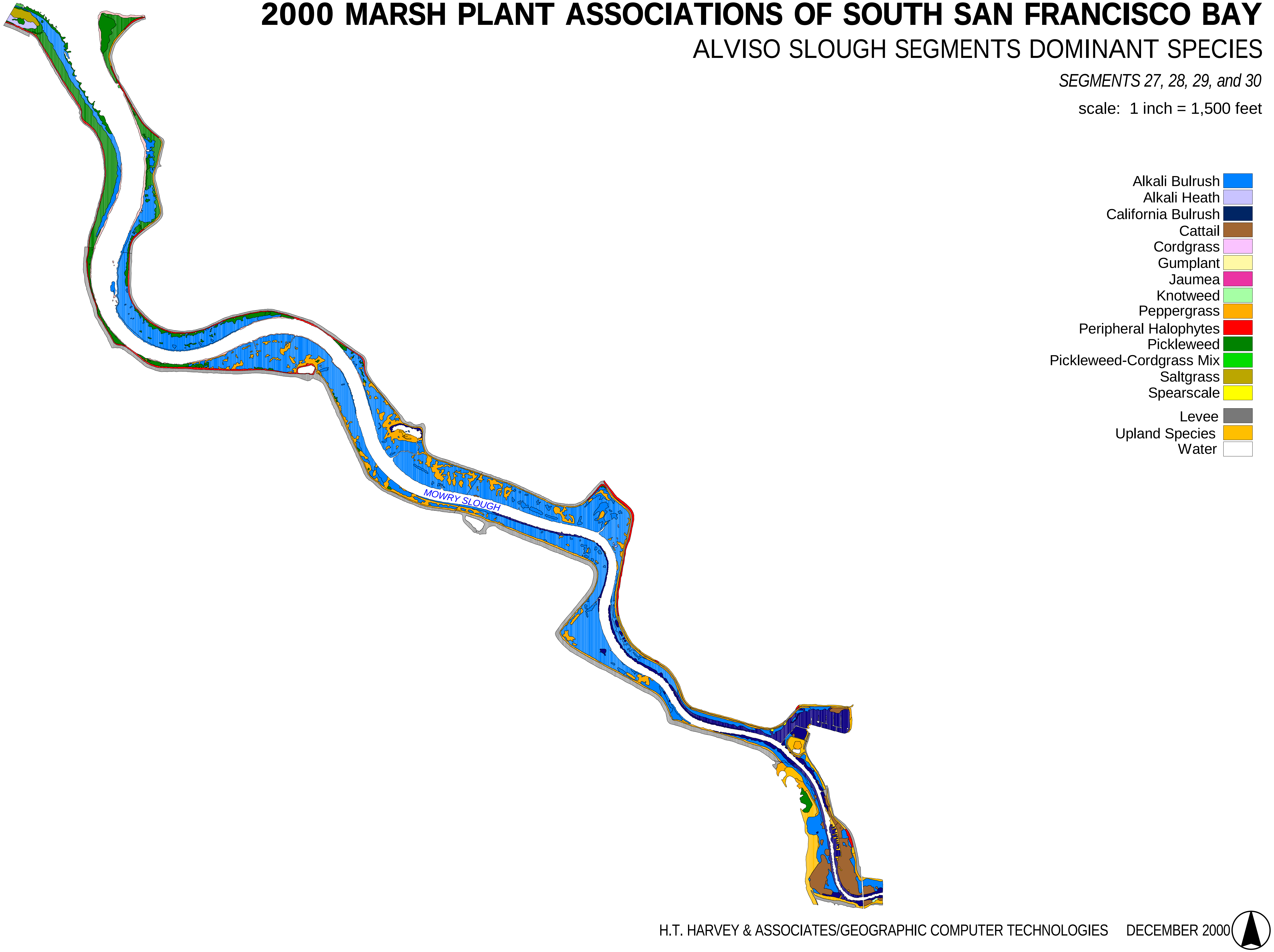
2000 MARSH PLANT ASSOCIATIONS OF SOUTH SAN FRANCISCO BAY

ALVISO SLOUGH SEGMENTS DOMINANT SPECIES

SEGMENTS 27, 28, 29, and 30

scale: 1 inch = 1,500 feet



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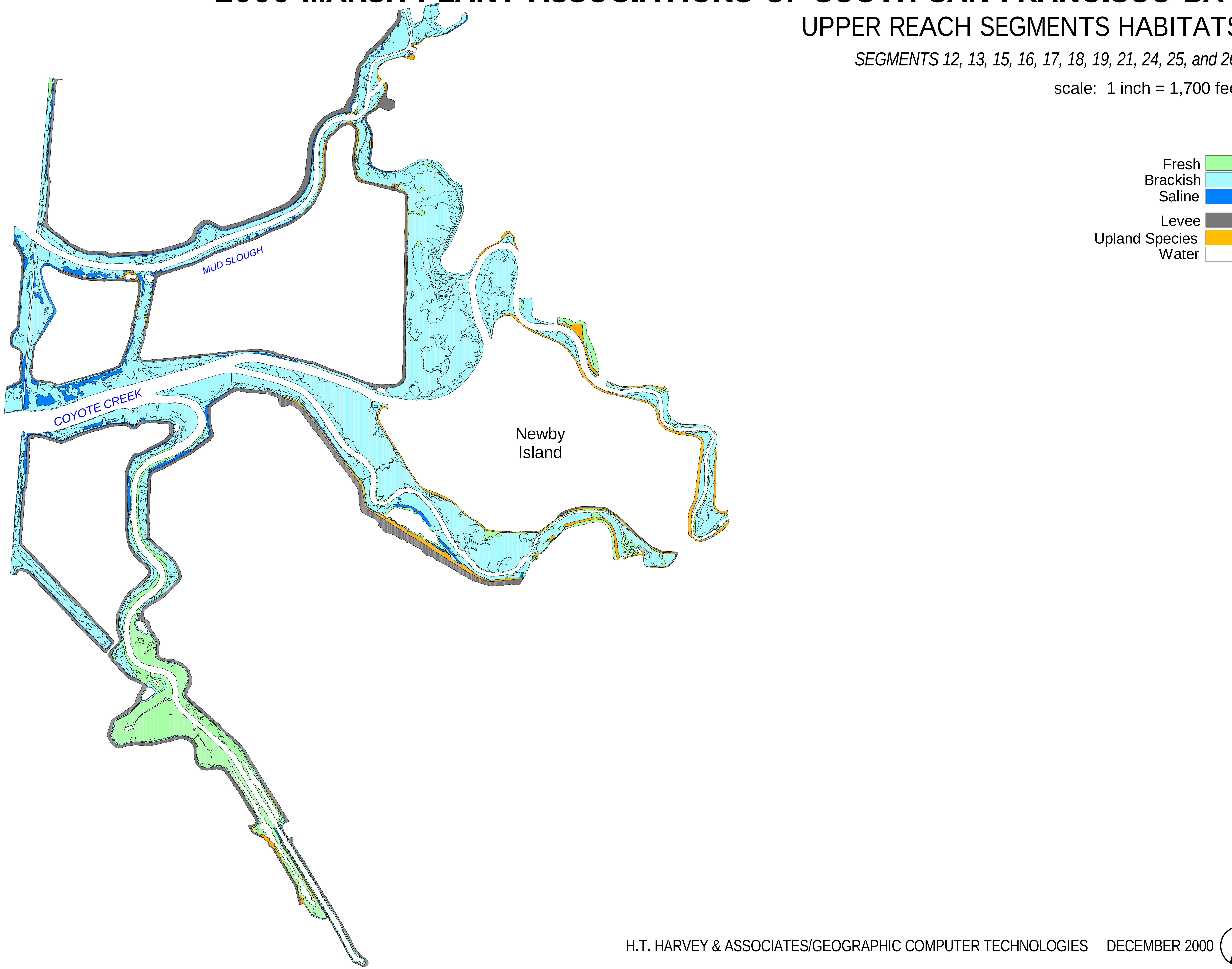
2000 MARSH PLANT ASSOCIATIONS OF SOUTH SAN FRANCISCO BAY

UPPER REACH SEGMENTS HABITATS

SEGMENTS 12, 13, 15, 16, 17, 18, 19, 21, 24, 25, and 26

scale: 1 inch = 1,700 feet



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2000 MARSH PLANT ASSOCIATIONS OF SOUTH SAN FRANCISCO BAY

UPPER REACH SEGMENTS DOMINANT SPECIES

SEGMENTS 12, 13, 15, 16, 17, 18, 19, 21, 24, 25, and 26

scale: 1 inch = 1,700 feet

Alkali Bulrush
Alkali Heath
California Bulrush
Cattail
Cordgrass
Gumplant
Jaumea
Knotweed
Peppergrass
Peripheral Halophytes
Pickleweed
Pickleweed-Cordgrass Mix
Saltgrass
Spearscale
Levee
Upland Species
Water

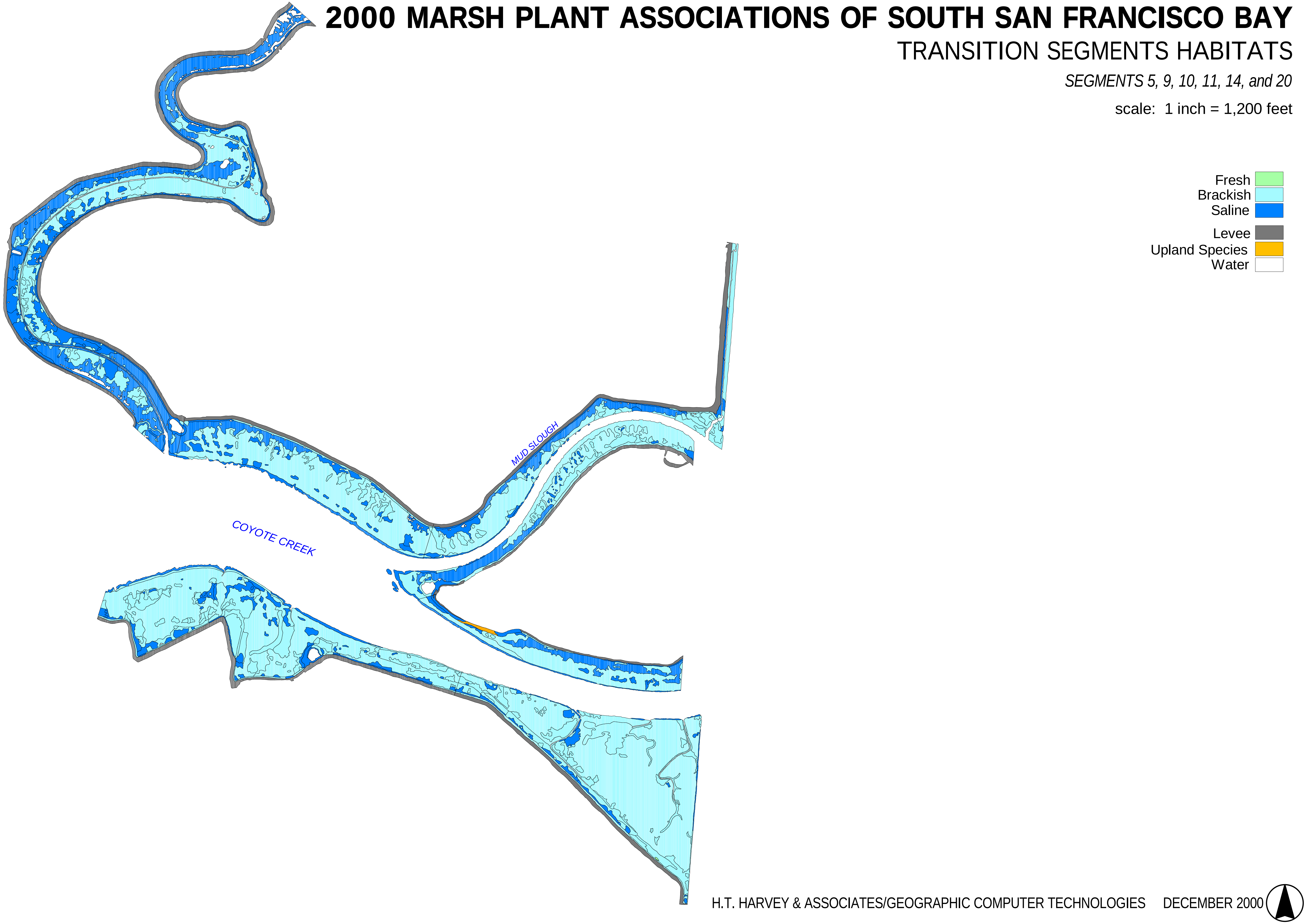
H.T. HARVEY & ASSOCIATES/GEOGRAPHIC COMPUTER TECHNOLOGIES DECEMBER 2000

2000 MARSH PLANT ASSOCIATIONS OF SOUTH SAN FRANCISCO BAY

TRANSITION SEGMENTS HABITATS

SEGMENTS 5, 9, 10, 11, 14, and 20

scale: 1 inch = 1,200 feet



H.T. HARVEY & ASSOCIATES/GEOGRAPHIC COMPUTER TECHNOLOGIES DECEMBER 2000

APPENDIX B.
VEGETATION MATRICES

Table B1. Acreage Summary of Segment 1 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	0.0	19.2	27.2	18.6	12.2	12.6	16.3
Cordgrass	8.2	1.4	3.4	2.8	9.7	1.94	0.9
Pickleweed-Cordgrass Mix	14.1	0.0	0.0	1.3	0.8	0.7	0.0
Pickleweed-Spearscale Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alkali Heath	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gumplant	0.0	0.0	0.0	0.0	0.2	0.1	0.1
Peripheral Halophytes	2.6	1.5	1.7	0.0	1.4	1.43	1.2
Total Saline Dominant Species:	24.9	22.1	32.3	22.7	24.3	16.8	18.5
Brackish Marsh Vegetation							
Alkali Bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Peppergrass	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spearscale	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Brackish Dominant Species:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cattail	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Segment Acreage	24.9	22.1	32.3	23.3	26.5	27.1	24.4

Table B2. Acreage Summary of Segment 2 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	26.0	35.5	32.9	32.4	19.0	36.2	36.4
Cordgrass	13.3	2.3	2.6	3.8	10.5	3.1	1.5
Pickleweed-Cordgrass Mix	0.0	0.0	0.0	1.8	0.0	0.0	0.7
Pickleweed-Spearscale Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alkali Heath	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gumplant	0.0	0.0	0.0	0.2	0.2	1.4	1.0
Peripheral Halophytes	3.6	2.3	1.6	0.7	3.0	2.2	2.0
Total Saline Dominant Species:	42.9	40.1	37.1	38.9	32.7	42.9	41.6
Brackish Marsh Vegetation							
Alkali Bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Peppergrass	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spearscale	0.0	0.0	0.0	0.4	7.5	0.0	0.0
Total Brackish Dominant Species:	0.0	0.0	0.0	0.4	7.5	0.0	0.0
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cattail	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Segment Acreage	42.9	40.1	37.1	39.8	41.2	42.9	41.7

Table B3. Acreage Summary of Segment 3 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	97.8	114.7	79.3	95.1	98.7	118.3	187.4
Cordgrass	4.1	3.4	2.9	86.6	104.6	15.9	46.3
Pickleweed-Cordgrass Mix	68.6	69.9	98.8	36.0	0.0	83.3	0.0
Pickleweed-Spearscale Mix	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Alkali Heath	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jaumea	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gumplant	0.0	0.0	2.7	6.9	2.2	7.4	6.6
Peripheral Halophytes	2.4	2.6	1.1	1.0	2.2	1.0	1.3
Total Saline Dominant Species:	172.9	190.6	184.8	225.6	207.9	225.9	241.5
Brackish Marsh Vegetation							
Alkali Bulrush	0.0	0.0	0.1	0.0	49.2	50.8	39.9
Peppergrass	0.0	1.1	1.2	1.6	1.8	1.8	1.5
Spearscale	0.0	0.0	0.0	0.2	2.4	0.0	0.0
Total Brackish Dominant Species:	0.0	1.1	1.3	1.8	53.4	52.6	41.4
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cattail	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Segment Acreage	172.9	191.7	212.3	227.6	262.1	278.5	282.9

Table B4. Acreage Summary of Segment 4 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	36.4	43.9	46.9	50.1	49.8	47.6	57.5
Cordgrass	6.1	6.2	4.1	5.6	12.9	17.1	9.9
Pickleweed-Cordgrass Mix	7.0	3.4	6.2	7.2	0.1	0.0	0.0
Pickleweed-Spearscale Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alkali Heath	0.0	0.0	0.0	0.2	0.0	0.0	0.0
Gumplant	0.0	0.0	0.0	0.1	0.1	0.1	0.2
Peripheral Halophytes	0.4	2.4	1.5	0.9	1.7	1.7	1.8
Total Saline Dominant Species:	49.9	55.9	58.7	64.0	64.6	66.5	69.4
Brackish Marsh Vegetation							
Alkali Bulrush	0.0	0.0	0.0	0.0	4.8	6.2	7.2
Peppergrass	0.0	0.1	0.1	0.1	0.1	0.2	0.1
Spearscale	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Total Brackish Dominant Species:	0.0	0.1	0.1	0.1	5.0	6.4	7.3
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cattail	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Segment Acreage	49.9	56.0	58.8	64.0	70.0	72.9	76.7

Table B5. Acreage Summary of Segment 5 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	60.5	62.3	30.5	36.6	34.4	41.6	44.5
Cordgrass	0.5	2.1	2.7	2.6	3.6	2.3	2.0
Pickleweed-Cordgrass Mix	0.0	0.0	0.0	0.0	0.0	1.1	0.0
Pickleweed-Spearscale Mix	0.0	0.0	18.9	7.9	2.2	0.0	0.0
Alkali Heath	0.0	0.0	0.0	0.2	0.1	0.4	0.2
Gumplant	0.0	0.0	0.0	0.1	0.0	0.3	0.2
Peripheral Halophytes	1.2	0.5	1.0	2.8	3.2	6.6	4.2
Total Saline Dominant Species:	62.2	64.9	53.1	50.2	43.5	52.3	51.2
Brackish Marsh Vegetation							
Alkali Bulrush	25.1	19.2	27.3	32.1	34.7	32.0	31.4
Peppergrass	0.0	1.4	2.4	4.0	3.4	7.5	7.5
Spearscale	0.0	0.0	0.0	3.7	13.6	0.1	0.6
Total Brackish Dominant Species:	25.1	20.6	29.7	39.8	51.7	39.6	39.5
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cattail	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Segment Acreage	87.3	85.5	82.8	90.0	95.5	92.4	91.4

Table B6. Acreage Summary of Segment 8 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	188.0	204.9	151.8	149.4	101.0	171.1	182.4
Cordgrass	13.1	11.7	10.2	22.5	98.0	32.5	17.8
Pickleweed-Cordgrass Mix	23.0	0.0	49.0	25.7	0.0	0.0	0.0
Pickleweed-Spearscale Mix	0.0	0.0	0.0	0.0	0.0	6.6	0.0
Alkali Heath	0.0	0.0	0.0	0.1	0.0	0.3	0.0
Gumplant	0.0	0.0	0.0	23.8	25.7	27.5	29.7
Saltgrass	0.0	0.0	0.0	0.0	0.0	0.0	3.3
Peripheral Halophytes	7.1	10.0	7.8	6.0	10.1	7.7	5.8
Total Saline Dominant Species:	231.2	226.6	218.8	227.5	234.8	245.7	239.0
Brackish Marsh Vegetation							
Alkali Bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Peppergrass	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spearscale	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Total Brackish Dominant Species:	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cattail	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Segment Acreage	231.2	226.6	215.3	228.5	239.1	248.7	239.0

Table B7. Acreage Summary of Segment 9 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.
DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	3.6	32.4	15.4	10.0	3.5	6.0	5.4
Cordgrass	3.7	8.9	3.9	6.6	7.3	4.7	2.6
Pickleweed-Cordgrass Mix	42.6	0.0	0.0	0.1	0.0	0.2	0.4
Pickleweed-Spearscale Mix	0.0	0.0	0.3	0.5	0.0	0.0	0.0
Alkali Heath	0.0	0.0	0.0	0.0	0.0	0.2	0.1
Gumplant	0.0	0.0	0.0	0.0	0.0	0.3	0.6
Peripheral Halophytes	1.2	0.0	1.3	2.0	3.3	1.2	1.3
Total Saline Dominant Species:	51.1	41.3	20.9	19.2	14.1	12.6	10.3
Brackish Marsh Vegetation							
Alkali Bulrush	16.3	22.2	44.1	50.4	67.0	60.2	56.9
Peppergrass	0.6	1.3	1.2	1.7	1.4	4.3	4.8
Spearscale	0.0	0.0	0.0	1.5	1.9	3.0	2.1
Total Brackish Dominant Species:	16.9	23.5	45.3	53.6	70.2	67.5	63.8
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cattail	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Segment Acreage	68.0	64.8	66.2	72.8	84.8	80.2	74.2

Table B8. Acreage Summary of Segment 10 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.
DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	21.7	21.2	10.7	10.4	8.3	8.0	9.2
Cordgrass	6.8	11.0	8.4	8.3	5.0	3.6	1.5
Pickleweed-Cordgrass Mix	0.0	0.0	0.0	0.0	0.0	0.1	0.7
Pickleweed-Spearscale Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alkali Heath	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Gumplant	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Peripheral Halophytes	0.7	0.1	0.6	0.6	1.6	0.2	0.4
Total Saline Dominant Species:	29.2	32.3	19.7	19.3	14.9	12.0	11.8
Brackish Marsh Vegetation							
Alkali Bulrush	9.7	5.8	19.7	24.3	37.1	30.7	30.4
Peppergrass	2.6	1.7	1.6	2.7	1.7	6.3	5.4
Spearscale	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Total Brackish Dominant Species:	12.3	7.5	21.3	27.0	38.9	37.0	35.9
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cattail	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Segment Acreage	41.5	39.8	41.0	46.3	53.8	49.0	47.7

Table B9. Acreage Summary of Segment 11 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	2.0	22.4	3.8	3.9	1.7	1.8	3.0
Cordgrass	0.0	1.6	1.1	1.1	1.6	2.3	0.6
Pickleweed-Cordgrass Mix	16.3	0.0	0.0	0.0	0.0	0.0	0.0
Pickleweed-Spearscale Mix	0.0	0.0	0.1	0.1	0.1	0.0	0.0
Alkali Heath	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gumplant	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Peripheral Halophytes	1.0	0.0	0.4	1.1	1.5	1.2	0.2
Total Saline Dominant Species:	19.3	24.0	5.4	6.4	5.0	5.3	3.9
Brackish Marsh Vegetation							
Alkali Bulrush	51.2	48.8	63.4	64.4	68.5	68.6	65.9
Peppergrass	7.7	5.6	6.2	6.4	5.5	8.2	10.4
Spearscale	0.0	0.0	0.0	1.2	1.1	0.4	0.2
Total Brackish Dominant Species:	58.9	54.4	69.6	72.0	75.1	77.2	76.5
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cattail	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Segment Acreage	78.2	78.4	75.1	78.3	80.7	82.6	80.5

Table B10. Acreage Summary of Segment 12 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	0.1	2.8	0.6	2.0	0.7	0.5	2.1
Cordgrass	0.0	2.2	1.1	1.1	0.7	1.4	0.2
Pickleweed-Cordgrass Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pickleweed-Spearscale Mix	0.0	0.0	0.4	0.0	0.0	0.0	0.0
Alkali Heath	0.0	0.0	0.0	0.1	0.1	0.0	0.0
Gumplant	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Saltgrass-Gumplant Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Peripheral Halophytes	0.6	0.0	1.7	1.1	10.2	2.2	2.4
Total Saline Dominant Species:	0.7	5.0	3.8	4.3	11.7	4.1	4.8
Brackish Marsh Vegetation							
Alkali Bulrush	28.2	21.2	25.4	24.1	19.0	24.2	26.4
Peppergrass	13.5	17.5	13.4	14.5	9.9	18.4	14.3
Spearscale	0.0	0.0	0.0	0.5	1.7	0.0	0.1
Total Brackish Dominant Species:	41.7	38.7	38.8	39.0	30.6	42.6	40.8
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	0.1	0.2	0.2	0.2	0.3
Cattail	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	0.0	0.0	0.1	0.2	0.2	0.2	0.3
Total Segment Acreage	42.4	43.7	43.1	43.5	44.5	47.4	46.0

Table B11. Acreage Summary of Segment 13 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	0.0	0.4	0.8	1.5	0.5	0.4	0.5
Cordgrass	0.0	0.4	0.0	0.2	0.0	0.0	0.0
Pickleweed-Cordgrass Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pickleweed-Spearscale Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alkali Heath	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Gumplant	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Peripheral Halophytes	0.7	0.0	11.9	7.0	4.0	3.1	1.8
Total Saline Dominant Species:	0.7	0.8	12.7	8.7	4.5	3.5	2.4
Brackish Marsh Vegetation							
Alkali Bulrush	95.4	79.9	84.8	73.3	63.0	76.1	83.8
Peppergrass	13.5	26.8	13.6	15.6	7.0	23.6	14.4
Spearscale	0.0	0.0	0.0	9.0	6.3	0.0	0.3
Total Brackish Dominant Species:	108.9	106.7	98.4	97.9	76.2	99.7	98.5
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	1.3	4.3	26.7	7.0	5.7
Cattail	0.0	0.0	0.1	0.2	1.8	1.1	2.2
Total Freshwater Dominant Species:	0.0	0.0	1.4	4.5	28.5	8.1	7.9
Total Segment Acreage	109.6	107.5	113.0	115.5	117.5	119.4	108.8

Table B12. Acreage Summary of Segment 14 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	5.8	8.9	3.4	2.5	0.5	0.8	6.7
Cordgrass	2.9	2.0	1.5	2.1	2.0	2.4	1.4
Pickleweed-Cordgrass Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pickleweed-Spearscale Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alkali Heath	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gumplant	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Peripheral Halophytes	0.7	0.0	0.0	0.6	0.9	1.4	1.0
Total Saline Dominant Species:	9.4	10.9	4.9	5.2	3.4	4.6	9.1
Brackish Marsh Vegetation							
Alkali Bulrush	10.8	9.1	14.6	16.7	19.3	18.5	13.8
Peppergrass	0.0	0.1	0.5	0.3	0.1	0.4	0.3
Spearscale	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Total Brackish Dominant Species:	10.8	9.2	15.1	17.0	19.4	18.9	14.0
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cattail	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Segment Acreage	20.2	20.1	20.0	22.2	23.0	23.9	23.2

Table B13. Acreage Summary of Segment 15 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	1.3	4.2	2.0	1.2	0.4	0.2	5.2
Cordgrass	0.8	0.7	0.4	0.7	0.2	0.8	0.1
Pickleweed-Cordgrass Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pickleweed-Spearscale Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alkali Heath	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gumplant	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Peripheral Halophytes	0.2	0.0	0.2	0.5	0.8	1.4	0.1
Total Saline Dominant Species:	2.3	4.9	2.6	2.3	1.3	2.4	5.3
Brackish Marsh Vegetation							
Alkali Bulrush	20.1	16.7	18.7	17.9	22.5	21.0	15.6
Peppergrass	7.5	7.8	7.4	8.9	6.1	9.8	9.6
Spearscale	0.0	0.0	0.0	0.3	0.7	0.2	0.1
Total Brackish Dominant Species:	27.6	24.5	26.1	27.2	29.2	31.0	25.2
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cattail	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Segment Acreage	29.9	29.4	28.7	29.5	30.5	33.4	30.6

Table B14. Acreage Summary of Segment 16 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Cordgrass	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pickleweed-Cordgrass Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pickleweed-Spearscale Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alkali Heath	0.0	0.0	0.0	0.2	0.0	0.0	0.0
Gumplant	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Peripheral Halophytes	1.0	0.0	2.1	1.1	0.0	0.0	0.0
Total Saline Dominant Species:	1.0	0.1	2.1	1.3	0.0	0.0	0.0
Brackish Marsh Vegetation							
Alkali Bulrush	36.5	29.4	35.3	18.2	33.6	28.2	26.9
Peppergrass	8.7	14.8	5.7	4.0	0.9	12.3	11.5
Spearscale	0.0	0.0	0.0	18.4	5.7	0.9	2.1
Total Brackish Dominant Species:	45.2	44.2	41.0	40.6	40.2	41.4	40.4
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	0.3	0.7	0.7	3.4	3.7
Cattail	0.0	0.0	0.1	0.1	0.0	0.1	0.6
Total Freshwater Dominant Species:	0.0	0.0	0.4	0.9	0.7	3.5	4.3
Total Segment Acreage	46.2	44.2	45.1	43.3	42.8	54.8	44.7

Table B15. Acreage Summary of Segment 17 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.
DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	1.9	1.8	0.0	0.1	0.0	0.0	0.0
Cordgrass	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pickleweed-Cordgrass Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pickleweed-Spearscale Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alkali Heath	0.0	0.0	1.8	2.3	0.0	0.1	0.0
Gumplant	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Peripheral Halophytes	0.7	0.0	0.0	1.1	2.1	1.8	0.0
Total Saline Dominant Species:	2.6	1.8	1.8	3.5	2.1	1.9	0.0
Brackish Marsh Vegetation							
Alkali Bulrush	90.7	75.9	75.9	44.5	76.3	68.3	66.5
Peppergrass	7.8	18.9	18.9	21.1	11.7	28.4	29.4
Spearscale	0.0	0.0	0.0	26.6	11.3	0.0	1.8
Total Brackish Dominant Species:	98.5	94.8	94.8	92.2	99.3	96.7	97.8
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	0.0	0.1	0.1	0.0	0.1
Cattail	0.0	0.0	0.0	0.5	0.7	0.2	1.2
Total Freshwater Dominant Species:	0.0	0.0	0.0	0.5	0.8	0.2	1.3
Total Segment Acreage	101.1	96.6	96.6	98.4	104.2	102.8	99.2

Table B16. Acreage Summary of Segment 18 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.
DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	1.1	2.1	0.8	1.6	0.6	0.7	1.3
Cordgrass	0.0	0.0	0.0	0.2	0.2	0.0	0.0
Pickleweed-Cordgrass Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pickleweed-Spearscale Mix	0.0	0.0	0.9	0.1	1.3	0.0	0.0
Alkali Heath	0.0	0.3	0.2	0.3	0.1	0.1	0.2
Gumplant	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Peripheral Halophytes	0.6	0.0	0.6	1.7	1.3	2.1	1.0
Total Saline Dominant Species:	1.7	2.4	2.5	3.8	3.5	2.9	2.5
Brackish Marsh Vegetation							
Alkali Bulrush	32.7	24.2	24.7	13.4	24.2	22.9	23.9
Peppergrass	3.5	8.2	7.2	4.4	2.3	8.3	6.2
Spearscale	0.0	0.0	0.0	12.1	3.7	1.3	1.5
Total Brackish Dominant Species:	36.2	32.4	31.9	29.8	30.3	32.5	31.7
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	0.0	0.1	0.1	0.0	0.3
Cattail	0.0	0.0	0.0	0.1	0.2	0.1	0.1
Giant Reed	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	0.0	0.0	0.0	0.2	0.3	0.1	0.4
Total Segment Acreage	37.9	33.8	38.7	36.8	37.4	38.3	34.5

Table B17. Acreage Summary of Segment 19 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	6.2	11.3	2.6	2.1	30.9	1.0	2.7
Cordgrass	0.0	2.0	1.8	0.7	0.1	0.5	0.0
Pickleweed-Cordgrass Mix	0.0	0.0	0.0	0.0	0.0	0.2	0.0
Pickleweed-Spearscale Mix	0.0	0.0	0.6	0.0	0.2	0.0	0.0
Alkali Heath	0.0	0.4	0.2	0.3	0.0	0.1	0.2
Gumplant	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Peripheral Halophytes	0.5	0.5	1.5	2.8	3.6	3.8	3.1
Total Saline Dominant Species:	6.7	14.2	6.7	6.0	34.8	5.6	6.0
Brackish Marsh Vegetation							
Alkali Bulrush	31.4	22.1	31.4	24.7	0.8	29.8	27.4
Peppergrass	0.5	1.1	1.7	1.2	0.3	2.0	2.3
Spearscale	0.0	0.0	0.0	4.2	0.5	0.1	0.0
Total Brackish Dominant Species:	31.9	23.2	33.1	30.1	1.7	31.9	29.7
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cattail	0.0	0.0	0.0	0.2	0.0	0.6	0.6
Total Freshwater Dominant Species:	0.0	0.0	0.0	0.2	0.0	0.6	0.6
Total Segment Acreage	38.6	37.1	40.8	36.2	36.5	38.4	36.3

Table B18. Acreage Summary of Segment 20 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	29.6	31.2	18.6	18.2	14.6	14.4	13.6
Cordgrass	0.0	6.0	5.0	4.7	2.7	2.6	1.7
Pickleweed-Cordgrass Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pickleweed-Spearscale Mix	0.0	0.0	0.0	0.1	0.2	0.0	0.0
Alkali Heath	0.0	0.0	0.0	0.1	0.2	0.0	0.3
Gumplant	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Peripheral Halophytes	0.3	0.0	1.6	1.4	3.3	1.9	1.3
Total Saline Dominant Species:	29.9	37.2	25.2	24.5	20.9	18.9	16.9
Brackish Marsh Vegetation							
Alkali Bulrush	25.3	17.0	28.9	33.1	36.4	37.9	36.8
Peppergrass	2.0	3.3	2.5	3.3	3.3	6.7	7.2
Spearscale	0.0	0.0	0.0	0.1	2.1	0.1	0.1
Total Brackish Dominant Species:	27.3	20.3	31.4	36.5	41.8	44.7	44.0
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cattail	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Segment Acreage	57.2	57.5	56.7	61.1	62.7	63.6	61.0

Table B19. Acreage Summary of Segment 21 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	2.9	7.0	2.9	2.2	1.1	1.0	3.6
Cordgrass	0.4	0.4	0.3	0.4	0.3	0.2	0.1
Pickleweed-Cordgrass Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pickleweed-Spearscale Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alkali Heath	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Gumplant	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Peripheral Halophytes	0.8	3.6	0.4	0.3	1.2	0.9	1.9
Total Saline Dominant Species:	4.1	11.0	3.6	2.9	2.7	2.1	5.6
Brackish Marsh Vegetation							
Alkali Bulrush	20.0	15.1	18.6	17.6	20.6	20.5	18.4
Peppergrass	3.0	3.7	4.1	5.3	3.4	6.2	5.1
Spearscale	0.0	0.0	0.0	0.8	1.0	0.2	0.0
Total Brackish Dominant Species:	23.0	18.8	22.7	23.7	24.9	26.9	23.5
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cattail	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Segment Acreage	27.1	29.8	26.7	26.7	27.6	29.0	29.1

Table B20. Acreage Summary of Segment 22 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	5.2	6.1	7.3	6.1	5.2	5.0	5.5
Cordgrass	2.3	3.9	2.8	3.8	3.5	4.7	2.3
Pickleweed-Cordgrass Mix	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Pickleweed-Spearscale Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alkali Heath	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gumplant	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Peripheral Halophytes	0.4	0.0	0.5	1.0	1.2	0.9	0.9
Total Saline Dominant Species:	7.9	10.0	10.6	10.9	9.9	10.7	8.7
Brackish Marsh Vegetation							
Alkali Bulrush	0.0	0.0	0.2	1.0	2.9	2.7	4.6
Peppergrass	0.0	0.2	0.4	0.0	0.0	0.6	0.7
Spearscale	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Brackish Dominant Species:	0.0	0.2	0.6	1.0	2.9	3.3	5.4
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cattail	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Segment Acreage	7.9	10.2	11.2	11.9	12.8	14.1	14.1

Table B21. Acreage Summary of Segment 23 for 1989, 1994/1995, 1996, 1997, 1998, 1999 and 2000.
DOMINANT SPECIES CATEGORY

	Year						
Saline Marsh Vegetation	1989	1994/1995	1996	1997	1998	1999	2000
Pickleweed	8.9	14.1	14.1	11.1	10.2	10.2	10.9
Cordgrass	8.5	3.7	3.6	4.8	6.2	5.9	6.2
Pickleweed-Cordgrass Mix	0.0	0.0	0.0	0.1	0.0	1.3	0.2
Pickleweed-Spearscale Mix	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alkali Heath	0.0	0.0	0.2	0.0	0.0	0.2	0.3
Gumplant	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Saltgrass	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Peripheral Halophytes	0.3	0.0	0.8	1.4	1.7	1.5	1.7
Total Saline Dominant Species:	17.7	17.8	18.7	17.4	18.1	19.1	20.0
Brackish Marsh Vegetation							
Alkali Bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Peppergrass	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spearscale	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Brackish Dominant Species:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Freshwater Marsh Vegetation							
California Bulrush	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cattail	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Segment Acreage	17.7	17.8	21.2	17.7	18.4	19.8	20.1

Table B22. Acreage Summary of Segment 24* for 1994/1995, 1996, 1997, 1998, 1999 and 2000.
DOMINANT SPECIES CATEGORY

	Year					
Saline Marsh Vegetation	1994/1995	1996	1997	1998	1999	2000
Pickleweed	0.8	0.2	0.6	0.6	0.2	1.3
Cordgrass	0.0	0.0	0.0	0.0	0.0	0.0
Pickleweed-Cordgrass Mix	0.0	0.0	0.0	0.0	0.0	0.0
Pickleweed-Spearscale Mix	0.0	0.0	0.0	0.0	0.0	0.0
Alkali Heath	0.0	0.0	0.0	0.0	0.0	0.0
Gumplant	0.0	0.0	0.0	0.0	0.0	0.0
Peripheral Halophytes	1.5	2.2	0.7	0.8	0.5	1.0
Total Saline Dominant Species:	2.3	2.4	1.3	1.4	0.7	2.3
Brackish Marsh Vegetation						
Alkali Bulrush	1.5	2.0	1.8	2.2	2.4	2.7
Peppergrass	7.0	6.0	5.7	7.1	7.1	4.6
Spearscale	0.0	0.0	0.0	0.5	0.1	0.1
Total Brackish Dominant Species:	8.5	8.0	7.5	9.7	9.6	7.4
Freshwater Marsh Vegetation						
California Bulrush	1.4	1.6	1.9	2.0	2.6	2.8
Cattail	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	1.4	1.6	1.9	2.0	2.6	2.8
Total Segment Acreage	20.2	12.1	10.7	11.2	12.9	12.4

Table B23. Acreage Summary of Segment 25* for 1994/1995, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year					
Saline Marsh Vegetation	1994/1995	1996	1997	1998	1999	2000
Pickleweed	0.0	0.0	0.0	0.0	0.0	0.1
Cordgrass	0.0	0.0	0.0	0.0	0.0	0.0
Pickleweed-Cordgrass Mix	0.0	0.0	0.0	0.0	0.0	0.0
Pickleweed-Spearscale Mix	0.0	0.0	0.0	0.0	0.0	0.0
Alkali Heath	0.0	0.0	0.0	0.0	0.0	0.0
Gumplant	0.0	0.0	0.0	0.0	0.0	0.0
Peripheral Halophytes	5.3	4.0	2.6	0.0	1.0	0.0
Total Saline Dominant Species:	5.3	4.0	2.6	0.0	1.0	0.1
Brackish Marsh Vegetation						
Alkali Bulrush	2.9	4.3	3.4	3.3	5.8	6.5
Peppergrass	10.4	7.7	6.5	48.6	7.6	7.1
Spearscale	0.0	0.0	0.3	0.5	0.1	0.1
Total Brackish Dominant Species:	13.3	12.0	10.3	52.3	13.5	13.7
Freshwater Marsh Vegetation						
California Bulrush	29.8	30.3	31.3	0.1	38.6	36.2
Cattail	0.2	0.8	1.5	0.2	2.0	1.3
Knotweed	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	30.0	31.1	32.8	0.3	40.6	37.5
Total Segment Acreage	48.6	47.2	46.2	51.7	55.3	51.3

***Segment 25 not mapped in 1989**

Table B24. Acreage Summary of Segment 26* for 1994/1995, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year					
Saline Marsh Vegetation	1994/1995	1996	1997	1998	1999	2000
Pickleweed	0.0	0.0	0.0	0.0	0.0	0.0
Cordgrass	0.0	0.0	0.0	0.0	0.0	0.1
Pickleweed-Cordgrass Mix	0.0	0.0	0.0	0.0	0.0	0.0
Pickleweed-Spearscale Mix	0.0	0.0	0.0	0.0	0.0	0.0
Alkali Heath	0.0	0.0	0.0	0.0	0.0	0.0
Gumplant	0.0	0.0	0.0	0.0	0.0	0.0
Peripheral Halophytes	1.3	1.3	0.8	0.1	0.0	0.0
Total Saline Dominant Species:	1.3	1.3	0.8	0.1	0.0	0.1
Brackish Marsh Vegetation						
Alkali Bulrush	0.0	0.0	0.0	0.0	0.0	0.0
Peppergrass	2.5	2.6	0.6	0.1	2.9	3.3
Spearscale	0.0	0.0	0.0	0.0	0.0	0.0
Total Brackish Dominant Species:	2.5	2.6	0.6	0.2	3.0	3.3
Freshwater Marsh Vegetation						
California Bulrush	17.8	18.7	17.5	18.8	18.0	18.4
Cattail	0.1	0.2	0.4	0.3	0.1	1.0
Knotweed	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	17.9	18.9	17.9	19.1	18.1	19.4
Total Segment Acreage	23.7	23.1	23.0	24.1	23.7	22.8

***Segment 26 not mapped in 1989**

Table B25. Acreage Summary of Segment 27* for 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year				
Saline Marsh Vegetation	1996	1997	1998	1999	2000
Pickleweed	0.0	0.9	0.0	0.0	0.9
Cordgrass	0.0	0.0	0.0	0.0	0.0
Peripheral Halophytes	1.0	2.1	2.3	0.0	0.3
Total Saline Dominant Species:	1.0	3.0	2.3	0.0	1.2
Brackish Marsh Vegetation					
Alkali Bulrush	11.4	9.1	8.9	7.4	7.7
Peppergrass	0.6	1.7	0.1	1.2	1.9
Spearscale**	0.0	0.1	0.1	0.0	0.0
Total Brackish Dominant Species:	12.0	10.8	9.1	8.6	9.6
Freshwater Marsh Vegetation					
California Bulrush	3.3	4.4	6.7	4.7	5.8
Cattail	7.6	7.8	8.4	10.8	9.8
Total Freshwater Dominant Species:	10.9	12.2	15.2	15.5	15.6
Total Segment Acreage	35.0	35.7	35.7	36.5	26.5

***Segment 27 not mapped in 1989 and 1994/1995**

**Not a Dominant Species Category in 1996

Table B26. Acreage Summary of Segment 28* for 1989, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year					
Saline Marsh Vegetation	1989	1996	1997	1998	1999	2000
Pickleweed	0.0	0.5	0.2	0.1	0.1	0.0
Cordgrass	8.9	1.6	1.8	0.8	0.0	0.0
Peripheral Halophytes	0.0	0.3	1.4	4.0	3.4	1.6
Total Saline Dominant Species:	8.9	2.4	3.4	4.8	3.5	1.6
Brackish Marsh Vegetation						
Alkali Bulrush	48.7	53.7	49.8	61.9	57.0	55.8
Peppergrass	7.4	9.9	15.8	2.2	10.2	13.6
Spearscale**	0.0	0.0	0.1	0.2	0.0	0.1
Total Brackish Dominant Species:	56.1	63.5	65.7	64.3	67.2	69.5
Freshwater Marsh Vegetation						
California Bulrush	0.2	10.5	9.1	15.5	15.6	15.1
Cattail	0.0	0.3	0.4	0.5	0.6	0.5
Total Freshwater Dominant Species:	0.2	10.8	9.5	16.0	16.2	15.6
Total Segment Acreage	65.2	77.8	78.9	85.7	90.3	86.9

***Segment 28 not mapped in 1994/1995**

**Not a Dominant Species Category in 1996

Table B27. Acreage Summary of Segment 29* for 1989, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year					
Saline Marsh Vegetation	1989	1996	1997	1998	1999	2000
Pickleweed	21.9	14.8	12.1	9.0	9.3	6.6
Cordgrass	12.9	5.6	6.8	4.6	2.3	1.7
Peripheral Halophytes	0.0	2.2	4.3	5.8	5.6	4.4
Total Saline Dominant Species:	34.8	22.5	23.2	19.4	17.2	12.7
Brackish Marsh Vegetation						
Alkali Bulrush	18.4	48.4	47.2	58.7	65.5	62.2
Peppergrass	9.0	10.0	9.5	3.9	11.0	13.3
Spearscale**	0.0	0.0	0.3	0.1	0.1	0.0
Total Brackish Dominant Species:	27.4	58.3	57.0	62.6	76.6	75.5
Freshwater Marsh Vegetation						
California Bulrush	0.0	0.0	0.0	0.0	0.3	0.4
Cattail	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	0.0	0.0	0.0	0.0	0.3	0.4
Total Segment Acreage	72.2	81.1	80.6	82.0	94.3	88.6

***Segment 29 not mapped in 1994/1995**

**Not a Dominant Species Category in 1996

Table B28. Acreage Summary of Segment 30* for 1989, 1996, 1997, 1998, 1999 and 2000.

DOMINANT SPECIES CATEGORY

	Year					
Saline Marsh Vegetation	1989	1996	1997	1998	1999	2000
Pickleweed	24.9	26.5	23.1	19.7	21.0	24.7
Cordgrass	6.1	8.0	9.8	10.7	13.0	3.3
Pickleweed-Cordgrass Mix	0.0	0.0	0.0	0.0	0.0	0.2
Alkali Heath	0.0	0.0	0.0	0.0	0.0	1.0
Saltgrass	0.0	0.0	0.0	0.0	0.0	1.3
Peripheral Halophytes	2.6	1.5	2.6	2.9	3.7	2.5
Total Saline Dominant Species:	33.6	36.0	35.5	33.3	37.7	32.9
Brackish Marsh Vegetation						
Alkali Bulrush	0.0	1.5	1.7	6.5	5.5	11.6
Peppergrass	1.2	2.0	0.0	0.0	0.0	1.1
Spearscale**	0.0	0.0	0.0	0.0	0.0	0.0
Total Brackish Dominant Species:	1.2	3.4	1.7	6.5	5.5	12.7
Freshwater Marsh Vegetation						
California Bulrush	0.0	0.0	0.0	0.0	0.0	0.0
Cattail	0.0	0.0	0.0	0.0	0.0	0.0
Total Freshwater Dominant Species:	0.0	0.0	0.0	0.0	0.0	0.0
Total Segment Acreage	34.8	39.4	37.7	40.8	46.8	45.7

***Segment 30 not mapped in 1994/1995**

**Not a Dominant Species Category in 1996

APPENDIX C.
SOUTH BAY MARSHES:
PLANT LIST

Appendix C. Plants Observed in the South Bay Marsh Project Site		
FAMILY NAME	**SCIENTIFIC NAME**	**COMMON NAME**
Aceraceae	*Acer negundo* ssp. *californica*	California box elder
Aizoceae	*Mesembryanthemum nodiflorum*	slender-leaved iceplant
	Tetragonia tetragonioides	New Zealand spinach
Apiaceae	*Foeniculum vulgare*	sweet fennel
	Conium maculatum	poison hemlock
Asteraceae	*Baccharis pilularis*	coyote brush
	Carduus pycnocephalus	Italian thistle
	Centaurea solstitialis	yellow star-thistle
	Conyza canadensis	horsetail
	Grindelia sp.	gumplant
	Picris echioides	bristly ox-tongue
Brassicaceae	*Brassica nigra*	black mustard
	Hirschfeldia incana	small-pod mustard
	Lepidium latifolium	perennial peppergrass
Chenopodiaceae	*Atriplex semibaccata*	Australian saltbush
	Atriplex triangularis	spearscale
	Bassia hyssopifolia	five-hook bassia
	Salicornia virginica	common pickleweed
	Salicornia europeae	annual pickleweed
	Salsola soda	Russian thistle
Cuscutaceae	*Cuscuta salina* var. *major*	salt marsh dodder
Cyperaceae	*Scirpus acutus*	tule
	Scirpus californicus	California bulrush
	Scirpus maritimus	alkali bulrush
Frankeniaceae	*Frankenia salina*	alkali heath
Juglandaceae	*Juglans californica*	California black walnut
Poaceae	*Arundo donax*	giant reed
	Bromus diandrus	ripgut grass
	Bromus hordeaceus	soft chess
	Distichlis spicata	saltgrass
	Hordeum sp.	barley
	Spartina foliosa	cordgrass
Polygonaceae	*Polygonum punctatum*	knotweed
Salicaceae	*Populus fremontii*	Fremont’s cottonwood
Solanaceae	*Solanum americanum*	deadly nightshade
	Nicotiana glauca	tree-tobacco
Typhaceae	*Typha* sp.	cattail
The species are arranged alphabetically by family name for all vascular plants encountered during the plant survey. Plants are also listed alphabetically within each family. In some cases it was not possible to accurately identify a particular plant to the species level due to the absence of specific anatomic structures required for identification.		