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# MARSH PLANT ASSOCIATIONS OF SOUTH SAN FRANCISCO BAY: 2001 COMPARATIVE STUDY

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## EXECUTIVE SUMMARY

Large-scale vegetation changes in the marshes of South San Francisco Bay were first observed in the 1970's. Early studies conducted for the South Bay Dischargers Authority in 1984 confirmed those changes. In 1989, as part of a monitoring program required by the San Francisco Bay Regional Water Quality Control Board, the City of San Jose commissioned a detailed study of the marshes potentially affected by the freshwater discharge from the WPCP. Subsequent mapping studies were conducted by the City of San Jose in 1991, 1994, and annually thereafter. These studies documented changes in the distribution and aerial extent of salt, brackish and freshwater marsh. This study is a continuation of the vegetation monitoring that has been conducted since 1989.

The 2001 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 using PenMap software on Sunscreen PC's. This method builds topology in the field during the mapping process. Acreage calculations by plant associations, dominant species and habitat type were done in GIS and maps were produced. The baseline (1989) data was also digitized and rectified to the 2001 ortho images. Comparisons were made between the 2001 mapping and previous years' mapping.

The digitization and rectification of the 1989 data of the 1989 data yielded only minor differences from the original 1989 planimitered data. The digitization and rectification of the 1989 data caused a difference of 2.10 acres (0.2% of the total area) within the Main Study Area and 4.25 acres (2.5%) within the Reference site. The greater relative correction for the Reference site is due to its smaller size.

The total marsh area mapped in 2001 was 1334.69 acres for the Main Study Area and 167.95 acres for the Reference Site. 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. Although a similar distribution of habitats is noted in the Reference Area, brackish marsh habitats comprise a much greater proportion of the area than in the Reference Area.

The surface area of marsh habitat has increased by 159.9 acres between 1989 and 2001 within the Main Study Area. During the same period, 48.5 acres of new marsh has formed in the Reference Area. 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 entire study area is becoming less saline. 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 existing salt marsh to brackish marsh habitat.

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 affecting the entire system.

The WPCP has influenced plant species distribution in the South Bay Marshes. For example, the majority of Artesian Slough, a slough that dead ends at the discharge point for the WPCP, is freshwater marsh habitat. Without the WPCP discharge we would predict that Artesian Slough would consist of a mixture of brackish and salt marsh habitats. However, in the past twelve years, we have seen only minimal conversion of salt marsh to brackish marsh habitat in the Lower Reach segments, and therefore can assume that the influence of the WPCP discharge does not extend beyond the Transition Zone of the Main Study Area

## INTRODUCTION

Large-scale vegetation changes in the marshes of South San Francisco Bay were first observed in the 1970's (H. T. Harvey & Associates 1984). Areas that had been salt marsh were now being colonized by plant species more characteristic of brackish marsh. Based upon these reports, causal mechanisms for the vegetation change were reviewed. A potential cause of that change was freshwater input from the San Jose/Santa Clara Water Pollution Control Plant (WPCP). Early studies confirmed those changes (H. T. Harvey & Associates 1984). Efforts were made to determine the extent of changes through time by examining historic aerial photography (CH2MHill 1989). These studies relied on historic aerial photographs of different scales and could not be field truthed. However, the data indicated that large scale vegetation changes (both conversion and new marsh formation) were occurring in the marshes of South San Francisco Bay.

In 1989, as part of a monitoring program required by the San Francisco Bay Regional Water Quality Control Board (RWQCB), the City of San Jose commissioned a detailed study of the marshes potentially affected by the freshwater discharge from the WPCP (H. T. Harvey & Associates 1989). Simultaneously, and also at the behest of the RWQCB, the Sunnyvale WPCP commissioned a study of the vegetation of the marshes in Guadalupe and Alviso Sloughs. Both of these studies include collection of new aerial photography and detailed mapping of dominant plant species in the field. These data now provide a baseline for comparison of changes in plant species distribution in the marshes of South San Francisco Bay.

Subsequent mapping studies were conducted by the City of San Jose in 1991, 1994, and annually thereafter. These studies documented changes in the distribution and extent of salt, brackish and freshwater marsh (CH2MHill 1989, H.T. Harvey & Associates 1994, 1995, 1996, 1997, 1998, 1999 and 2000). Starting in 1994 it was recognized that the Alviso Slough mapping conducted for the Sunnyvale WPCP could serve as a reference area for the City of San Jose's vegetation mapping. To use Alviso Slough as a reference area for these studies, it is assumed that discharges from the San Jose/Santa Clara WPCP will not flow 'upstream' into Alviso Slough, and directly impact these marshes. However Alviso Slough does received direct freshwater discharge from the Guadalupe River; this is similar to the main study area that receives freshwater discharge from Coyote Creek. Therefore, all mapping efforts since 1995 have included the main study area and this additional reference area (Alviso Slough).

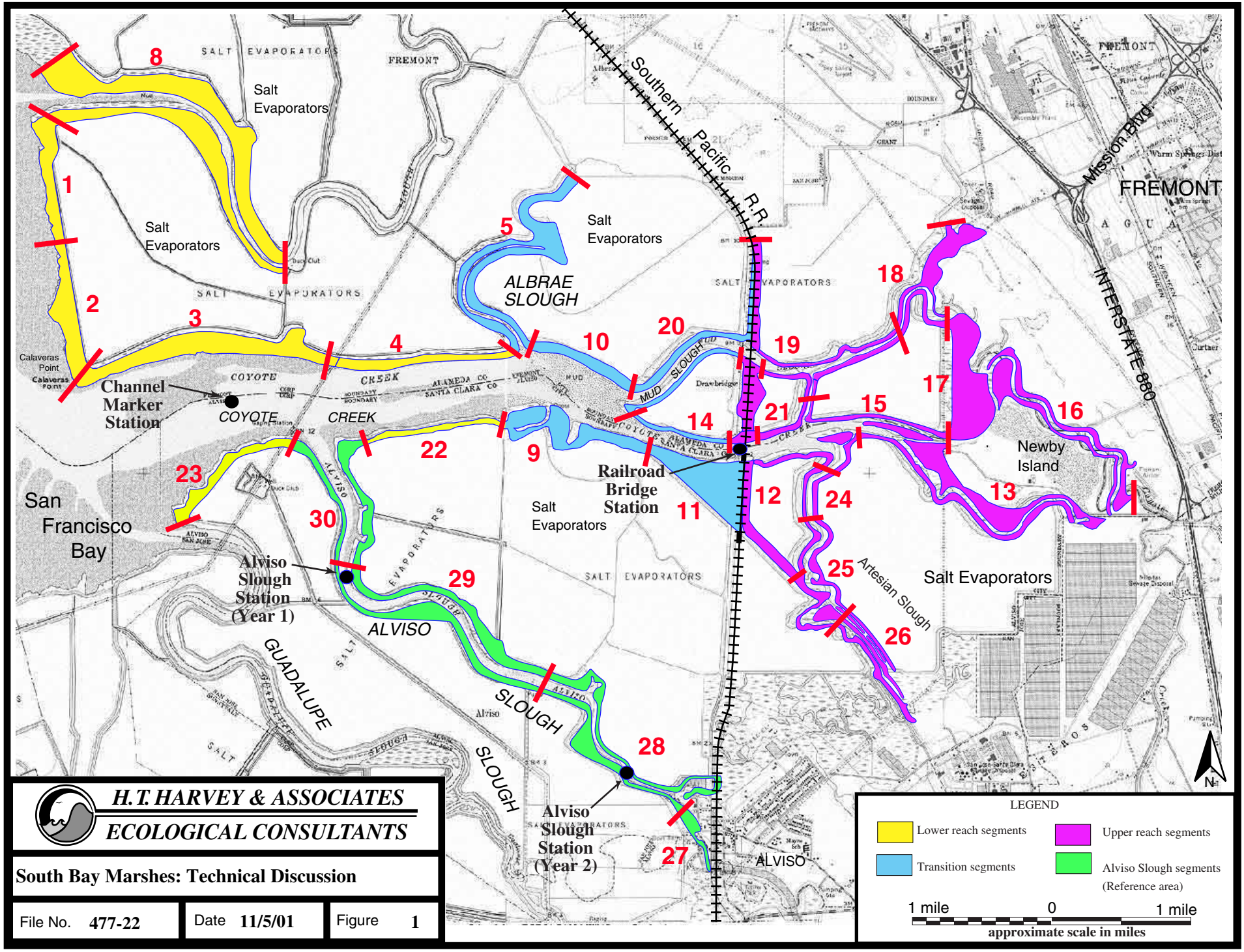
The dominant plant species of tidal salt marshes in South San Francisco Bay include pickleweed (*Salicornia virginica*) and cordgrass (*Spartina foliosa*). Pickleweed dominated salt marsh provides habitat for a unique assemblage of animal species including the federally and state-endangered salt marsh harvest mouse (*Reithrodontomys raviventris raviventris).* Therefore, it is important to determine the area of vegetation change as well as to understand the factors responsible for the observed conversion of salt marsh to less saline marsh types. 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 are 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, many other factors also 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 factors 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 and Niering 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.

This study is a continuation of the vegetation monitoring that has been conducted since 1989. The vegetation mapping conducted by this study can only determine the location and extent of change. This study does not monitor or manipulate variables that may be responsible for the observed change. Therefore, the continual mapping of vegetation in the South San Francisco Bay marshes is an accounting of the area of change through time and a comparison of the rate of change between the main study area and a reference area.

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**South Bay Marshes: Technical Discussion**

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# 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 Main 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 1). 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

## AERIAL PHOTOGRAPHY AND ORTHORECTIFICATION

The subconsultant responsible for aerial photography acquisition and digital imagery production, HJW, Inc., took color-infrared aerial (CIR) photographs of the entire study area. These aerial photographs were taken on June 7, 2001. 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.

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.

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 the digital images of the orthorectified CIR photos. All mapping was conducted using PenMap software on Sunscreen PC's in the field. This method builds topology during the mapping process eliminating the need to digitize hand drawn polygons. Plant association acreages and color-coded figures for the entire Study Area were generated using ArcInfo and ArcView GIS software.

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). To facilitate comparison of results between monitoring years, vegetation associations are assigned to dominant species categories (as defined below).

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 during site visits between 14 August and 20 September 2001. Marsh vegetation was observed primarily from areas directly adjacent to the marshes 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.

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).

## 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, so that the vegetation association called Pickleweed consists of from 85-100% Pickleweed and 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 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 approximately equal amount of each species.

The upland species category consists of species not commonly found in 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 grouped 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 collect comparable data.

## DIGITIZATION OF BASELINE DATA

To improve area comparisons and the precision of the baseline data, the 1989 data was digitized and rectified to the 2001 orthophotos. The original 1989 maps of the plant species association were used for digitization. Initially polygons by species were colored by hand. Specific colors were chosen to represent different species. The maps were scanned and colors were amplified and gaps in coloring filled in Adobe Photoshop. Topology was then built using Image Analysis 1.1a for ArcView. The images were rectifed to the 2001 data using ImageAnalysis. SeedTool was used to select the colors and all like colors are attributed and turned into polygons. This step was completed for all colors. Area calculations were conducted in ArcView.

## 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 year's results are compared to baseline 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 1) as described earlier. 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, 2000 and 2001) by location (reach) was also conducted to compare trends between reaches. The final step in the analysis overlaid the data from the 1989 mapping onto 2001 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

## DIGITIZATION OF 1989 DATA

Only minor changes in mapped area from the digitization and rectification of the 1989 data occurred. Changes in area are inherent with the process of rectifying aerial photos to surveyed data. Furthermore, the active process of digitization of polygons and associated QA/QC measures finds small errors in the original hand-drawn mapping effort. Although it was anticipated that the digitization process would yield substantial changes in mapped marsh area, very little change occurred. This indicates that the original 1989 data is the result of a highly accurate mapping effort using quality CIR imagery. Furthermore, the scale of the original aerial transparencies used for the mapping was greater than later efforts, further reducing errors associated with curvature of the earth, curvature of the lens, topography and airplane angle. The revised 1989 data are used as the baseline information throughout this report. Revised dominant species maps and habitat maps for 1989 segment reach data are located in Appendix A.

### Main Study Area

The detailed analysis and digitization of the 1989 data resulted in only minor differences (when compared to the data used in previous reports) to the overall marsh area within the Main Study Area. A measurement change of 2.10 acres occurred within the Main Study Area from the digitization and rectification process. This is a 0.2% difference in wetland area caused by the digitization process.

Although the overall marsh area varied little from the digitization and rectification process, more detailed analysis of the 1989 data yielded a difference in the area of brackish marsh from that originally mapped (-8.56 acres) and a difference in the area of salt marsh (+10.65 acres). This is likely due to the increased rigor associated with polygon digitization versus hand planimetering of polygons. However, these measurements within the Main Study Area only constitute a 1.5% difference in brackish marsh habitat and a 1.4% difference in salt marsh habitat.

**Table 1. Summary of Area of Dominant Species by Habitat Type for the Main Study Area for 1989 (Note: Segments 24, 25 and 26 were not mapped in 1989).**

| Dominant Species Category | 1989 |
|---|---|
| **Salt Marsh Categories** | |
| Cordgrass | 84.15 |
| Pickleweed | 669.07 |
| Peripheral Halophytes | 25.60 |
| Misc Others | 0.13 |
| ***Sub-Total*** | **778.95** |
| **Brackish Marsh Categories** | |
| Alkali Bulrush | 489.64 |
| Peppergrass | 66.10 |
| ***Sub-Total*** | **555.74** |
| **Freshwater Marsh Categories** | |
| Cattail | 0.00 |
| ***Sub-Total*** | **0.00** |
| **TOTAL** | **1334.69** |

**Reference Area**

Only minor differences from the digitization process occurred in total marsh area within the Reference site. The change in measurement technique resulted in a difference of 4.25 acres in total marsh area. This is 2.5% of the total wetland area that differed due to the digitization and rectification of the data.

The digitization of the 1989 data for the Reference Area produced a minor difference of 2.0 acres in brackish marsh habitats and 2.3 acres in salt marsh habitats due to measurement technique. The differences in area from the change in technique are 2.1% of brackish marsh and 2.9% of salt marsh within the Reference site.

**Table 2. Summary of Area of Dominant Species by Habitat Type for the Reference Area (Alviso Slough) for 1989 (Note: Segment 27 was not mapped in 1989).**

| Dominant Species Category | 1989 |
|---|---|
| **Salt Marsh Categories** | |
| Cordgrass | 28.32 |
| Pickleweed | 43.61 |
| Peripheral Halophytes | 3.06 |
| Misc. Others | 0.00 |
| ***Sub-Total*** | **74.99** |
| **Brackish Marsh Categories** | |
| Alkali Bulrush | 72.31 |
| Peppergrass | 20.40 |
| ***Sub-Total*** | **92.71** |
| **Freshwater Marsh Categories** | |
| California Bulrush | 0.25 |
| ***Sub-Total*** | **0.25** |
| **TOTAL** | **167.95** |

## GENERAL SPECIES DISTRIBUTION, DOMINANT SPECIES CATEGORY AND HABITAT ACREAGES FOR 2001

### Main Study Area

Information is presented below by dominant species categories and by habitat type. The spatial distribution of dominant plant species and habitat types for the 2001 data are presented in Appendix B 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. The dominant plant species within the Main Study Area are alkali bulrush and pickleweed (Table 3); these two species comprise nearly 70% of the marsh within the Main Study Area. The total acreage of salt marsh habitat and brackish marsh habitat within the Main Study Area is nearly equal.

**Table 3. Summary of Acreages of the Main Study Area by dominant species categories for each habitat type for 2001.**

| Dominant Species Category | 2001 |
|---|---|
| **Salt Marsh Categories** | |
| Cordgrass | 121.36 |
| Pickleweed | 572.11 |
| Pickleweed-Cordgrass Mix | 16.49 |
| Saltgrass | 8.51 |
| Alkali Heath | 0.71 |
| Gumplant | 43.22 |
| Peripheral Halophytes | 21.08 |
| Misc. Others | 1.28 |
| ***Sub-Total*** | **784.76** |
| **Brackish Marsh Categories** | |
| Alkali Bulrush | 547.78 |
| Peppergrass | 172.99 |
| Spearscale | 43.81 |
| Misc. Others | 0.00 |
| ***Sub-Total*** | **764.57** |
| **Freshwater Marsh Categories** | |
| California Bulrush | 64.82 |
| Cattail | 4.89 |
| Misc. Others | 0.07 |
| ***Sub-Total*** | **69.71** |
| **TOTAL** | **1619.04** |

The Upper Reach segments (Figure 1, Appendix B) 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 1, Appendix B) 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 B).

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).

**Reference Area (Alviso Slough)**

The spatial distribution of dominant plant species and habitat types in the Reference Area are presented in Appendix B. The 2001 plant association areas for Alviso Slough are presented in Table 4. Plant species within the Reference Area 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. However, alkali bulrush is the dominant plant species within the Reference Area and brackish marsh habitat comprises nearly three times the area of salt marsh habitat.

Brackish marsh associations occur throughout Alviso Slough. Patches of alkali bulrush occur as far downstream as Segment 30 (near the confluence with Coyote Creek). 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 2001.**

| Dominant Species Category | 2001 |
|---|---|
| **Salt Marsh Categories** | |
| Cordgrass | 19.15 |
| Pickleweed | 35.42 |
| Peripheral Halophytes | 0.32 |
| Misc. Others | 0.6 |
| ***Sub-Total*** | **55.49** |
| **Brackish Marsh Categories** | |
| Alkali Bulrush | 132.57 |
| Peppergrass | 26.65 |
| Spearscale | 0.04 |
| Misc. Others | 0.00 |
| ***Sub-Total*** | **159.26** |
| **Freshwater Marsh Categories** | |
| California Bulrush | 15.65 |
| Cattail | 10.94 |
| Misc. Others | 0.01 |
| ***Sub-Total*** | **26.6** |
| **TOTAL** | **241.35** |

**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. Although a similar distribution of habitats is noted in the Reference Area, brackish marsh habitats comprise a much greater proportion of the area than in the Reference Area.

## TEMPORAL AND SPATIAL CHANGES IN MARSH HABITAT ACREAGES FROM 1989 THROUGH 2001

This comparison does not include data from segments 24, 25 and 26 (Artesian Slough) of the Main Study Area and segment 27 (vicinity of the Gold Street Bridge) 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 temporal and spatial evaluation.

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

The surface area of marsh habitat has increased by 159.9 acres between 1989 and 2001 within the Main Study Area (Upper, Transition and Lower Reaches Combined) (Table 5). During the same period, 48.5 acres of new marsh has formed in the Reference Area (Table 6). This equates to a 12% increase in marsh acreage in the Main Study Area and a 29% increase in marsh acreage in the Reference Area between 1989 and 2001.

Marsh area remained relatively stable from 1989 to 1996 in the Main Study Area (Figure 2). The formation of new marsh habitat in the Main Study Area has occurred primarily between 1996 and 2001 in the Lower Reach and between 1996 and 1998 in the Transition Reach (Figure 2). Gains in marsh area between 1989 and 2001 were greatest in the Lower Reach (155.40 acres), while 23.66 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 2001 however a slight decrease occurred between 1999 and 2000 (Figure 2). In contrast, in the Transition Reach marsh area increased in 1997 and 1998 but decreased slightly in 1999, 2000 and 2001 (Figure 2). 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 2).

A trend of increasing marsh area is apparent from 1989 through 1999 in the Reference Area (Figure 2). However, a decline in total marsh acreage in the Reference Area occurred between 1999 and 2001.

**Table 5. Summary of Acreages of the Main Study Area by dominant species categories for each habitat type for 1989 and 2001*.**

| Dominant Species Category | 1989 | 2001 | Change | Percent Change |
|---|---|---|---|---|
| **Salt Marsh Categories** | | | | |
| Cordgrass | 84.15 | 121.36 | +37.21 | 44% |
| Pickleweed | 669.07 | 571.49 | -97.58 | 15% |
| Pickleweed-Cordgrass Mix** | 0.00 | 16.49 | +16.49 | - |
| Alkali Heath** | 0.00 | 0.71 | +0.71 | - |
| Gumplant** | 0.00 | 43.22 | +43.22 | - |
| Peripheral Halophytes | 25.60 | 21.10 | -4.50 | 18% |
| Misc Others | 0.13 | 7.63 | +7.50 | 5,769% |
| ***Sub-Total*** | **778.95** | **782.00** | **+3.05** | **0.4%** |
| **Brackish Marsh Categories** | | | | |
| Alkali Bulrush | 489.64 | 540.90 | +51.26 | 10% |
| Peppergrass | 66.10 | 155.45 | +89.35 | 135% |
| Spearscale** | 0.00 | 5.64 | +5.64 | - |
| Misc. Others | 0.00 | 0.00 | - | - |
| ***Sub-Total*** | **555.74** | **701.99** | **+146.25** | **26%** |
| **Freshwater Marsh Categories** | | | | |
| California Bulrush | 0.00 | 8.34 | +8.34 | - |
| Cattail | 0.00 | 2.24 | +2.24 | - |
| Misc. Others | 0.00 | 0.02 | +0.02 | - |
| ***Sub-Total*** | **0.00** | **10.60** | **+10.60** | **-** |
| **TOTAL** | **1334.69** | **1494.59** | **+159.90** | **12%** |

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

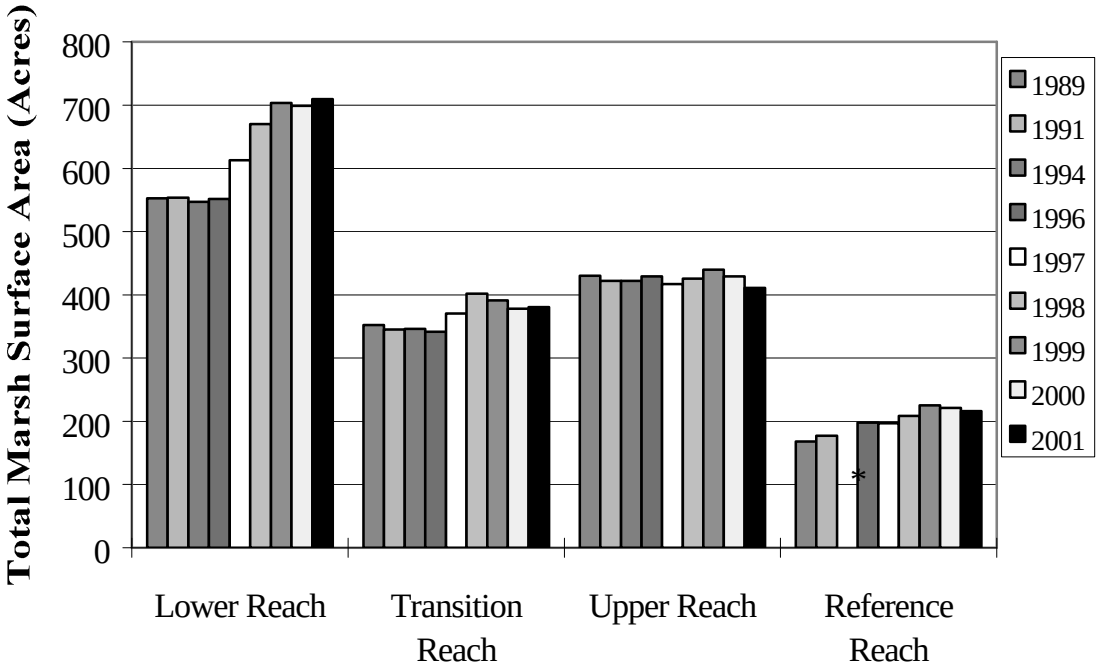
** Not a dominant species category in 1989

**Table 6. Summary of Acreages of the Reference Area (Alviso Slough) by dominant species categories for each habitat type for 1989 and 2001.***

| Dominant Species Category | 1989 | 2001 | Change | Percent Change |
|---|---|---|---|---|
| **Salt Marsh Categories** | | | | |
| Cordgrass | 28.32 | 19.15 | -9.17 | 32% |
| Pickleweed | 43.61 | 34.45 | -9.16 | 21% |
| Peripheral Halophytes | 3.06 | 0.32 | -2.74 | 90% |
| Misc. Others | 0.00 | 0.57 | +0.57 | - |
| ***Sub-Total*** | **74.99** | **54.49** | **-20.5** | **27%** |
| | | | | |
| **Brackish Marsh Categories** | | | | |
| Alkali Bulrush | 72.31 | 125.16 | +52.85 | 73% |
| Peppergrass | 20.40 | 25.49 | +5.09 | 25% |
| Spearscale** | 0.00 | 0.04 | +0.04 | - |
| Misc. Others | 0.00 | 0.00 | 0.00 | - |
| ***Sub-Total*** | **92.71** | **150.69** | **+57.98** | **63%** |
| | | | | |
| **Freshwater Marsh Categories** | | | | |
| California Bulrush | 0.25 | 9.42 | +9.17 | 3,668% |
| Cattail | 0.00 | 1.40 | +1.40 | - |
| Misc. Others | 0.00 | 0.00 | 0.00 | - |
| ***Sub-Total*** | **0.25** | **10.82** | **+10.57** | **4,228%** |
| | | | | |
| **TOTAL** | **167.95** | **216.00** | **+48.05** | **29%** |

* Comparison consists of segments 28-30.
** Not a dominant species category in 1989.

**Figure 2. Total Marsh Acreage Comparison from 1989 to 2001 by Reach**




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

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

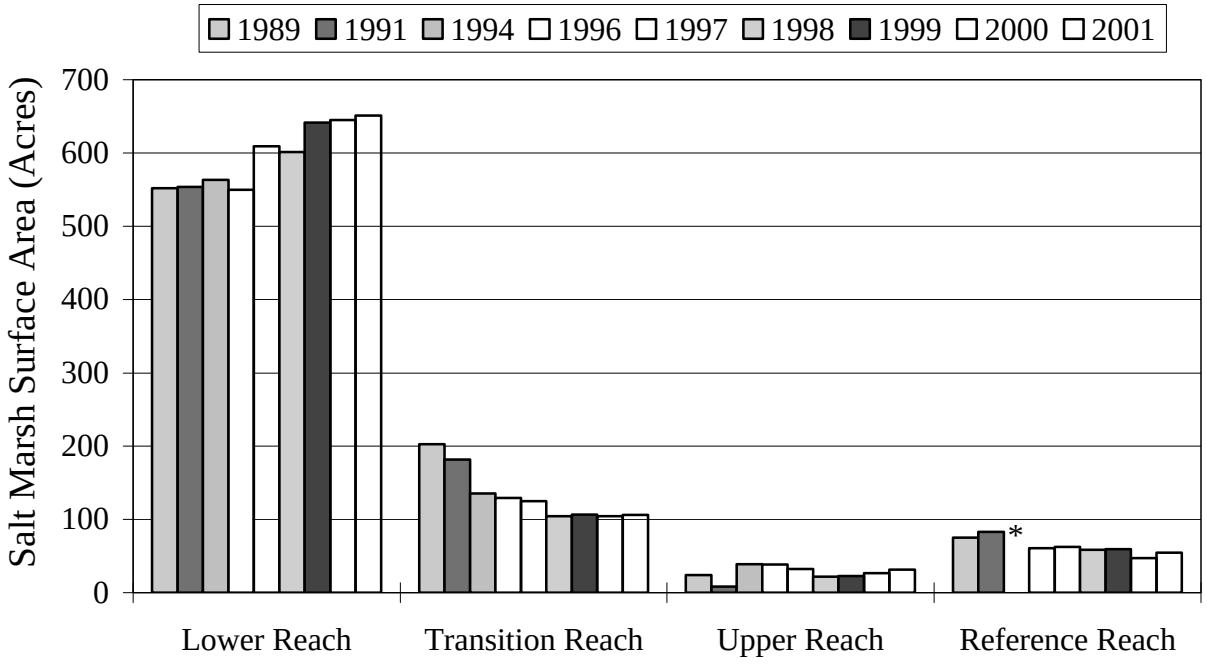
**Salt Marsh.** Figures 4, 5 and 6 present the surface area of salt, brackish and freshwater marsh habitats by year and location (reach). Salt marsh area decreased in the Transition Reach from 1989 through 2001; the rate of decrease in salt marsh area was greatest between 1989 and 1994 (Figure 3). Conversely, salt marsh area increased in the Lower Reach from 1989 through 2001 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 2001 (+3.05 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 3).

A relatively large loss of salt marsh habitat has occurred in the Reference Area between 1989 and 2001 (Table 6). In contrast to the Main Study Area this loss was not compensated for by new salt marsh formation. Approximately 20.5 acres of salt marsh (27% of the total) has been lost during the study period and is comprised of 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 3), including a slight decline in 2001.

**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 2001 (Tables 5 and 6). During this period, brackish marsh increased by 146.25 acres (26% increase) and 57.98 acres (63% increase) in the Main Study and Reference Areas, respectively (Tables 5 and 6). This is due mostly to marsh conversion (from salt to brackish) in the Reference Area. However, a combination of marsh conversion in the Transition Reach and new brackish marsh formation in the Lower Reach accounts for most of the new brackish marsh in the Main Study Area. Furthermore, freshwater marsh has increased in the Main Study and Reference Areas during the past 12 years (Tables 5 and 6).

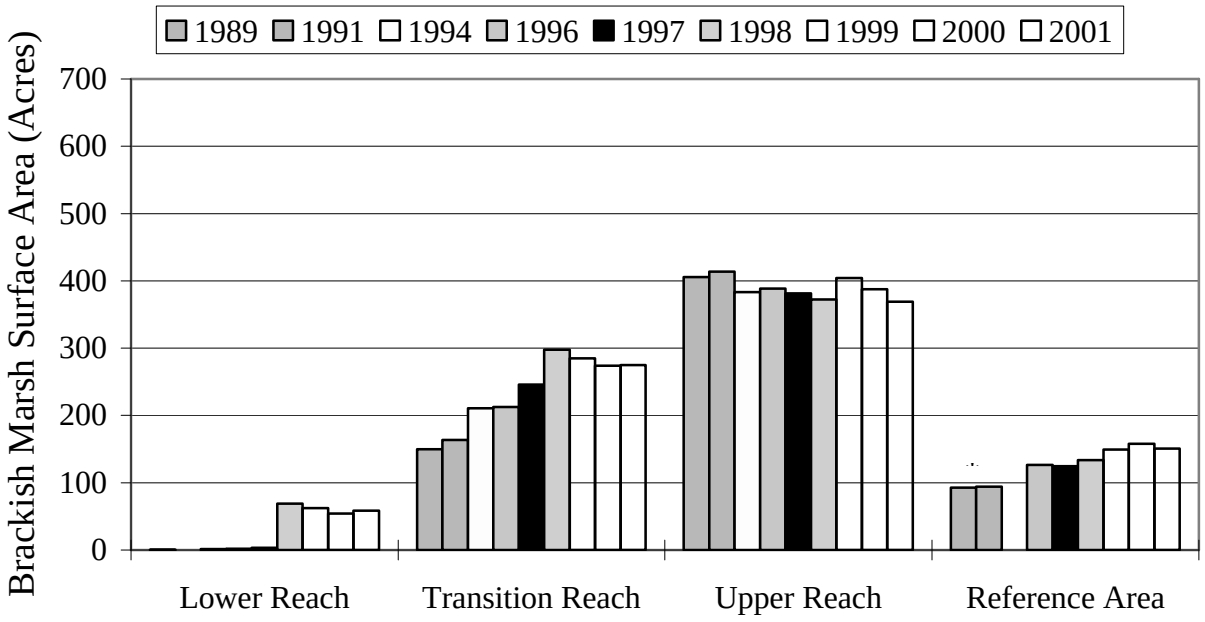
In the Main Study Area, gains in brackish marsh have occurred in the Lower and Transition Reaches while brackish marsh has decreased slightly in the Upper Reach (Figure 4). Expansion of brackish marsh area occurred primarily between 1997 and 1998 in the Lower Reach and from 1991 through 1998 in the Transition Reach (Figure 6). The Reference Area exhibited a steady trend of increasing brackish marsh area from 1991 through 2000 but a slight decrease from 2000 to 2001 (Figure 4). Increases in freshwater marsh habitat have only occurred in the Upper Reach and Reference Area (Figure 5).

**Figure 3. Salt Marsh Acreage Comparison from 1989 to 2001, by Reach.**



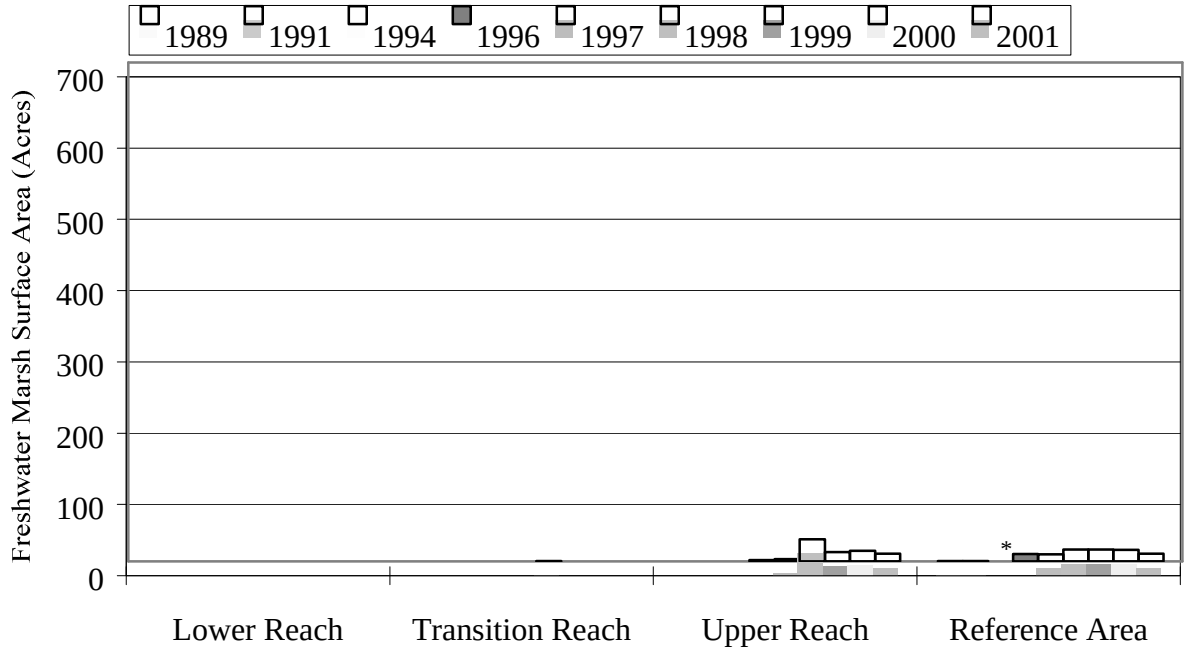

***No data collected in 1994 within Reference Area.**

**Figure 4. Brackish Marsh Acreage Comparison from 1989 to 2001, by Reach.**




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

**Figure 5. Freshwater Marsh Acreage Comparison from 1989 to 2001, 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 2001 (Figures 7 and 8). 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 6). The relative decline in the percentage of salt marsh was greater in the Reference Area compared to the Main Study Area (Figure 6).

Similar to the pattern for salt marsh habitat, the percentage of brackish marsh has been relatively stable in the Main Study Area (Figure 7). 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 7). A slight decrease occurred between 1999 and 2000 (Figure 7). A larger increase in the percentage of brackish marsh was observed in the Reference Area compared to the Main Study Area (Figure 7). 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 7) during the same time that the percentage of salt marsh declined (Figure 6).

**Figure 6. Temporal Comparison of the Proportion of Salt Marsh Area Between the Main Study and Reference Areas**

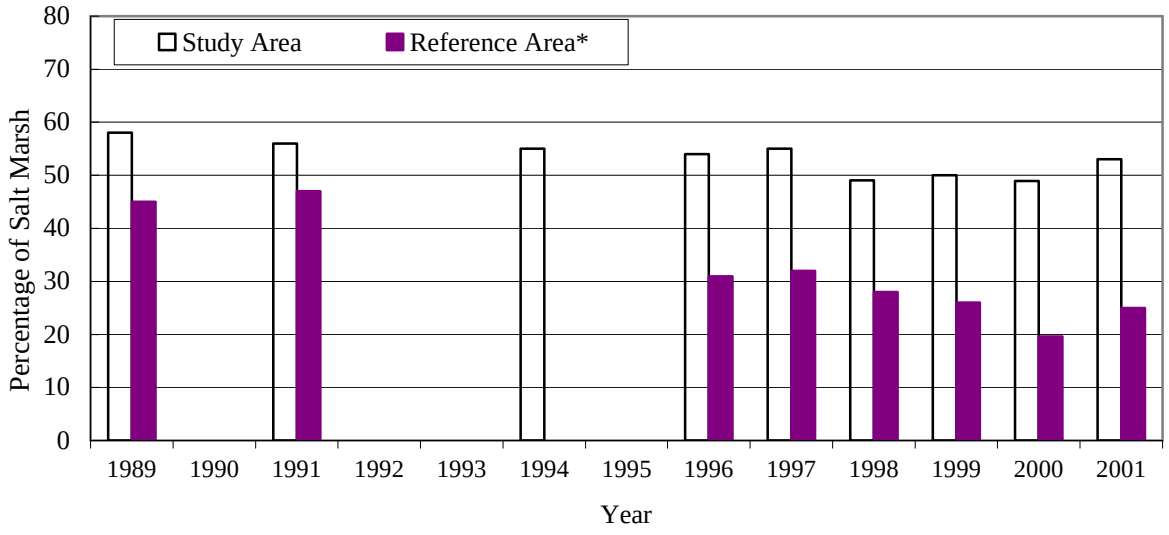
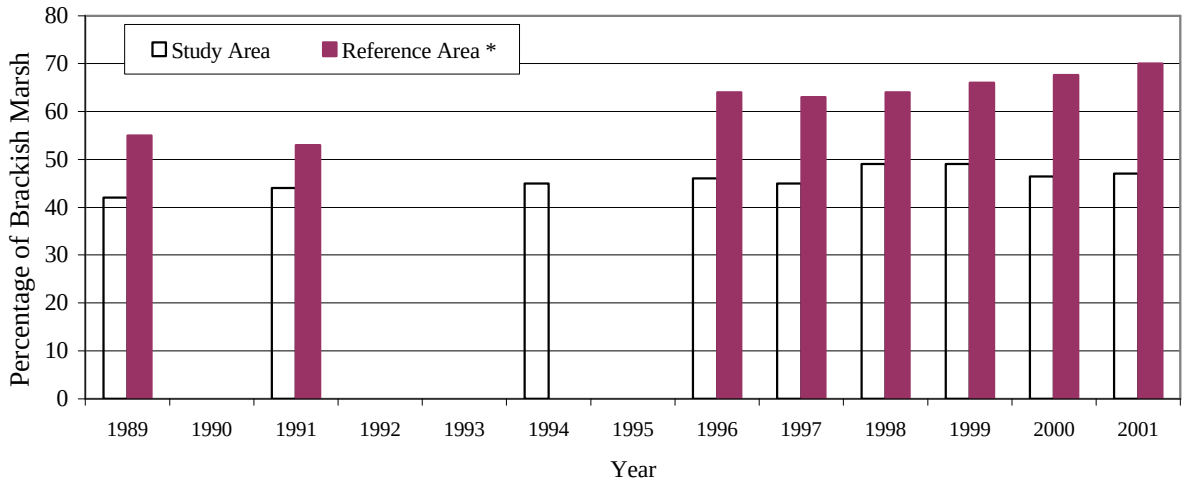


**Figure 7. Temporal Comparison of the Proportion of Brackish Marsh Area Between the Main Study and Reference Areas**




***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 2001. This table differs from Tables 5 and 6, in that the changes are defined by reach with a detailed explanation. Because the 1989 data is now georectified to the 2001 orthophotos the area of change presented in Tables 5 and 6 are accurate and fully describe the combination of marsh conversion and formation. The area calculations in Table 7 were derived from a segment reach level analysis in ArcView (Appendix C).

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 2001.**

| Segment Location | Change in SM acreage | Change in BM acreage | Change in FM acreage | Change in TM acreage | Evaluation Results |
|---|---|---|---|---|---|
| Lower | 98.73 | 57.92 | 0.00 | 155.40 | Increase in TM acreage is due to 56.67 acres of new BM marsh formation and 98.73 of new SM 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 1.1 acres of SM has converted to BM during the past 12 years. **Net SM conversion: 1.1 acres.** |
| Transition | -96.63 | 125.29 | 0.00 | 23.66 | 9 acres of new SM has formed in the Transition Reach. 19.66 acres on new BM has formed since 1989. 105 acres of SM has converted to BM. **Net SM conversion: 105 acres.** |
| Upper | 7.16 | -36.91 | 10.59 | -19.16 | No SM has converted to BM, however a total of 7.16 acres of BM has converted to SM in the Upper Reach during the past 12 years. Approximately 5 new acres of FM has been added to the mapping area since 1989 while approximately 6 acres of BM have converted to FM. The TM area has decreased 19 acres; most of that loss occurred within BM habitats. **Net SM conversion: 0.0 acres.** |
| Reference | -20.49 | 57.97 | 10.57 | 48.05 | New marsh formation includes 9.4 acres of FM, 22.2 acres of BM and 1.1 acres of SM. 21.6 acres of SM have converted to BM. 1.1 acres of BM has converted to FM. Approximately 11 acres of new marsh was from areas added by additional mapping within segment 27. **Net SM conversion: 21.6 acres.** |

**Total SM Conversion Within Main Study Area= 98.9 acres (12.7% of total SM acreage in 1989).**
**Total SM Conversion Within Reference Area = 21.6 acres (28.8% 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 increase of 159.9 acres of overall marsh area since 1989 in the Main Study Area. The majority of this increase is due to sediment accretion along slough and river channels and subsequent vegetation colonization to form new marsh area. Some small portion of the overall increase in marsh area can be attributed to differences in segment break lines and the boundaries of the mapped area. However, this difference is a very small (<2%) portion of the overall change.

The majority of all new marsh formation in the Main Study Area occurred in the Lower Reach (Segments 2, 3 and 4) located near the mouth of Coyote Creek. 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*). It should be noted that nearly the entire brackish marsh habitat within the Lower Reach is newly formed marsh. Only about 1 acre of salt marsh conversion has occurred in the last twelve years within the Lower Reach, however nearly 57 acres of new brackish marsh habitat has formed.

The formation of new brackish marsh in an area historically dominated by salt marsh plant species is an interesting observation with many possible explanations. Alkali bulrush may have a competitive advantage over other species at the specific combination of salinity and inundation stresses encountered in this region. Also, the fact that these soils are recently deposited and are at an elevation that affords them frequent flooding may reduce the amount of salts and other phytotoxins that have been able to accumulate in the soil interstices. Some combination of these and/or additional factors, such as freshwater discharges may favor the germination of alkali bulrush at these sites.

New marsh formation in the Lower Reach occurred rapidly beginning in 1997 and continued until 2000. The mudflats at Calaveras Point likely reached an elevation that would support wetland plant species in 1996/97 and were rapidly colonized thereafter. Most of the mudflat area at that elevation is now entirely vegetated, therefore rates of new marsh formation have begun to slow. It should be noted that the large mudflat in Coyote Creek just upstream of the confluence with Alviso Slough is nearing an elevation that will support wetland plant species. Small patches of cordgrass were noted on the mudflats this year. We predict that this mudflat will rapidly colonize with a mixture of alkali bulrush, cordgrass and annual pickleweed within the next few years. This would again dramatically increase the area of vegetated marsh within the Main Study Area.

From 1989 to 2001, losses in salt marsh habitat (in the Main Study Area) 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 twelve 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 Reach where 105 acres of existing salt marsh habitat has become brackish marsh

habitat during the past twelve years. Conversely during the past year, 1 acre of salt marsh conversion has occurred within the Lower Reach and 7 acres of brackish marsh has converted to salt marsh within the Upper Reach segments (via conversion of alkali bulrush to pickleweed-dominated habitats along Mud Slough).

The only segments where salt marsh conversion has not occurred during the last 12 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 and in the bayward portion of Mowry Slough (Segment 8) within the Main 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 likely occurred inland of the channel-side vegetation (SFEI 1999). Those areas that were historically salt marsh have largely 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). The formation of new alkali bulrush-dominated marshes in a matrix of salt marsh habitats has been observed in the Lower Reach in this study. This is further evidence of the highly dynamic nature of vegetation trends in South San Francisco Bay. These changes from historical conditions appear driven by large-scale environmental factors such as changes in local freshwater inputs and landscape-scale changes such as salt pond construction (SFEI 1999).

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 70 acres within the Main Study area. 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 2001, Segments 25, 26 and 27 (the most upstream reaches of Alviso and Artesian Sloughs) comprised the majority of the freshwater marsh habitat within the study.

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 less in the Main Study Area than in the 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. In 2001 small gains in salt marsh habitat from the previous year occurred in both the Main Study Area and Reference Area. This trend seems to further highlight the influence of multiple factors affecting changes in marsh vegetation communities in South San Francisco Bay.

The potential impacts 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 & Associates 2001). Those data are currently being evaluated.

Interstitial soil salinities and soil bulk density were significantly different between habitat types (H. T. Harvey & Associates 2001). Freshwater marshes had the lowest interstitial salinities and salt marshes the highest; brackish marsh habitats had intermediate interstitial salinities. Soil bulk densities were the highest in salt and brackish marsh habitats and were significantly lower in fresh marsh habitats. The reference area and the Upper Reach had mean interstitial salinities significantly lower than the remainder of the Main Study Area. The Transition and Lower Zones had significantly higher mean interstitial salinities than the Reference Area (H. T. Harvey & Associates 2001). 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 is likely related to a combination of environmental stress factors including interstitial salinities, interspecific competition and depth and duration of flooding over the marsh surface, among others. 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 and as high as 51.8 ppt. Furthermore, alkali bulrush is a dominant plant species in the colonization of new marsh in the high salinity zones of the Lower Reach.

The WPCP has influenced the plant species distribution in the South Bay Marshes. For example, the majority of Artesian Slough, a slough that dead ends at the discharge point for the WPCP, is freshwater marsh habitat. Without the WPCP discharge we would predict that Artesian Slough would consist of a mixture of brackish and salt marsh habitats.

Although the WPCP has had an effect upon portions of the system, discharges from Guadalupe River (Alviso Slough), Coyote Creek and the Sacramento/San Joaquin Delta also play a role in marsh conversion and formation. For example, the Reference Area has experienced a greater rate of salt marsh conversion than the Main Study Area and the Reference Area is hydrologically disconnected from the WPCP discharge (H. T. Harvey & Associates 2001). Also, conversion of brackish marsh habitats to salt marsh habitats has been noted in the Upper Reach, the reach closest to the WPCP discharge point. In the past twelve years, we have seen only minimal conversion of salt marsh to brackish marsh habitat (approximately 1 acre) in the Lower Reach segments, and therefore can assume that the influence of the WPCP discharge does not extend beyond the Transition Zone of the Main Study Area.

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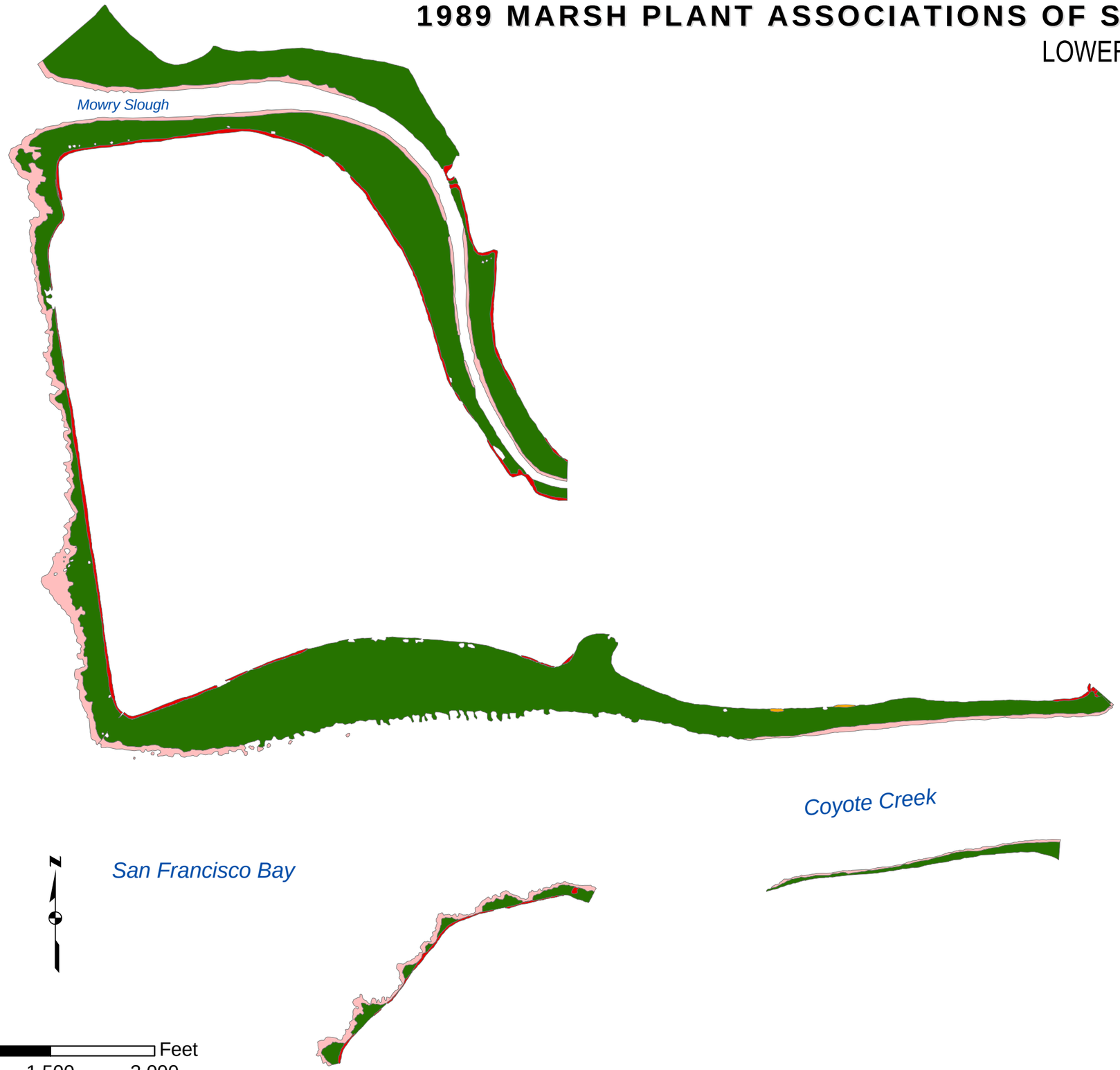
**APPENDIX A.**
**SOUTH BAY MARSHES:**
**1989 VEGETATION MAPS**

# 1989 MARSH PLANT ASSOCIATIONS OF SOUTH SAN FRANCISCO BAY

## LOWER REACH SEGMENT DOMINANT SPECIES

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




- Cordgrass
- Peppergrass
- Peripheral halophytes
- Pickleweed

H.T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

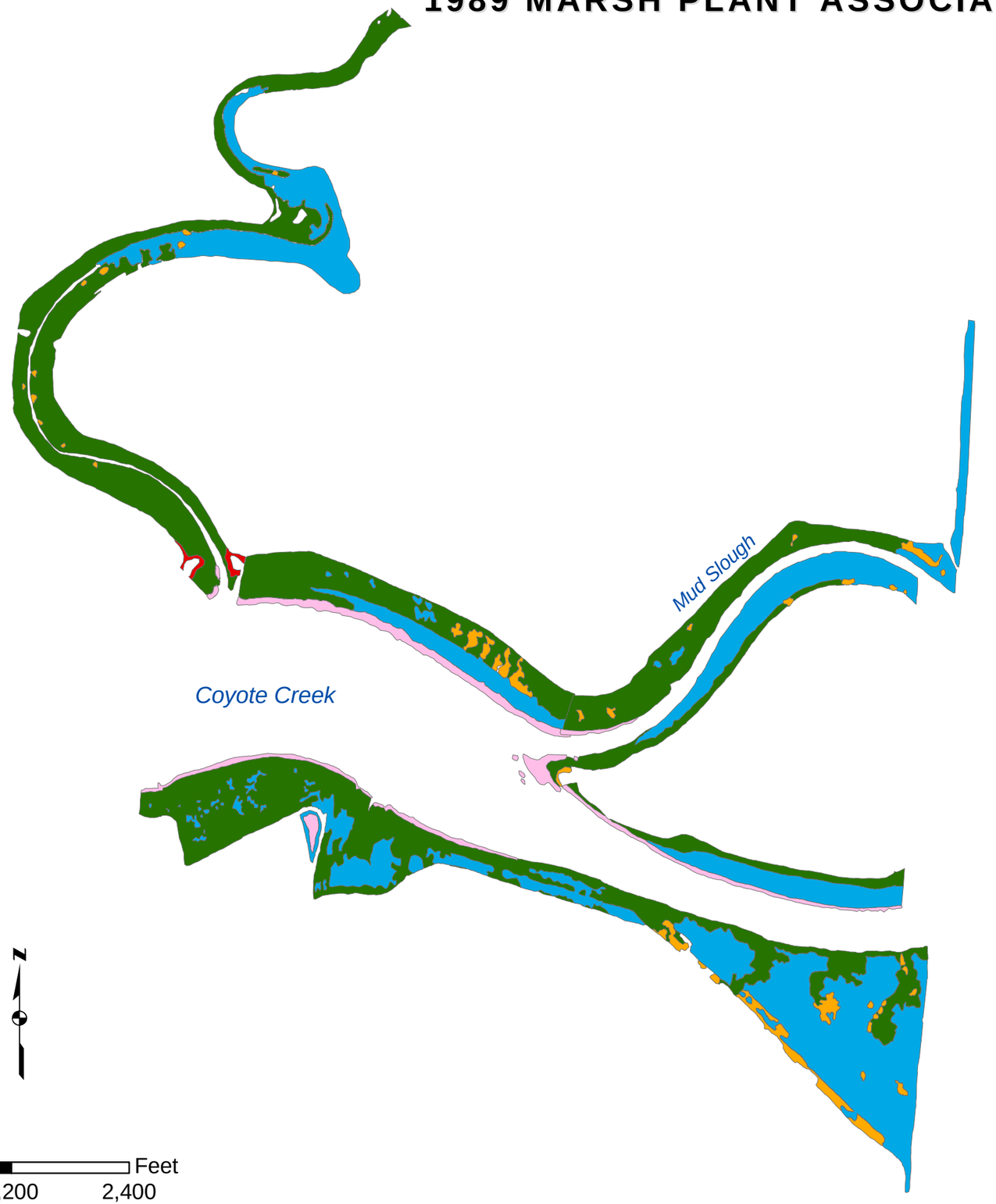
**1989 South Bay Marsh Studies Dominant Plant Species By Reach**

| File No. 477-22 | Date 10/18/01 | Figure A-1 |
|---|---|---|

# 1989 MARSH PLANT ASSOCIATIONS OF SOUTH SAN FRANCISCO BAY

## TRANSITION SEGMENTS DOMINANT SPECIES

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




H.T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

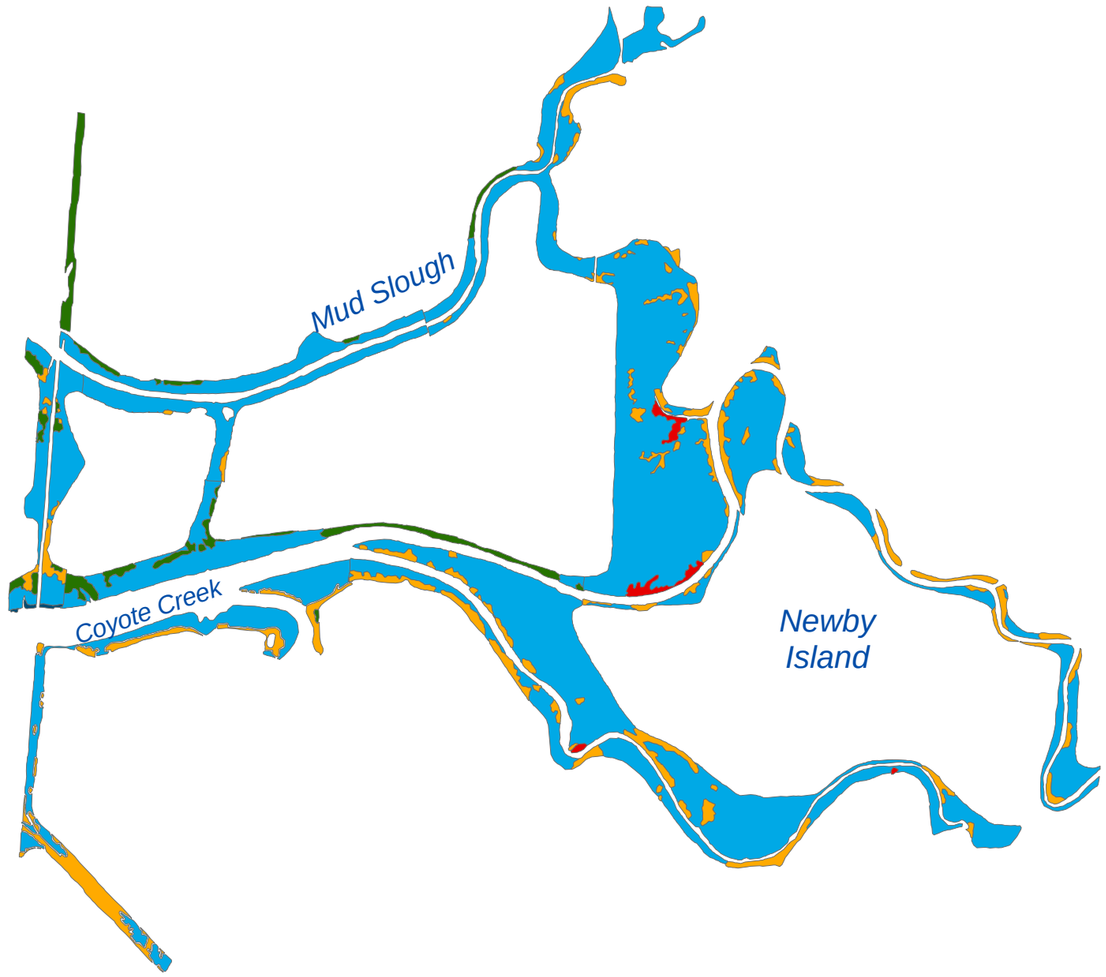
**1989 South Bay Marsh Studies Dominant Plant Species By Reach**

| File No. 477-22 | Date 10/18/01 | Figure A-2 |
|---|---|---|

# 1989 MARSH PLANT ASSOCIATIONS OF SOUTH SAN FRANCISCO BAY

## UPPER REACH SEGMENTS DOMINANT SPECIES

*SEGMENTS 12, 13, 15, 16, 17, 18, 19 and 21*




- Alkali bulrush
- Cordgrass
- Peppergrass
- Peripheral halophytes
- Pickleweed

N

0 1,800 3,600 Feet

*H.T. HARVEY & ASSOCIATES*
*ECOLOGICAL CONSULTANTS*

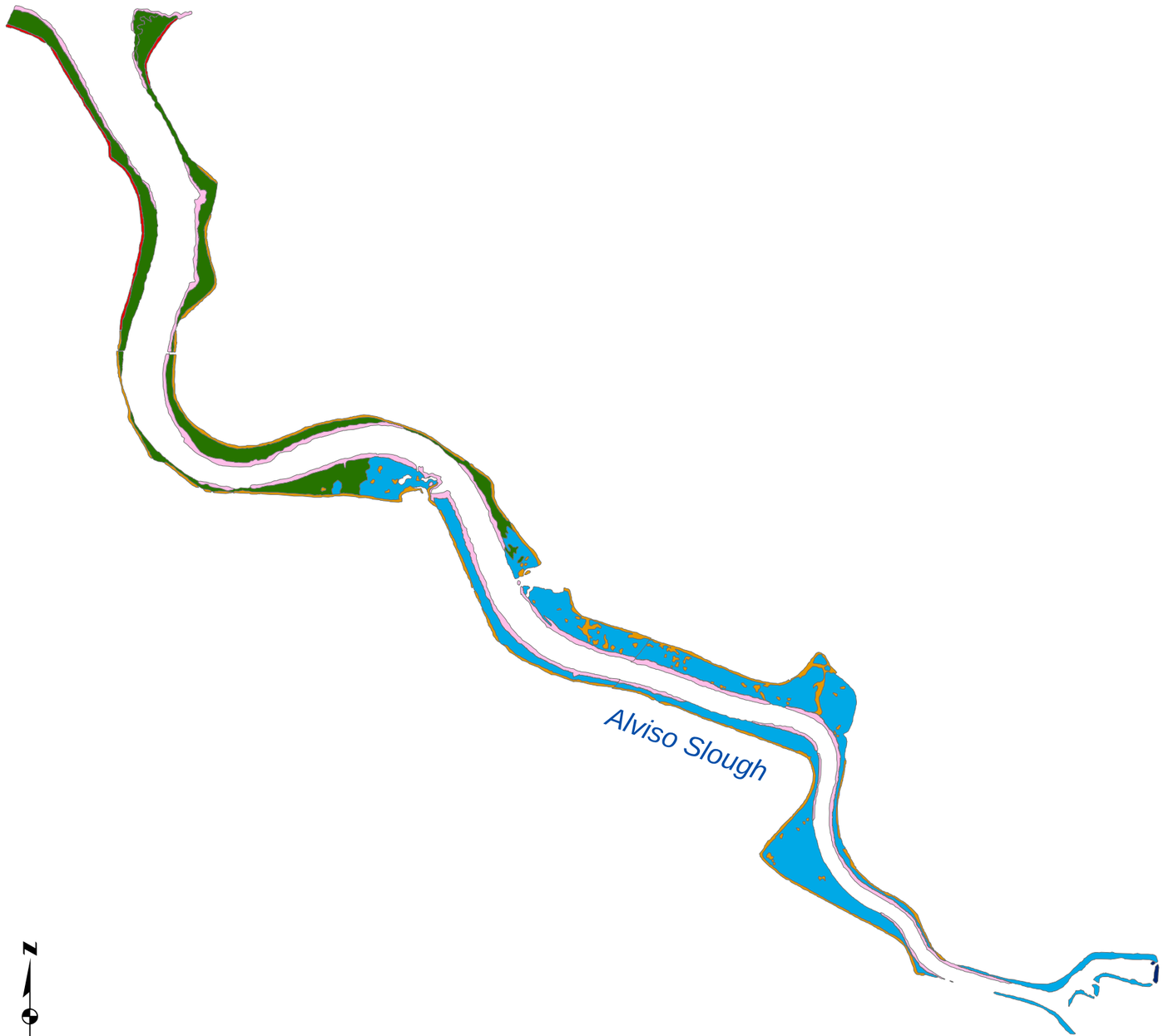
**1989 South Bay Marsh Studies Dominant Plant Species By Reach**

| File No. **477-22** | Date **10/18/01** | Figure **A-3** |
|---|---|---|

# 1989 MARSH PLANT ASSOCIATIONS OF SOUTH SAN FRANCISCO BAY

## ALVISO SLOUGH SEGMENTS DOMINANT SPECIES

*SEGMENTS 27, 28, 29 and 30*




- Alkali bulrush
- California bulrush
- Cordgrass
- Perennial peppergrass
- Peripheral halophytes
- Pickleweed

N

0 1,500 3,000 Feet

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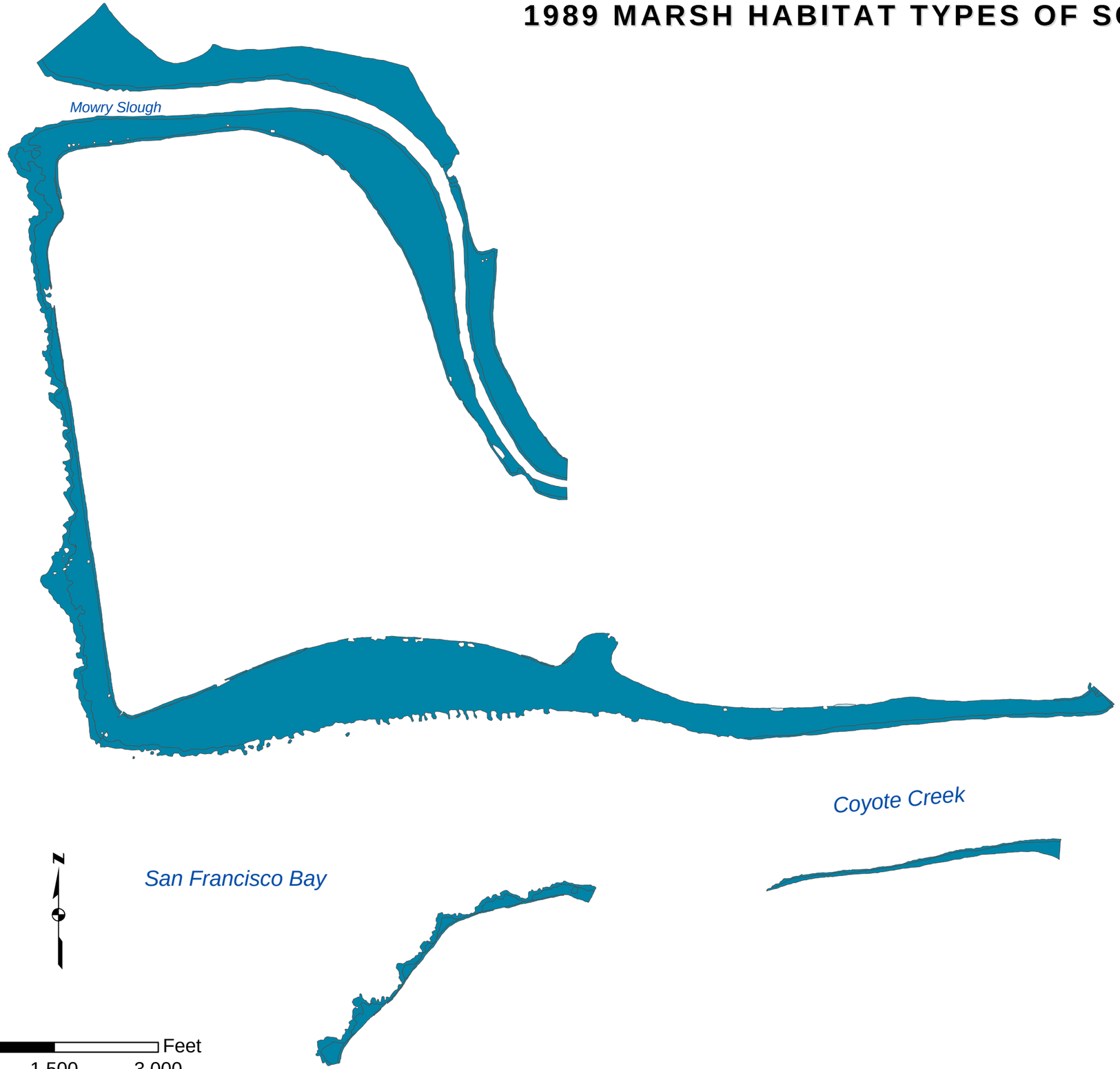
**1989 South Bay Marsh Studies Dominant Plant Species By Reach**

| File No. 477-22 | Date 10/18/01 | Figure A-4 |
|---|---|---|

# 1989 MARSH HABITAT TYPES OF SOUTH SAN FRANCISCO BAY

## LOWER REACH SEGMENT HABITATS

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




Brackish

Saline

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**1989 South Bay Marsh Studies Marsh Habitat Types By Reach**

File No. **477-22** | Date **10/18/01** | Figure **A-5**

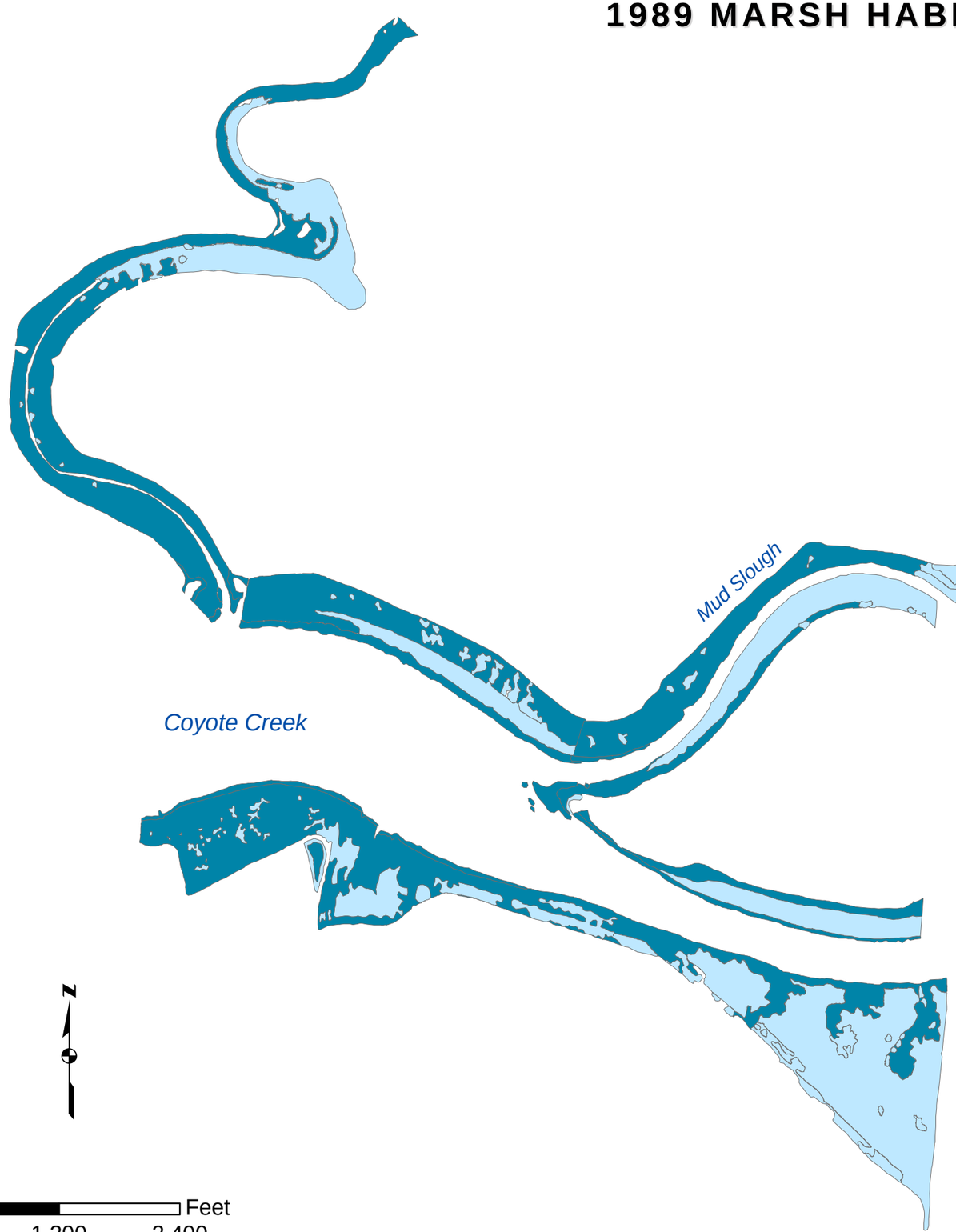
# 1989 MARSH HABITAT TYPES OF SOUTH SAN FRANCISCO BAY

## TRANSITION SEGMENTS DOMINANT SPECIES

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

Brackish

Saline




Feet

0 1,200 2,400

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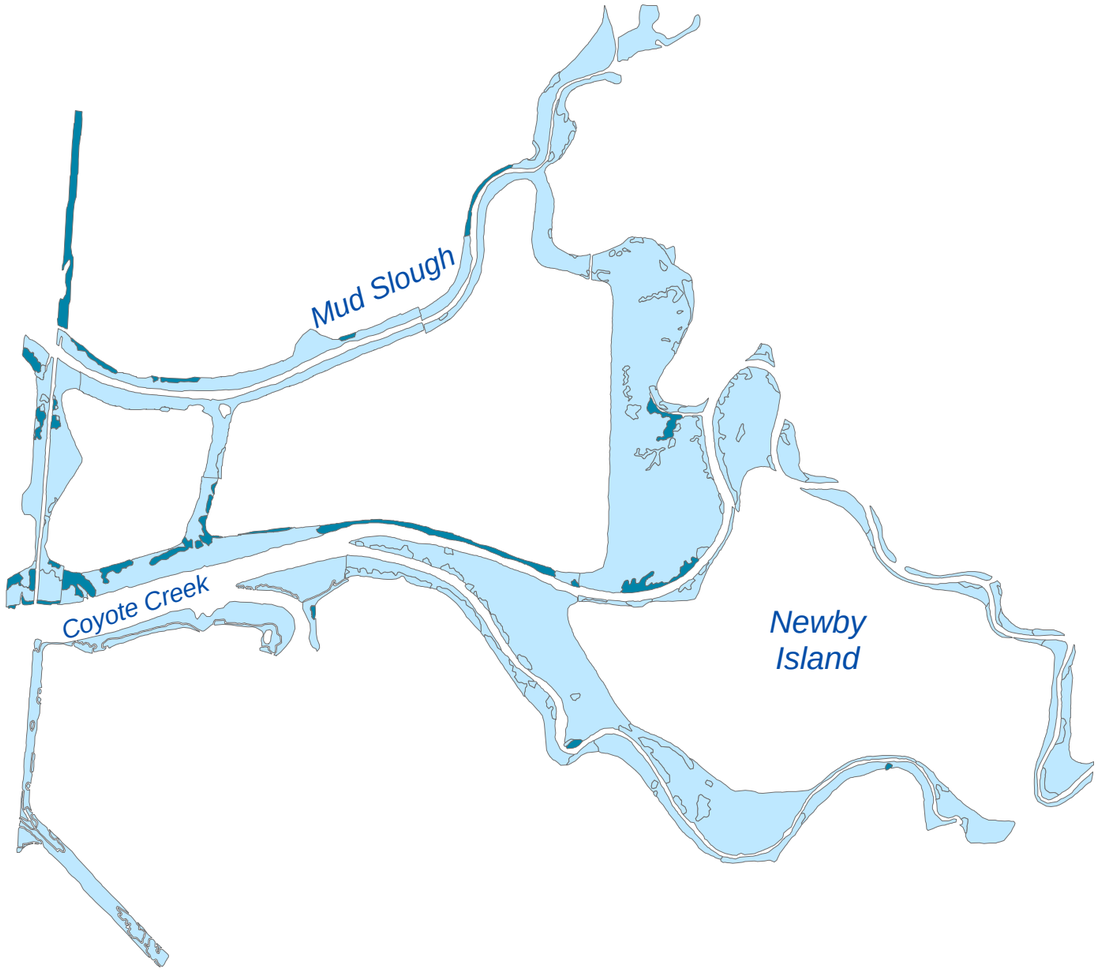
**1989 South Bay Marsh Studies Marsh Habitat Types By Reach**

File No. **477-22** | Date **10/18/01** | Figure **A-6**

# 1989 MARSH HABITAT TYPES OF SOUTH SAN FRANCISCO BAY

## UPPER REACH SEGMENTS DOMINANT SPECIES

*SEGMENTS 12, 13, 15, 16, 17, 18, 19, and 21*

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**1989 South Bay Marsh Studies Marsh Habitat Types By Reach**

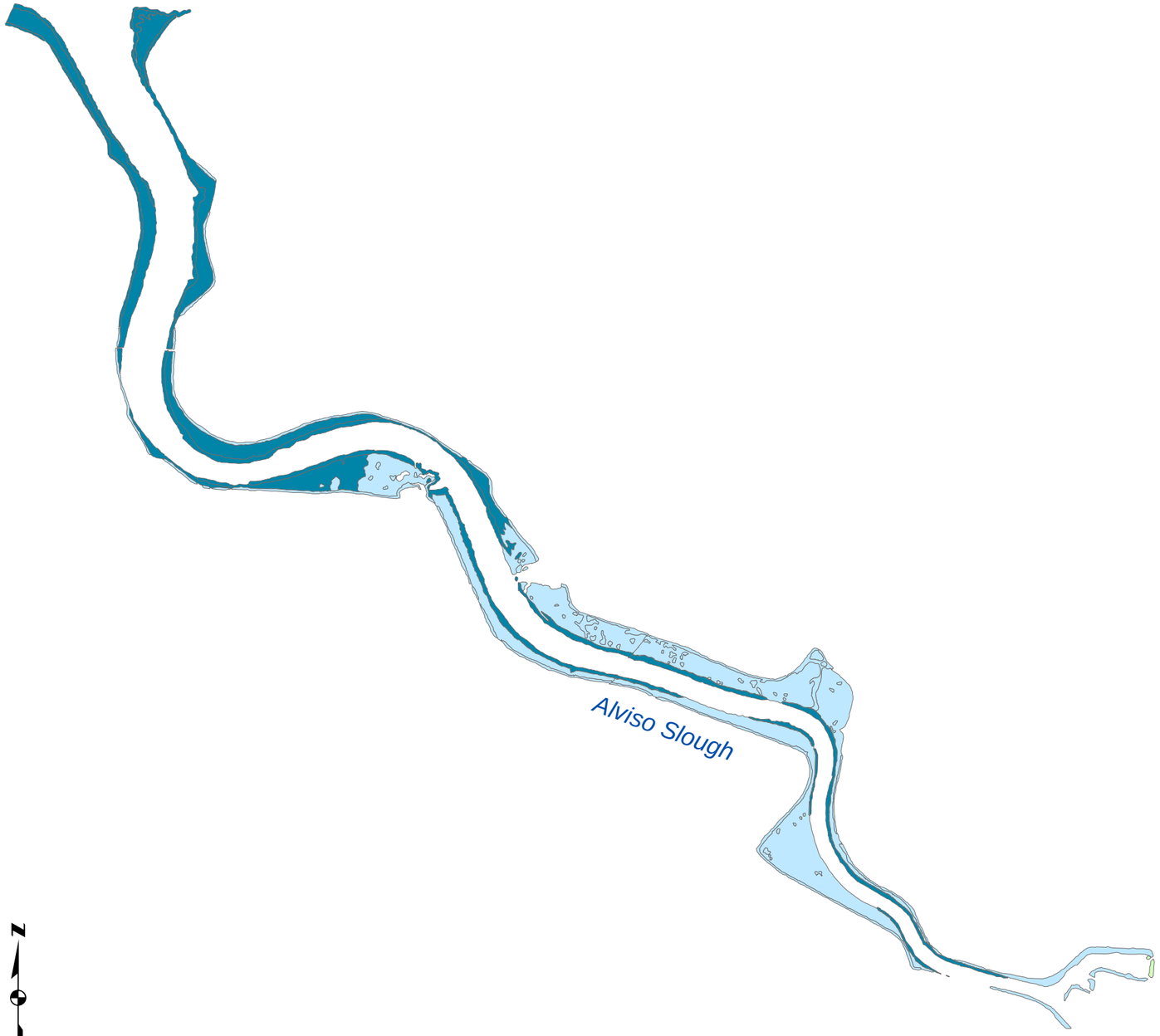
| File No. 477-22 | Date 10/18/01 | Figure A-7 |
|---|---|---|

# 1989 MARSH HABITAT TYPES OF SOUTH SAN FRANCISCO BAY

## ALVISO SLOUGH SEGMENTS HABITATS

*SEGMENTS 28, 29 and 30*

Fresh
Brackish
Saline




N

0 1,500 3,000 Feet

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**1989 South Bay Marsh Studies Marsh Habitat Types By Reach**

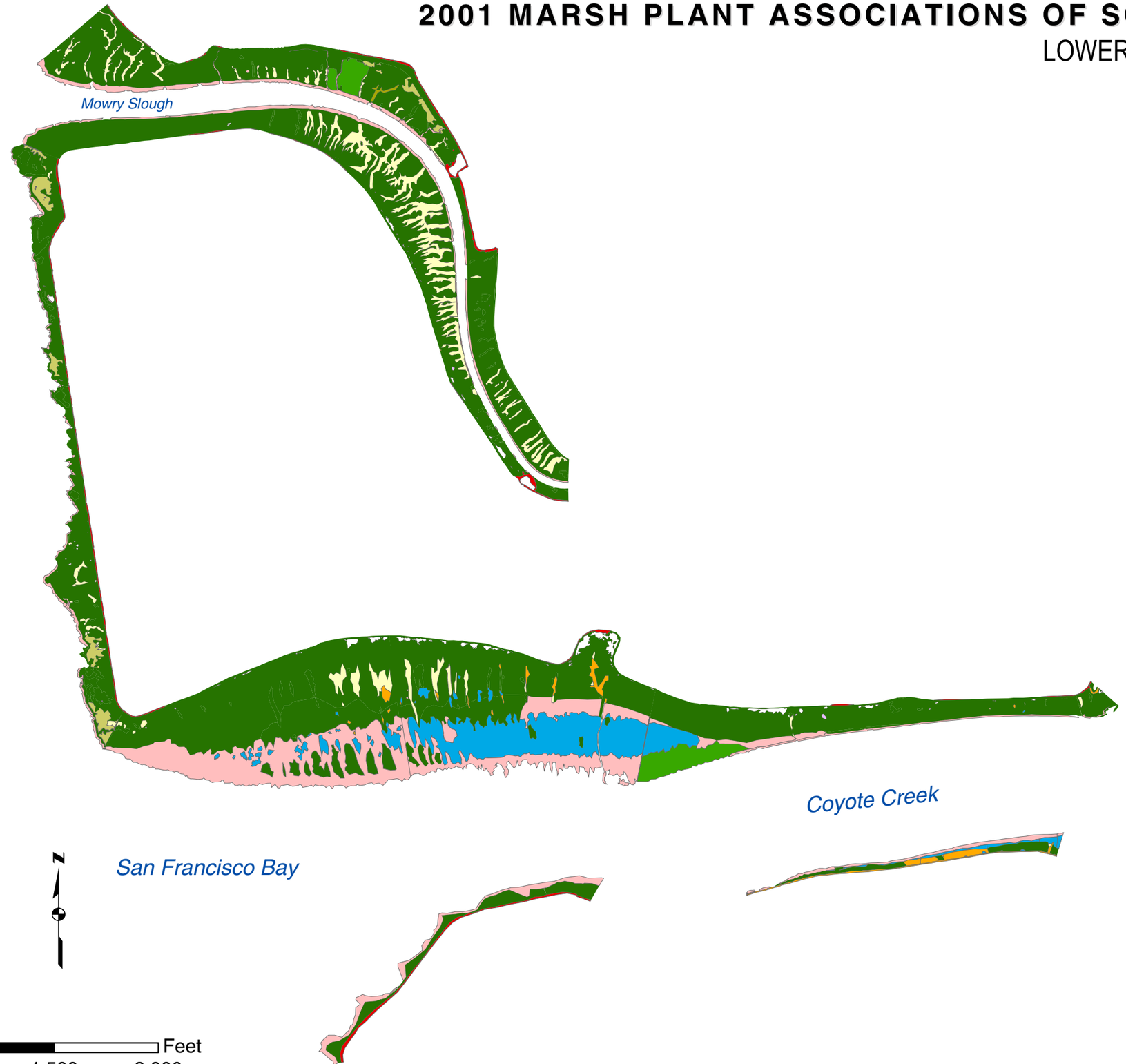
File No. **477-22** | Date **10/18/01** | Figure **A-8**

**APPENDIX B.**
**SOUTH BAY MARSHES:**
**2001 VEGETATION MAPS**

# 2001 MARSH PLANT ASSOCIATIONS OF SOUTH SAN FRANCISCO BAY

## LOWER REACH SEGMENT DOMINANT SPECIES

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




- Alkali Bulrush
- Alkali Heath
- Cordgrass
- Gumplant
- Knotweed
- Peppergrass
- Peripheral Halophytes
- Pickleweed
- Pickleweed-Cordgrass Mix
- Saltgrass
- Saltgrass-Gumplant Mix
- Spearscale
- Water

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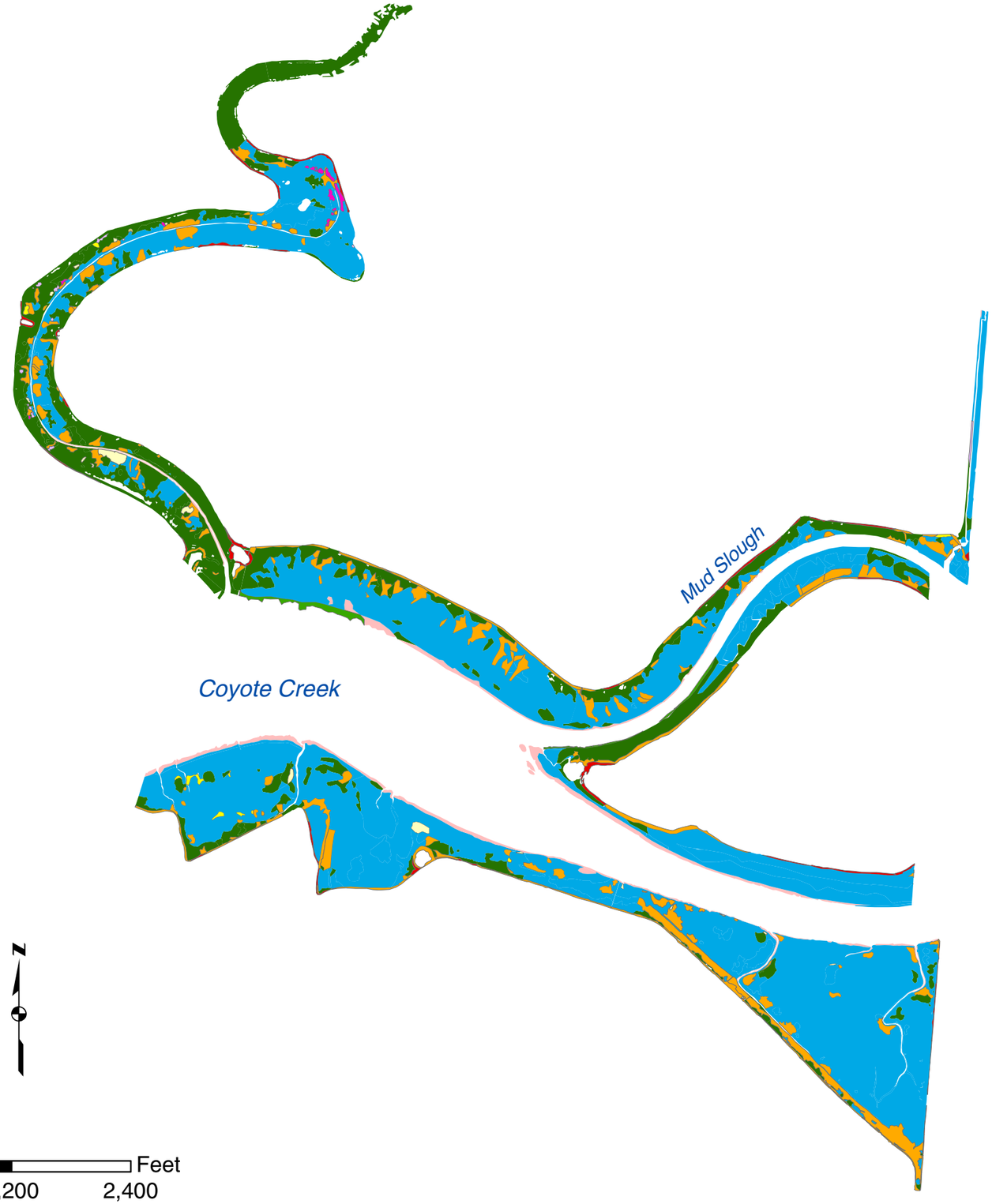
**2001 South Bay Marsh Studies Dominant Plant Species By Reach**

| File No. 477-22 | Date 10/18/01 | Figure B-1 |
|---|---|---|

# 2001 MARSH PLANT ASSOCIATIONS OF SOUTH SAN FRANCISCO BAY

## TRANSITION SEGMENTS DOMINANT SPECIES

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




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

*H.T. HARVEY & ASSOCIATES*
*ECOLOGICAL CONSULTANTS*

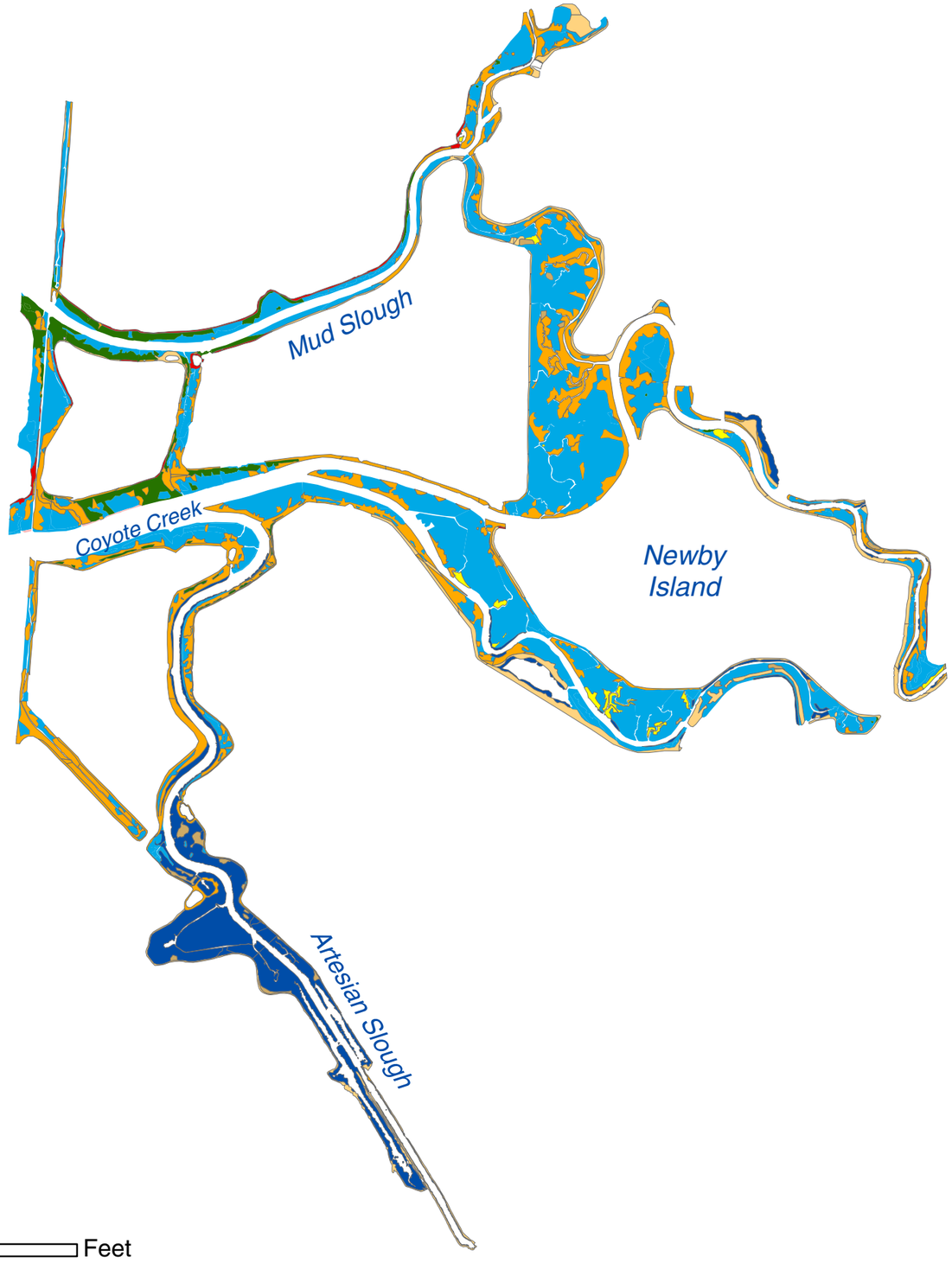
**2001 South Bay Marsh Studies Dominant Plant Species By Reach**

| File No. **477-22** | Date **10/18/01** | Figure **B-2** |
|---|---|---|

# 2001 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*




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

0 1,800 3,600 Feet

H.T. HARVEY & ASSOCIATES
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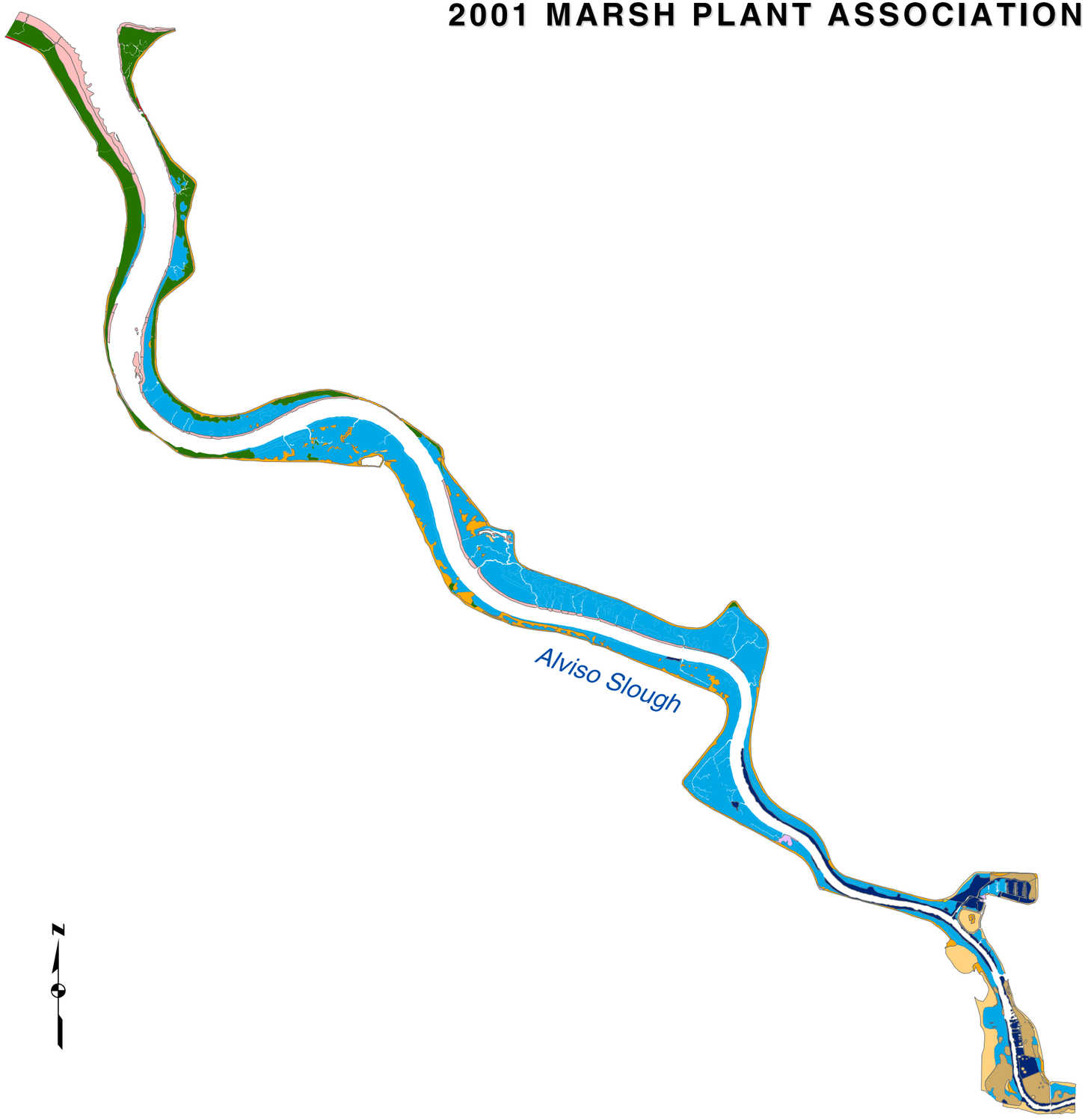
**2001 South Bay Marsh Studies Dominant Plant Species By Reach**

| File No. 477-22 | Date 10/18/01 | Figure B-3 |
|---|---|---|

# 2001 MARSH PLANT ASSOCIATIONS OF SOUTH SAN FRANCISCO BAY

## ALVISO SLOUGH SEGMENTS DOMINANT SPECIES

*SEGMENTS 27, 28, 29 and 30*




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


*H.T. HARVEY & ASSOCIATES*
*ECOLOGICAL CONSULTANTS*

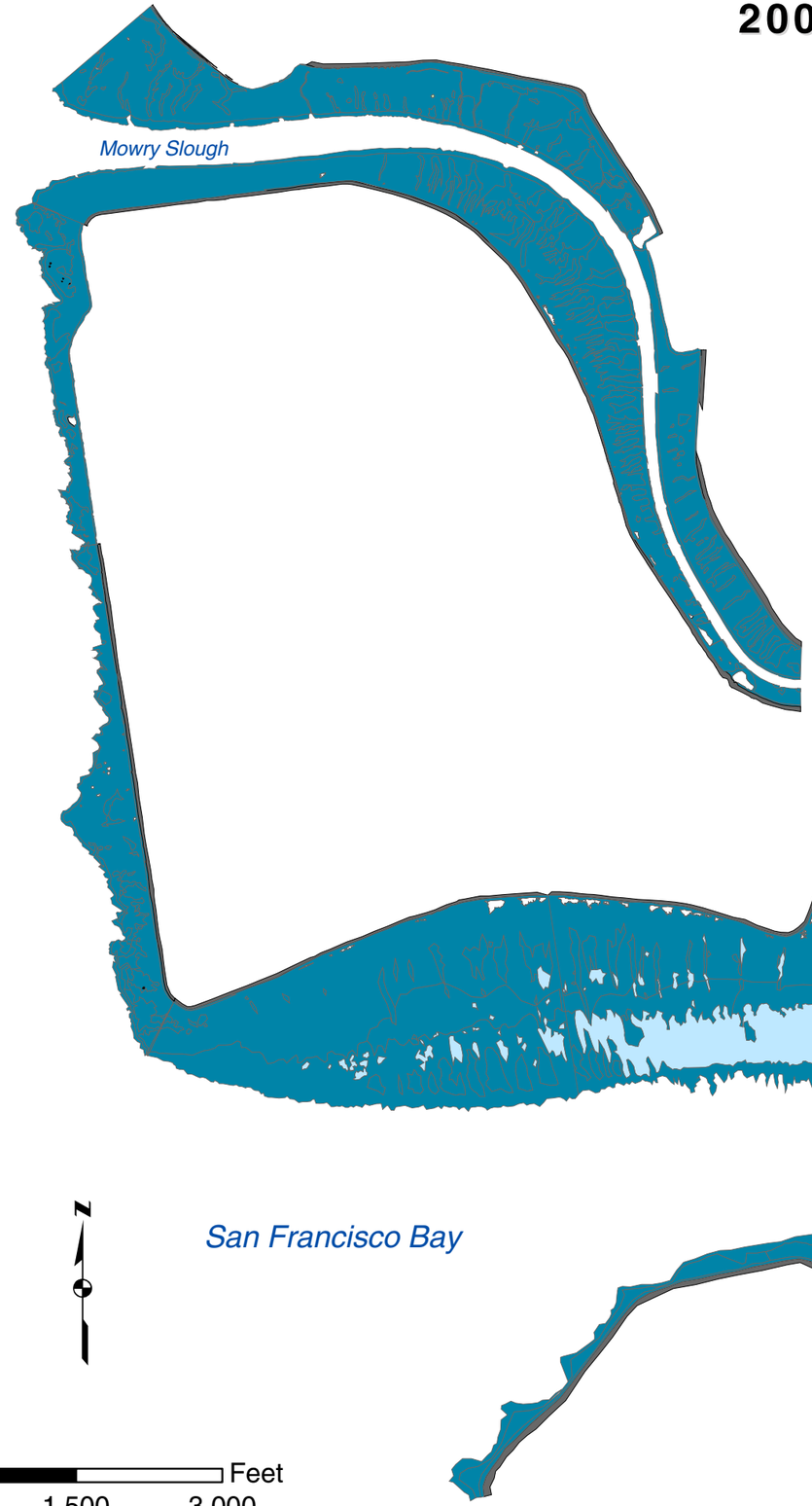

**2001 South Bay Marsh Studies Dominant Plant Species By Reach**

| File No. **477-22** | Date **10/18/01** | Figure **B-4** |
|---|---|---|

# 2001 MARSH HABITAT TYPES OF SOUTH SAN FRANCISCO BAY

## LOWER REACH SEGMENT HABITATS

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




- Fresh
- Brackish
- Saline
- Levee
- Upland Species
- Water

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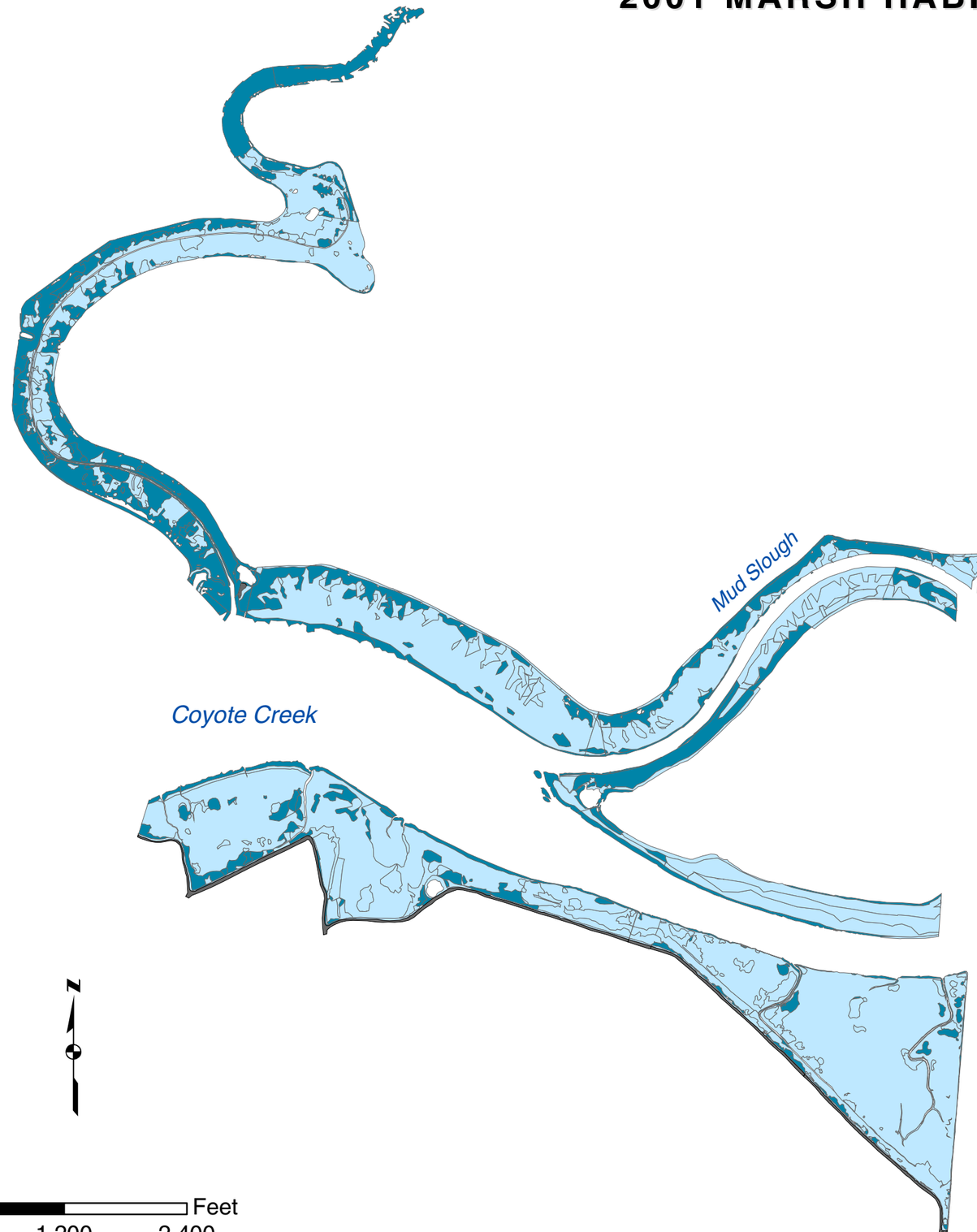
**2001 South Bay Marsh Studies Marsh Habitat Types By Reach**

| File No. 477-22 | Date 10/18/01 | Figure B-5 |
|---|---|---|

# 2001 MARSH HABITAT TYPES OF SOUTH SAN FRANCISCO BAY

## TRANSITION SEGMENTS DOMINANT SPECIES

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




Fresh
Brackish
Saline

Levee
Upland Species
Water

*H.T. HARVEY & ASSOCIATES*
*ECOLOGICAL CONSULTANTS*

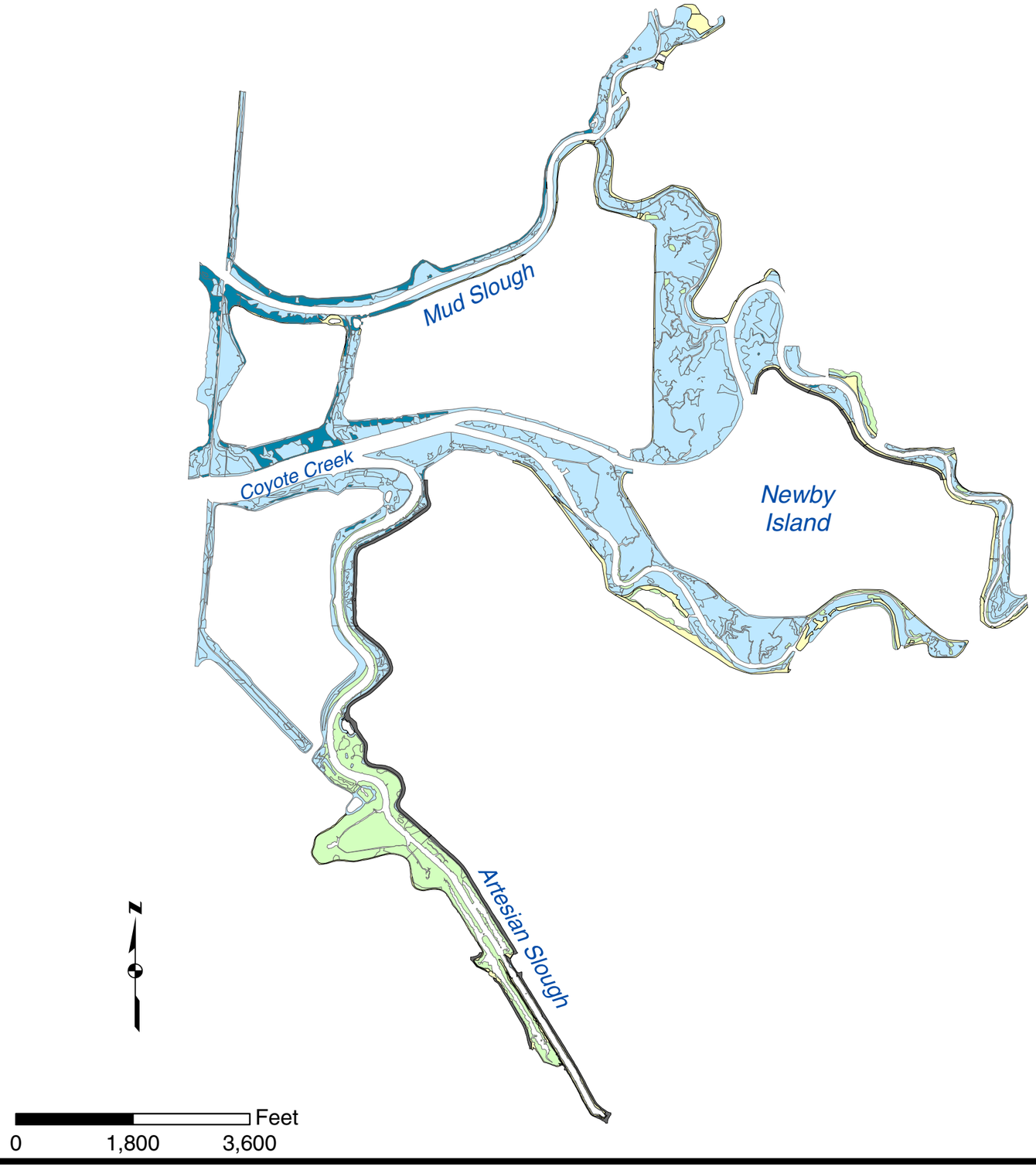
**2001 South Bay Marsh Studies Marsh Habitat Types By Reach**

| File No. **477-22** | Date **10/18/01** | Figure **B-6** |
|---|---|---|

# 2001 MARSH HABITAT TYPES OF SOUTH SAN FRANCISCO BAY

## UPPER REACH SEGMENTS DOMINANT SPECIES

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




Fresh
Brackish
Saline

Levee
Upland Species
Water

H.T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

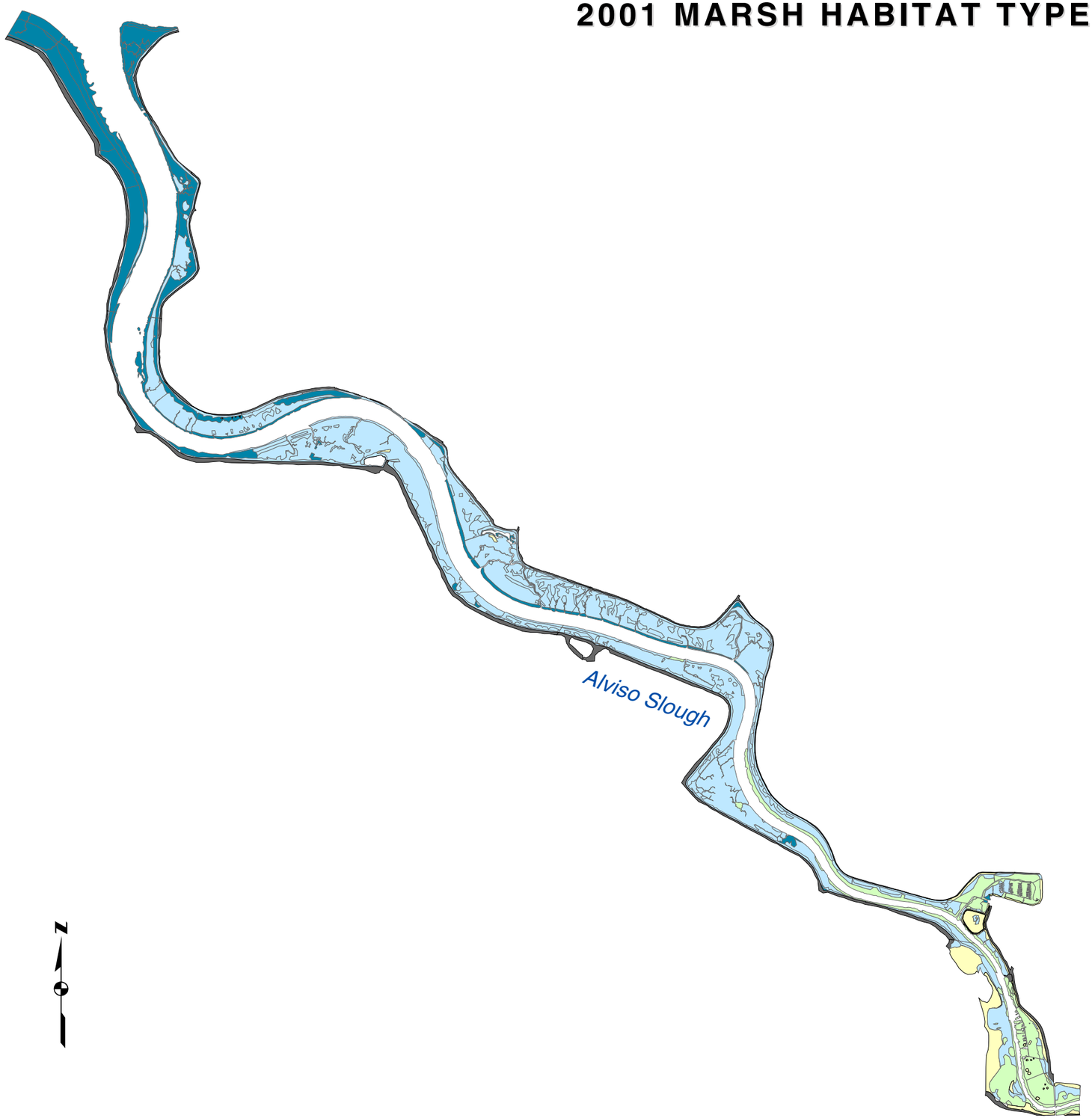
**2001 South Bay Marsh Studies Marsh Habitat Types By Reach**

| File No. 477-22 | Date 10/18/01 | Figure B-7 |
|---|---|---|

# 2001 MARSH HABITAT TYPES OF SOUTH SAN FRANCISCO BAY

## ALVISO SLOUGH SEGMENTS HABITATS

*SEGMENTS 27, 28, 29 and 30*




Fresh
Brackish
Saline

Levee
Upland Species
Water

N

0 1,500 3,000 Feet

H.T. HARVEY & ASSOCIATES
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**2001 South Bay Marsh Studies Marsh Habitat Types By Reach**

| File No. 477-22 | Date 10/18/01 | Figure B-8 |
|---|---|---|

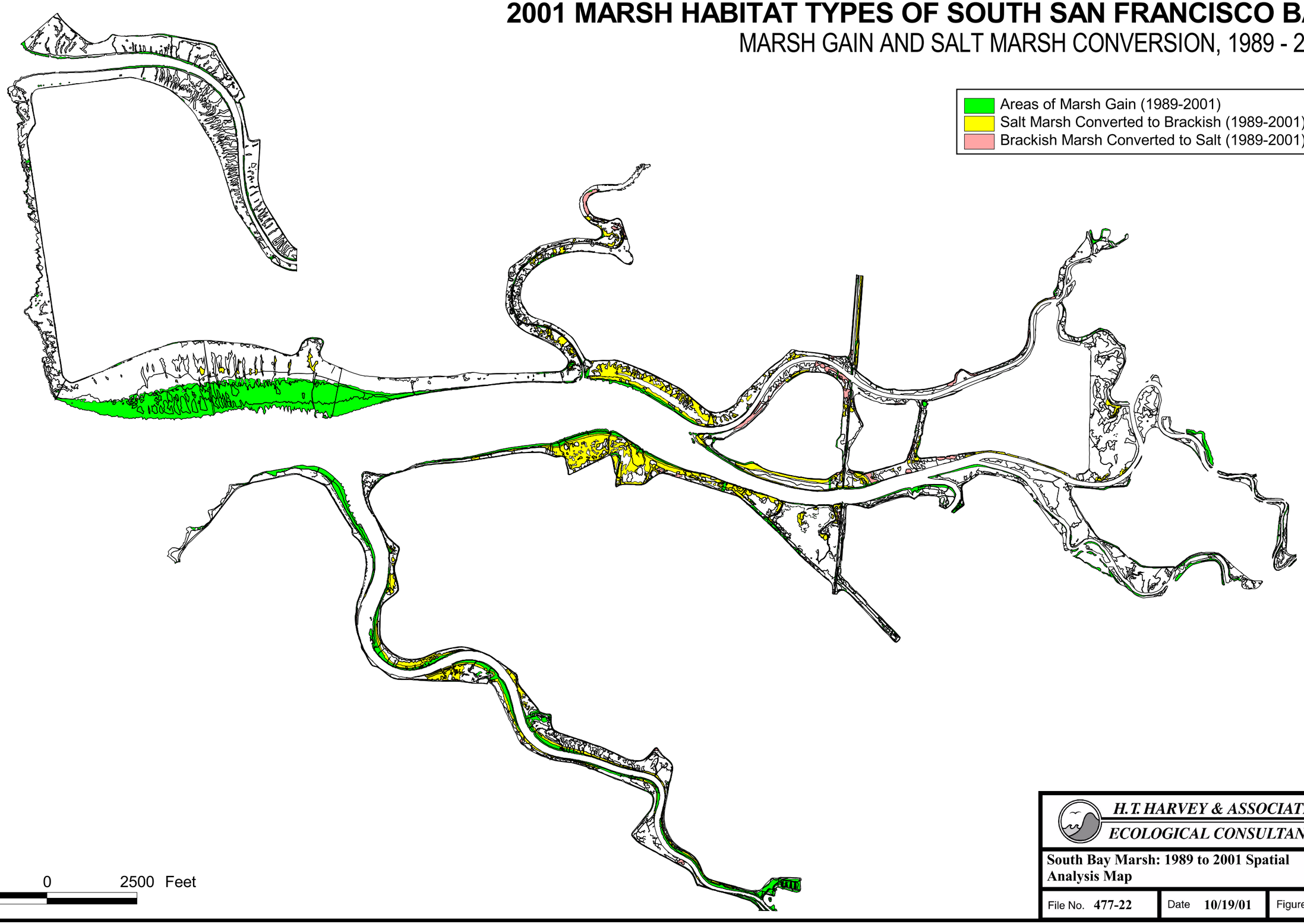
**APPENDIX C.**
**1989/2001 SPATIAL ANALYSIS MAP**

# 2001 MARSH HABITAT TYPES OF SOUTH SAN FRANCISCO BAY

## MARSH GAIN AND SALT MARSH CONVERSION, 1989 - 2001

N

Areas of Marsh Gain (1989-2001)
Salt Marsh Converted to Brackish (1989-2001)
Brackish Marsh Converted to Salt (1989-2001)



2500 0 2500 Feet

*H.T. HARVEY & ASSOCIATES*
*ECOLOGICAL CONSULTANTS*

**South Bay Marsh: 1989 to 2001 Spatial Analysis Map**

File No. **477-22** | Date **10/19/01** | Figure **C**

**APPENDIX D.**
**VEGETATION MATRICES**

Table D1. 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 | 2001 |
| Pickleweed | 13.3 | 19.2 | 27.2 | 18.6 | 12.2 | 12.6 | 16.3 | 18.7 |
| Cordgrass | 9.0 | 1.4 | 3.4 | 2.8 | 9.7 | 1.94 | 0.9 | 1.5 |
| Pickleweed-Cordgrass Mix | 14.1 | 0.0 | 0.0 | 1.3 | 0.8 | 0.7 | 0.0 | 0.0 |
| Pickleweed-Spearscale Mix | 0.0 | 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 | 0.0 |
| Gumplant | 0.0 | 0.0 | 0.0 | 0.0 | 0.02 | 0.1 | 0.1 | 0.1 |
| Peripheral Halophytes | 1.0 | 1.5 | 1.7 | 0.0 | 3.86 | 1.43 | 1.2 | 4.4 |
| **Total Saline Dominant Species:** | **37.4** | **22.1** | **32.3** | **22.7** | **26.58** | **16.8** | **18.5** | **24.8** |
| Brackish Marsh Vegetation | | | | | | | | |
| Alkali Bulrush | 0.0 | 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 | 0.0 |
| Spearscale | 0.0 | 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** | **0.0** |
| Freshwater Marsh Vegetation | | | | | | | | |
| California Bulrush | 0.0 | 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 | 0.0 |
| **Total Freshwater Dominant Species:** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Total Segment Acreage** | **37.4** | **22.1** | **32.3** | **23.3** | **26.58** | **27.1** | **24.4** | **24.8** |

Table D2. 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 | 2001 |
| Pickleweed | 26.1 | 35.5 | 32.9 | 32.4 | 19.0 | 36.2 | 36.4 | 32.5 |
| Cordgrass | 13.7 | 2.3 | 2.6 | 3.8 | 10.5 | 3.1 | 1.5 | 3.1 |
| Pickleweed-Cordgrass Mix | 0.0 | 0.0 | 0.0 | 1.8 | 0.0 | 0.0 | 0.7 | 0.0 |
| Pickleweed-Spearscale Mix | 0.0 | 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 | 0.0 |
| Gumplant | 0.0 | 0.0 | 0.0 | 0.2 | 0.2 | 1.4 | 1.0 | 1.6 |
| Peripheral Halophytes | 3.9 | 2.3 | 1.6 | 0.7 | 3.88 | 2.2 | 2.0 | 5.0 |
| **Total Saline Dominant Species:** | **43.7** | **40.1** | **37.1** | **38.9** | **33.58** | **42.9** | **41.6** | **42.1** |
| Brackish Marsh Vegetation | | | | | | | | |
| Alkali Bulrush | 0.0 | 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 | 0.0 |
| Spearscale | 0.0 | 0.0 | 0.0 | 0.4 | 7.5 | 0.0 | 0.0 | 0.0 |
| **Total Brackish Dominant Species:** | **0.0** | **0.0** | **0.0** | **0.4** | **7.5** | **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 | 0.0 |
| Cattail | 0.0 | 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** | **0.0** |
| **Total Segment Acreage** | **43.7** | **40.1** | **37.1** | **39.8** | **41.2** | **42.9** | **41.7** | **42.1** |

Table D3. 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 | 2001 |
| Pickleweed | 160.1 | 114.7 | 79.3 | 95.1 | 98.7 | 118.3 | 187.4 | 163.7 |
| Cordgrass | 0.6 | 3.4 | 2.9 | 86.6 | 104.6 | 15.9 | 46.3 | 70.6 |
| Pickleweed-Cordgrass Mix | 0.0 | 69.9 | 98.8 | 36.0 | 0.0 | 83.3 | 0.0 | 0.0 |
| Pickleweed-Spearscale Mix | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| Alkali Heath | 0.0 | 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 | 0.0 |
| Gumplant | 0.0 | 0.0 | 2.7 | 6.9 | 2.2 | 7.4 | 6.6 | 7.6 |
| Peripheral Halophytes | 0.4 | 2.6 | 1.1 | 1.0 | 3.02 | 1.0 | 1.3 | 0.7 |
| **Total Saline Dominant Species:** | **161.1** | **190.6** | **184.8** | **225.6** | **208.62** | **225.9** | **241.5** | **242.6** |
| Brackish Marsh Vegetation | | | | | | | | |
| Alkali Bulrush | 0.0 | 0.0 | 0.1 | 0.0 | 49.2 | 50.8 | 39.9 | 44.2 |
| Peppergrass | 0.0 | 1.1 | 1.2 | 1.6 | 1.8 | 1.8 | 1.5 | 2.6 |
| Spearscale | 0.0 | 0.0 | 0.0 | 0.2 | 2.4 | 0.0 | 0.0 | 0.0 |
| **Total Brackish Dominant Species:** | **0.0** | **1.1** | **1.3** | **1.8** | **53.4** | **52.6** | **41.4** | **46.7** |
| Freshwater Marsh Vegetation | | | | | | | | |
| California Bulrush | 0.0 | 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 | 0.0 |
| **Total Freshwater Dominant Species:** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Total Segment Acreage** | **161.1** | **191.7** | **212.3** | **227.6** | **262.1** | **278.5** | **282.9** | **289.4** |

Table D4. 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 | 2001 |
| Pickleweed | 49.1 | 43.9 | 46.9 | 50.1 | 49.8 | 47.6 | 57.5 | 53.3 |
| Cordgrass | 6.2 | 6.2 | 4.1 | 5.6 | 12.9 | 17.1 | 9.9 | 6.5 |
| Pickleweed-Cordgrass Mix | 0.0 | 3.4 | 6.2 | 7.2 | 0.1 | 0.0 | 0.0 | 9.8 |
| Pickleweed-Spearscale Mix | 0.0 | 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 | 0.1 |
| Gumplant | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.3 |
| Peripheral Halophytes | 0.6 | 2.4 | 1.5 | 0.9 | 2.1 | 1.7 | 1.8 | 0.5 |
| **Total Saline Dominant Species:** | **55.9** | **55.9** | **58.7** | **64.0** | **65** | **66.5** | **69.4** | **70.5** |
| Brackish Marsh Vegetation | | | | | | | | |
| Alkali Bulrush | 0.0 | 0.0 | 0.0 | 0.0 | 4.8 | 6.2 | 7.2 | 5.5 |
| Peppergrass | 0.4 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.2 |
| Spearscale | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| **Total Brackish Dominant Species:** | **0.4** | **0.1** | **0.1** | **0.1** | **5.0** | **6.4** | **7.3** | **5.6** |
| Freshwater Marsh Vegetation | | | | | | | | |
| California Bulrush | 0.0 | 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 | 0.0 |
| **Total Freshwater Dominant Species:** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Total Segment Acreage** | **56.3** | **56.0** | **58.8** | **64.0** | **70.0** | **72.9** | **76.7** | **76.1** |

Table D5. 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 | 2001 |
| Pickleweed | 60.4 | 62.3 | 30.5 | 36.6 | 34.4 | 41.6 | 44.5 | 43.4 |
| Cordgrass | 0.3 | 2.1 | 2.7 | 2.6 | 3.6 | 2.3 | 2.0 | 0.9 |
| Pickleweed-Cordgrass Mix | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.1 | 0.0 | 0.0 |
| Pickleweed-Spearscale Mix | 0.0 | 0.0 | 18.9 | 7.9 | 2.2 | 0.0 | 0.0 | 0.0 |
| Alkali Heath | 0.0 | 0.0 | 0.0 | 0.2 | 0.1 | 0.4 | 0.2 | 0.3 |
| Gumplant | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.3 | 0.2 | 0.9 |
| Peripheral Halophytes | 1.2 | 0.5 | 1.0 | 2.8 | 3.55 | 6.6 | 4.2 | 2.6 |
| **Total Saline Dominant Species:** | **61.9** | **64.9** | **53.1** | **50.2** | **43.85** | **52.3** | **51.2** | **48.1** |
| Brackish Marsh Vegetation | | | | | | | | |
| Alkali Bulrush | 24.4 | 19.2 | 27.3 | 32.1 | 34.7 | 32.0 | 31.4 | 32.6 |
| Peppergrass | 0.8 | 1.4 | 2.4 | 4.0 | 3.4 | 7.5 | 7.5 | 8.1 |
| Spearscale | 0.0 | 0.0 | 0.0 | 3.7 | 13.6 | 0.1 | 0.6 | 0.2 |
| **Total Brackish Dominant Species:** | **25.2** | **20.6** | **29.7** | **39.8** | **51.7** | **39.6** | **39.5** | **40.8** |
| Freshwater Marsh Vegetation | | | | | | | | |
| California Bulrush | 0.0 | 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 | 0.0 |
| **Total Freshwater Dominant Species:** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Total Segment Acreage** | **87.1** | **85.5** | **82.8** | **90.0** | **95.5** | **92.4** | **91.4** | **89.0** |

Table D6. 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 | 2001 |
| Pickleweed | 199.7 | 204.9 | 151.8 | 149.4 | 101.0 | 171.1 | 182.4 | 181.5 |
| Cordgrass | 23.1 | 11.7 | 10.2 | 22.5 | 98.0 | 32.5 | 17.8 | 16.7 |
| Pickleweed-Cordgrass Mix | 0.0 | 0.0 | 49.0 | 25.7 | 0.0 | 0.0 | 0.0 | 4.8 |
| Pickleweed-Spearscale Mix | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 6.6 | 0.0 | 0.0 |
| Alkali Heath | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.3 | 0.0 | 0.0 |
| Gumplant | 0.0 | 0.0 | 0.0 | 23.8 | 25.7 | 27.5 | 29.7 | 32.1 |
| Saltgrass | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.3 | 0.0 |
| Peripheral Halophytes | 11.1 | 10.0 | 7.8 | 6.0 | 14.34 | 7.7 | 5.8 | 6.5 |
| **Total Saline Dominant Species:** | **233.9** | **226.6** | **218.8** | **227.5** | **239.1** | **245.7** | **239.0** | **241.5** |
| Brackish Marsh Vegetation | | | | | | | | |
| Alkali Bulrush | 0.0 | 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 | 0.0 |
| Spearscale | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total Brackish Dominant Species:** | **0.0** | **0.0** | **0.0** | **0.1** | **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 | 0.0 |
| Cattail | 0.0 | 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** | **0.0** |
| **Total Segment Acreage** | **233.9** | **226.6** | **215.3** | **228.5** | **239.1** | **248.7** | **239.0** | **241.5** |

Table D7. 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 | 2001 |
| Pickleweed | 46.0 | 32.4 | 15.4 | 10.0 | 3.5 | 6.0 | 5.4 | 7.7 |
| Cordgrass | 4.4 | 8.9 | 3.9 | 6.6 | 7.3 | 4.7 | 2.6 | 3.4 |
| Pickleweed-Cordgrass Mix | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.2 | 0.4 | 0.0 |
| Pickleweed-Spearscale Mix | 0.0 | 0.0 | 0.3 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| Alkali Heath | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.1 | 0.0 |
| Gumplant | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.6 | 0.5 |
| Peripheral Halophytes | 0.0 | 0.0 | 1.3 | 2.0 | 3.3 | 1.2 | 1.3 | 0.4 |
| **Total Saline Dominant Species:** | **50.4** | **41.3** | **20.9** | **19.2** | **14.1** | **12.6** | **10.3** | **12.1** |
| Brackish Marsh Vegetation | | | | | | | | |
| Alkali Bulrush | 15.4 | 22.2 | 44.1 | 50.4 | 67.0 | 60.2 | 56.9 | 56.7 |
| Peppergrass | 0.6 | 1.3 | 1.2 | 1.7 | 1.4 | 4.3 | 4.8 | 5.7 |
| Spearscale | 0.0 | 0.0 | 0.0 | 1.5 | 1.9 | 3.0 | 2.1 | 0.5 |
| **Total Brackish Dominant Species:** | **16.0** | **23.5** | **45.3** | **53.6** | **70.2** | **67.5** | **63.8** | **62.8** |
| Freshwater Marsh Vegetation | | | | | | | | |
| California Bulrush | 0.0 | 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 | 0.0 |
| **Total Freshwater Dominant Species:** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Total Segment Acreage** | **66.4** | **64.8** | **66.2** | **72.8** | **84.8** | **80.2** | **74.2** | **74.9** |

Table D8. 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 | 2001 |
| Pickleweed | 24.2 | 21.2 | 10.7 | 10.4 | 8.3 | 8.0 | 9.2 | 9.0 |
| Cordgrass | 6.4 | 11.0 | 8.4 | 8.3 | 5.0 | 3.6 | 1.5 | 2.0 |
| Pickleweed-Cordgrass Mix | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.7 | 1.3 |
| Pickleweed-Spearscale Mix | 0.0 | 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 | 0.0 |
| Gumplant | 0.0 | 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 | 0.1 |
| **Total Saline Dominant Species:** | **31.3** | **32.3** | **19.7** | **19.3** | **14.9** | **12.0** | **11.8** | **12.4** |
| Brackish Marsh Vegetation | | | | | | | | |
| Alkali Bulrush | 10.2 | 5.8 | 19.7 | 24.3 | 37.1 | 30.7 | 30.4 | 32.0 |
| Peppergrass | 2.5 | 1.7 | 1.6 | 2.7 | 1.7 | 6.3 | 5.4 | 5.8 |
| Spearscale | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| **Total Brackish Dominant Species:** | **12.7** | **7.5** | **21.3** | **27.0** | **38.9** | **37.0** | **35.9** | **37.8** |
| Freshwater Marsh Vegetation | | | | | | | | |
| California Bulrush | 0.0 | 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 | 0.0 |
| **Total Freshwater Dominant Species:** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Total Segment Acreage** | **44.0** | **39.8** | **41.0** | **46.3** | **53.8** | **49.0** | **47.7** | **50.2** |

Table D9. 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 | 2001 |
| Pickleweed | 17.4 | 22.4 | 3.8 | 3.9 | 1.7 | 1.8 | 3.0 | 2.9 |
| Cordgrass | 0.0 | 1.6 | 1.1 | 1.1 | 1.6 | 2.3 | 0.6 | 1.1 |
| Pickleweed-Cordgrass Mix | 0.0 | 0.0 | 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 | 0.0 |
| Alkali Heath | 0.0 | 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 | 0.1 |
| Peripheral Halophytes | 1.0 | 0.0 | 0.4 | 1.1 | 1.5 | 1.2 | 0.2 | 0.3 |
| **Total Saline Dominant Species:** | **18.4** | **24.0** | **5.4** | **6.4** | **5.0** | **5.3** | **3.9** | **4.4** |
| Brackish Marsh Vegetation | | | | | | | | |
| Alkali Bulrush | 51.0 | 48.8 | 63.4 | 64.4 | 68.5 | 68.6 | 65.9 | 64.8 |
| Peppergrass | 6.2 | 5.6 | 6.2 | 6.4 | 5.5 | 8.2 | 10.4 | 10.7 |
| Spearscale | 0.0 | 0.0 | 0.0 | 1.2 | 1.1 | 0.4 | 0.2 | 0.0 |
| **Total Brackish Dominant Species:** | **57.2** | **54.4** | **69.6** | **72.0** | **75.1** | **77.2** | **76.5** | **75.6** |
| Freshwater Marsh Vegetation | | | | | | | | |
| California Bulrush | 0.0 | 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 | 0.0 |
| **Total Freshwater Dominant Species:** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Total Segment Acreage** | **75.6** | **78.4** | **75.1** | **78.3** | **80.7** | **82.6** | **80.5** | **80.0** |

Table D10. 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 | 2001 |
| Pickleweed | 0.2 | 2.8 | 0.6 | 2.0 | 0.7 | 0.5 | 2.1 | 0.8 |
| Cordgrass | 0.0 | 2.2 | 1.1 | 1.1 | 0.7 | 1.4 | 0.2 | 0.0 |
| Pickleweed-Cordgrass Mix | 0.0 | 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 | 0.0 |
| Alkali Heath | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 |
| Gumplant | 0.0 | 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 | 0.0 |
| Peripheral Halophytes | 0.0 | 0.0 | 1.7 | 1.1 | 2.0 | 2.2 | 2.4 | 0.0 |
| **Total Saline Dominant Species:** | **0.2** | **5.0** | **3.8** | **4.3** | **3.5** | **4.1** | **4.8** | **0.8** |
| Brackish Marsh Vegetation | | | | | | | | |
| Alkali Bulrush | 25.7 | 21.2 | 25.4 | 24.1 | 29.12 | 24.2 | 26.4 | 22.0 |
| Peppergrass | 12.2 | 17.5 | 13.4 | 14.5 | 9.9 | 18.4 | 14.3 | 22.1 |
| Spearscale | 0.0 | 0.0 | 0.0 | 0.5 | 1.7 | 0.0 | 0.1 | 0.0 |
| **Total Brackish Dominant Species:** | **37.9** | **38.7** | **38.8** | **39.0** | **40.71** | **42.6** | **40.8** | **44.1** |
| Freshwater Marsh Vegetation | | | | | | | | |
| California Bulrush | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 |
| Cattail | 0.0 | 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** | **0.3** |
| **Total Segment Acreage** | **38.1** | **43.7** | **43.1** | **43.5** | **44.5** | **47.4** | **46.0** | **45.2** |

Table D11. 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 | 2001 |
| Pickleweed | 0.0 | 0.4 | 0.8 | 1.5 | 0.5 | 0.4 | 0.5 | 0.0 |
| Cordgrass | 0.0 | 0.4 | 0.0 | 0.2 | 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 | 0.0 |
| Pickleweed-Spearscale Mix | 0.0 | 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 | 0.0 |
| Gumplant | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Peripheral Halophytes | 0.4 | 0.0 | 11.9 | 7.0 | 4.0 | 3.1 | 1.8 | 0.0 |
| **Total Saline Dominant Species:** | **0.4** | **0.8** | **12.7** | **8.7** | **4.5** | **3.5** | **2.4** | **0.1** |
| Brackish Marsh Vegetation | | | | | | | | |
| Alkali Bulrush | 95.3 | 79.9 | 84.8 | 73.3 | 74.7 | 76.1 | 83.8 | 78.7 |
| Peppergrass | 15.8 | 26.8 | 13.6 | 15.6 | 19.6 | 23.6 | 14.4 | 15.9 |
| Spearscale | 0.0 | 0.0 | 0.0 | 9.0 | 6.3 | 0.0 | 0.3 | 3.4 |
| **Total Brackish Dominant Species:** | **111.1** | **106.7** | **98.4** | **97.9** | **100.6** | **99.7** | **98.5** | **98.0** |
| Freshwater Marsh Vegetation | | | | | | | | |
| California Bulrush | 0.0 | 0.0 | 1.3 | 4.3 | 5.7 | 7.0 | 5.7 | 4.4 |
| Cattail | 0.0 | 0.0 | 0.1 | 0.2 | 1.8 | 1.1 | 2.2 | 0.8 |
| **Total Freshwater Dominant Species:** | **0.0** | **0.0** | **1.4** | **4.5** | **7.5** | **8.1** | **7.9** | **5.2** |
| **Total Segment Acreage** | **111.5** | **107.5** | **113.0** | **115.5** | **112.6** | **119.4** | **108.8** | **103.2** |

Table D12. 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 | 2001 |
| Pickleweed | 5.9 | 8.9 | 3.4 | 2.5 | 0.5 | 0.8 | 6.7 | 0.5 |
| Cordgrass | 3.2 | 2.0 | 1.5 | 2.1 | 2.0 | 2.4 | 1.4 | 2.1 |
| Pickleweed-Cordgrass Mix | 0.0 | 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 | 0.0 |
| Alkali Heath | 0.0 | 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 | 0.0 |
| Peripheral Halophytes | 0.7 | 0.0 | 0.0 | 0.6 | 0.9 | 1.4 | 1.0 | 0.7 |
| **Total Saline Dominant Species:** | **9.8** | **10.9** | **4.9** | **5.2** | **3.4** | **4.6** | **9.1** | **3.4** |
| Brackish Marsh Vegetation | | | | | | | | |
| Alkali Bulrush | 10.6 | 9.1 | 14.6 | 16.7 | 19.3 | 18.5 | 13.8 | 18.4 |
| Peppergrass | 0.0 | 0.1 | 0.5 | 0.3 | 0.1 | 0.4 | 0.3 | 1.1 |
| Spearscale | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| **Total Brackish Dominant Species:** | **10.6** | **9.2** | **15.1** | **17.0** | **19.4** | **18.9** | **14.0** | **19.5** |
| Freshwater Marsh Vegetation | | | | | | | | |
| California Bulrush | 0.0 | 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 | 0.0 |
| **Total Freshwater Dominant Species:** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Total Segment Acreage** | **20.4** | **20.1** | **20.0** | **22.2** | **23.0** | **23.9** | **23.2** | **22.9** |

Table D13. 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 | 2001 |
| Pickleweed | 9.1 | 4.2 | 2.0 | 1.2 | 0.4 | 0.2 | 5.2 | 8.2 |
| Cordgrass | 0.0 | 0.7 | 0.4 | 0.7 | 0.2 | 0.8 | 0.1 | 0.3 |
| Pickleweed-Cordgrass Mix | 0.0 | 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 | 0.0 |
| Alkali Heath | 0.0 | 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 | 0.0 |
| Peripheral Halophytes | 0.0 | 0.0 | 0.2 | 0.5 | 0.8 | 1.4 | 0.1 | 0.2 |
| **Total Saline Dominant Species:** | **9.1** | **4.9** | **2.6** | **2.3** | **1.3** | **2.4** | **5.3** | **8.8** |
| Brackish Marsh Vegetation | | | | | | | | |
| Alkali Bulrush | 20.2 | 16.7 | 18.7 | 17.9 | 22.5 | 21.0 | 15.6 | 11.5 |
| Peppergrass | 0.0 | 7.8 | 7.4 | 8.9 | 6.1 | 9.8 | 9.6 | 10.2 |
| Spearscale | 0.0 | 0.0 | 0.0 | 0.3 | 0.7 | 0.2 | 0.1 | 0.0 |
| **Total Brackish Dominant Species:** | **20.2** | **24.5** | **26.1** | **27.2** | **29.2** | **31.0** | **25.2** | **21.7** |
| Freshwater Marsh Vegetation | | | | | | | | |
| California Bulrush | 0.0 | 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 | 0.0 |
| **Total Freshwater Dominant Species:** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Total Segment Acreage** | **29.3** | **29.4** | **28.7** | **29.5** | **30.5** | **33.4** | **30.6** | **30.5** |

Table D14. 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 | 2001 |
| Pickleweed | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 |
| Cordgrass | 0.0 | 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 | 0.0 |
| Pickleweed-Spearscale Mix | 0.0 | 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 | 0.0 |
| Gumplant | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Peripheral Halophytes | 0.0 | 0.0 | 2.1 | 1.1 | 0.0 | 0.0 | 0.0 | 0.4 |
| **Total Saline Dominant Species:** | **0.0** | **0.1** | **2.1** | **1.3** | **0.0** | **0.0** | **0.0** | **0.5** |
| Brackish Marsh Vegetation | | | | | | | | |
| Alkali Bulrush | 37.2 | 29.4 | 35.3 | 18.2 | 33.6 | 28.2 | 26.9 | 23.4 |
| Peppergrass | 11.0 | 14.8 | 5.7 | 4.0 | 0.9 | 12.3 | 11.5 | 16.2 |
| Spearscale | 0.0 | 0.0 | 0.0 | 18.4 | 5.7 | 0.9 | 2.1 | 1.1 |
| **Total Brackish Dominant Species:** | **48.2** | **44.2** | **41.0** | **40.6** | **40.2** | **41.4** | **40.4** | **40.7** |
| Freshwater Marsh Vegetation | | | | | | | | |
| California Bulrush | 0.0 | 0.0 | 0.3 | 0.7 | 0.7 | 3.4 | 3.7 | 3.4 |
| Cattail | 0.0 | 0.0 | 0.1 | 0.1 | 0.34 | 0.1 | 0.6 | 0.4 |
| **Total Freshwater Dominant Species:** | **0.0** | **0.0** | **0.4** | **0.9** | **1.04** | **3.5** | **4.3** | **3.8** |
| **Total Segment Acreage** | **48.2** | **44.2** | **45.1** | **43.3** | **41.24** | **54.8** | **44.7** | **45.1** |

Table D15. 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 | 2001 |
| Pickleweed | 0.0 | 1.8 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| Cordgrass | 0.0 | 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 | 0.0 |
| Pickleweed-Spearscale Mix | 0.0 | 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 | 0.0 |
| Gumplant | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Peripheral Halophytes | 3.3 | 0.0 | 0.0 | 1.1 | 2.1 | 1.8 | 0.0 | 0.0 |
| **Total Saline Dominant Species:** | **3.3** | **1.8** | **1.8** | **3.5** | **2.1** | **1.9** | **0.0** | **0.0** |
| Brackish Marsh Vegetation | | | | | | | | |
| Alkali Bulrush | 90.1 | 75.9 | 75.9 | 44.5 | 76.3 | 68.3 | 66.5 | 63.9 |
| Peppergrass | 8.8 | 18.9 | 18.9 | 21.1 | 11.7 | 28.4 | 29.4 | 29.0 |
| Spearscale | 0.0 | 0.0 | 0.0 | 26.6 | 11.3 | 0.0 | 1.8 | 0.3 |
| **Total Brackish Dominant Species:** | **98.9** | **94.8** | **94.8** | **92.2** | **99.3** | **96.7** | **97.8** | **93.2** |
| Freshwater Marsh Vegetation | | | | | | | | |
| California Bulrush | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.1 | 0.0 |
| Cattail | 0.0 | 0.0 | 0.0 | 0.5 | 0.7 | 0.2 | 1.2 | 0.9 |
| **Total Freshwater Dominant Species:** | **0.0** | **0.0** | **0.0** | **0.5** | **0.8** | **0.2** | **1.3** | **0.9** |
| **Total Segment Acreage** | **102.2** | **96.6** | **96.6** | **98.4** | **102.2** | **102.8** | **99.2** | **94.1** |

Table D16. 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 | 2001 |
| Pickleweed | 1.0 | 2.1 | 0.8 | 1.6 | 0.6 | 0.7 | 1.3 | 0.7 |
| Cordgrass | 0.0 | 0.0 | 0.0 | 0.2 | 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 | 0.0 |
| Pickleweed-Spearscale Mix | 0.0 | 0.0 | 0.9 | 0.1 | 1.3 | 0.0 | 0.0 | 0.0 |
| Alkali Heath | 0.0 | 0.3 | 0.2 | 0.3 | 0.1 | 0.1 | 0.2 | 0.0 |
| Gumplant | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Peripheral Halophytes | 0.0 | 0.0 | 0.6 | 1.7 | 1.3 | 2.1 | 1.0 | 1.1 |
| **Total Saline Dominant Species:** | **1.0** | **2.4** | **2.5** | **3.8** | **3.5** | **2.9** | **2.5** | **1.8** |
| Brackish Marsh Vegetation | | | | | | | | |
| Alkali Bulrush | 33.5 | 24.2 | 24.7 | 13.4 | 24.2 | 22.9 | 23.9 | 21.1 |
| Peppergrass | 3.3 | 8.2 | 7.2 | 4.4 | 2.3 | 8.3 | 6.2 | 10.4 |
| Spearscale | 0.0 | 0.0 | 0.0 | 12.1 | 3.7 | 1.3 | 1.5 | 0.2 |
| **Total Brackish Dominant Species:** | **36.8** | **32.4** | **31.9** | **29.8** | **30.3** | **32.5** | **31.7** | **31.6** |
| Freshwater Marsh Vegetation | | | | | | | | |
| California Bulrush | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.3 | 0.2 |
| Cattail | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.1 | 0.1 | 0.3 |
| Giant Reed | 0.0 | 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** | **0.5** |
| **Total Segment Acreage** | **37.8** | **33.8** | **38.7** | **36.8** | **34.1** | **38.3** | **34.5** | **33.9** |

Table D17. 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 | 2001 |
| Pickleweed | 7.0 | 11.3 | 2.6 | 2.1 | 0.7 | 1.0 | 2.7 | 10.4 |
| Cordgrass | 0.0 | 2.0 | 1.8 | 0.7 | 0.1 | 0.5 | 0.0 | 0.0 |
| Pickleweed-Cordgrass Mix | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 |
| Pickleweed-Spearscale Mix | 0.0 | 0.0 | 0.6 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 |
| Alkali Heath | 0.0 | 0.4 | 0.2 | 0.3 | 0.0 | 0.1 | 0.2 | 0.0 |
| Gumplant | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Peripheral Halophytes | 0.0 | 0.5 | 1.5 | 2.8 | 3.6 | 3.8 | 3.1 | 2.7 |
| **Total Saline Dominant Species:** | **7.0** | **14.2** | **6.7** | **6.0** | **4.4** | **5.6** | **6.0** | **13.1** |
| Brackish Marsh Vegetation | | | | | | | | |
| Alkali Bulrush | 29.9 | 22.1 | 31.4 | 24.7 | 30.01 | 29.8 | 27.4 | 17.7 |
| Peppergrass | 0.5 | 1.1 | 1.7 | 1.2 | 0.9 | 2.0 | 2.3 | 2.2 |
| Spearscale | 0.0 | 0.0 | 0.0 | 4.2 | 0.85 | 0.1 | 0.0 | 0.0 |
| **Total Brackish Dominant Species:** | **30.4** | **23.2** | **33.1** | **30.1** | **31.85** | **31.9** | **29.7** | **19.9** |
| Freshwater Marsh Vegetation | | | | | | | | |
| California Bulrush | 0.0 | 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 | 0.0 |
| **Total Freshwater Dominant Species:** | **0.0** | **0.0** | **0.0** | **0.2** | **0.0** | **0.6** | **0.6** | **0.0** |
| **Total Segment Acreage** | **37.4** | **37.1** | **40.8** | **36.2** | **36.25** | **38.4** | **36.3** | **33.0** |

Table D18. 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 | 2001 |
| Pickleweed | 30.8 | 31.2 | 18.6 | 18.2 | 14.6 | 14.4 | 13.6 | 18.0 |
| Cordgrass | 2.4 | 6.0 | 5.0 | 4.7 | 2.7 | 2.6 | 1.7 | 1.6 |
| Pickleweed-Cordgrass Mix | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 |
| Pickleweed-Spearscale Mix | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.0 | 0.0 | 0.0 |
| Alkali Heath | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.0 | 0.3 | 0.1 |
| Gumplant | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Peripheral Halophytes | 0.0 | 0.0 | 1.6 | 1.4 | 3.3 | 1.9 | 1.3 | 1.3 |
| **Total Saline Dominant Species:** | **33.2** | **37.2** | **25.2** | **24.5** | **20.9** | **18.9** | **16.9** | **21.6** |
| Brackish Marsh Vegetation | | | | | | | | |
| Alkali Bulrush | 26.5 | 17.0 | 28.9 | 33.1 | 36.4 | 37.9 | 36.8 | 31.4 |
| Peppergrass | 1.9 | 3.3 | 2.5 | 3.3 | 3.3 | 6.7 | 7.2 | 6.6 |
| Spearscale | 0.0 | 0.0 | 0.0 | 0.1 | 2.1 | 0.1 | 0.1 | 0.1 |
| **Total Brackish Dominant Species:** | **28.4** | **20.3** | **31.4** | **36.5** | **41.8** | **44.7** | **44.0** | **38.2** |
| Freshwater Marsh Vegetation | | | | | | | | |
| California Bulrush | 0.0 | 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 | 0.0 |
| **Total Freshwater Dominant Species:** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Total Segment Acreage** | **61.6** | **57.5** | **56.7** | **61.1** | **62.7** | **63.6** | **61.0** | **59.7** |

Table D19. 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 | 2001 |
| Pickleweed | 2.7 | 7.0 | 2.9 | 2.2 | 1.1 | 1.0 | 3.6 | 4.6 |
| Cordgrass | 0.5 | 0.4 | 0.3 | 0.4 | 0.3 | 0.2 | 0.1 | 0.1 |
| Pickleweed-Cordgrass Mix | 0.0 | 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 | 0.0 |
| Alkali Heath | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| Gumplant | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Peripheral Halophytes | 0.0 | 3.6 | 0.4 | 0.3 | 1.2 | 0.9 | 1.9 | 1.4 |
| **Total Saline Dominant Species:** | **3.2** | **11.0** | **3.6** | **2.9** | **2.7** | **2.1** | **5.6** | **6.1** |
| Brackish Marsh Vegetation | | | | | | | | |
| Alkali Bulrush | 19.8 | 15.1 | 18.6 | 17.6 | 20.6 | 20.5 | 18.4 | 14.9 |
| Peppergrass | 2.9 | 3.7 | 4.1 | 5.3 | 3.4 | 6.2 | 5.1 | 0.1 |
| Spearscale | 0.0 | 0.0 | 0.0 | 0.8 | 1.0 | 0.2 | 0.0 | 0.0 |
| **Total Brackish Dominant Species:** | **22.7** | **18.8** | **22.7** | **23.7** | **24.9** | **26.9** | **23.5** | **15.0** |
| Freshwater Marsh Vegetation | | | | | | | | |
| California Bulrush | 0.0 | 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 | 0.0 |
| **Total Freshwater Dominant Species:** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Total Segment Acreage** | **25.9** | **29.8** | **26.7** | **26.7** | **27.6** | **29.0** | **29.1** | **21.1** |

Table D20. 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 | 2001 |
| Pickleweed | 7.5 | 6.1 | 7.3 | 6.1 | 5.2 | 5.0 | 5.5 | 4.9 |
| Cordgrass | 2.7 | 3.9 | 2.8 | 3.8 | 3.5 | 4.7 | 2.3 | 4.1 |
| Pickleweed-Cordgrass Mix | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| Pickleweed-Spearscale Mix | 0.0 | 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 | 0.0 |
| Gumplant | 0.0 | 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 | 0.0 |
| **Total Saline Dominant Species:** | **10.6** | **10.0** | **10.6** | **10.9** | **9.9** | **10.7** | **8.7** | **9.0** |
| Brackish Marsh Vegetation | | | | | | | | |
| Alkali Bulrush | 0.0 | 0.0 | 0.2 | 1.0 | 2.9 | 2.7 | 4.6 | 2.3 |
| Peppergrass | 0.0 | 0.2 | 0.4 | 0.0 | 0.0 | 0.6 | 0.7 | 3.6 |
| Spearscale | 0.0 | 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** | **6.0** |
| Freshwater Marsh Vegetation | | | | | | | | |
| California Bulrush | 0.0 | 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 | 0.0 |
| **Total Freshwater Dominant Species:** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** | **0.0** |
| **Total Segment Acreage** | **10.6** | **10.2** | **11.2** | **11.9** | **12.8** | **14.1** | **14.1** | **14.9** |

Table D21. 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 | 8.8 | 14.1 | 14.1 | 11.1 | 10.2 | 10.2 | 10.9 |
| Cordgrass | 7.9 | 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 | 1.9 | 0.0 | 0.8 | 1.4 | 1.7 | 1.5 | 1.7 |
| **Total Saline Dominant Species:** | **18.6** | **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** | **18.6** | **17.8** | **21.2** | **17.7** | **18.1** | **19.8** | **20.1** |

Table D22. 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 | 2001 |
| Pickleweed | 0.8 | 0.2 | 0.6 | 0.6 | 0.2 | 1.3 | 0.6 |
| 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 | 0.0 | 0.0 | 0.0 | 0.0 |
| Gumplant | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Peripheral Halophytes | 1.5 | 2.2 | 0.7 | 0.8 | 0.5 | 1.0 | 0.0 |
| **Total Saline Dominant Species:** | **2.3** | **2.4** | **1.3** | **1.4** | **0.7** | **2.3** | **0.6** |
| Brackish Marsh Vegetation | | | | | | | |
| Alkali Bulrush | 1.5 | 2.0 | 1.8 | 2.2 | 2.4 | 2.7 | 2.0 |
| Peppergrass | 7.0 | 6.0 | 5.7 | 5.12 | 7.1 | 4.6 | 7.5 |
| Spearscale | 0.0 | 0.0 | 0.0 | 0.5 | 0.1 | 0.1 | 0.0 |
| **Total Brackish Dominant Species:** | **8.5** | **8.0** | **7.5** | **7.82** | **9.6** | **7.4** | **9.5** |
| Freshwater Marsh Vegetation | | | | | | | |
| California Bulrush | 1.4 | 1.6 | 1.9 | 2.0 | 2.6 | 2.8 | 2.2 |
| Cattail | 0.0 | 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** | **2.2** |
| **Total Segment Acreage** | **20.2** | **12.1** | **10.7** | **11.2** | **12.9** | **12.4** | **12.3** |

*** Segment 24 not mapped in 1989**

Table D23. 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 | 2001 |
| Pickleweed | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 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 | 0.0 | 0.0 | 0.0 | 0.0 |
| Gumplant | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Peripheral Halophytes | 5.3 | 4.0 | 2.6 | 4.21 | 1.0 | 0.0 | 0.0 |
| **Total Saline Dominant Species:** | **5.3** | **4.0** | **2.6** | **4.21** | **1.0** | **0.1** | **0.0** |
| Brackish Marsh Vegetation | | | | | | | |
| Alkali Bulrush | 2.9 | 4.3 | 3.4 | 5.56 | 5.8 | 6.5 | 4.9 |
| Peppergrass | 10.4 | 7.7 | 6.5 | 3.43 | 7.6 | 7.1 | 8.8 |
| Spearscale | 0.0 | 0.0 | 0.3 | 0.47 | 0.1 | 0.1 | 0.0 |
| **Total Brackish Dominant Species:** | **13.3** | **12.0** | **10.3** | **9.46** | **13.5** | **13.7** | **13.7** |
| Freshwater Marsh Vegetation | | | | | | | |
| California Bulrush | 29.8 | 30.3 | 31.3 | 36.11 | 38.6 | 36.2 | 35.9 |
| Cattail | 0.2 | 0.8 | 1.5 | 1.35 | 2.0 | 1.3 | 2.1 |
| Knotweed | 0.0 | 0.0 | 0.0 | 0.14 | 0.0 | 0.0 | 0.0 |
| **Total Freshwater Dominant Species:** | **30.0** | **31.1** | **32.8** | **37.6** | **40.6** | **37.5** | **38.0** |
| **Total Segment Acreage** | **48.6** | **47.2** | **46.2** | **51.27** | **55.3** | **51.3** | **51.7** |

***Segment 25 not mapped in 1989**

Table D24. 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 | 2001 |
| Pickleweed | 0.0 | 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 | 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 | 0.0 |
| Gumplant | 0.0 | 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 | 0.0 |
| **Total Saline Dominant Species:** | **1.3** | **1.3** | **0.8** | **0.1** | **0.0** | **0.1** | 0.0 |
| Brackish Marsh Vegetation | | | | | | | |
| Alkali Bulrush | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Peppergrass | 2.5 | 2.6 | 0.6 | 0.2 | 2.9 | 3.3 | 0.5 |
| Spearscale | 0.0 | 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** | **0.5** |
| Freshwater Marsh Vegetation | | | | | | | |
| California Bulrush | 17.8 | 18.7 | 17.5 | 18.8 | 18.0 | 18.4 | 18.4 |
| Cattail | 0.1 | 0.2 | 0.4 | 0.3 | 0.1 | 1.0 | 0.6 |
| Knotweed | 0.0 | 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** | **19.0** |
| **Total Segment Acreage** | **23.7** | **23.1** | **23.0** | **19.4** | **23.7** | **22.8** | **19.5** |

***Segment 26 not mapped in 1989**

Table D25. Acreage Summary of Segment 27* for 1996, 1997, 1998, 1999 and 2000.

**DOMINANT SPECIES CATEGORY**

| | Year | | | | | |
|---|---|---|---|---|---|---|
| Saline Marsh Vegetation | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
| Pickleweed | 0.0 | 0.9 | 0.0 | 0.0 | 0.9 | 1.0 |
| Cordgrass | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Peripheral Halophytes | 1.0 | 2.1 | 2.3 | 0.0 | 0.3 | 0.0 |
| **Total Saline Dominant Species:** | **1.0** | **3.0** | **2.3** | **0.0** | **1.2** | **1.0** |
| Brackish Marsh Vegetation | | | | | | |
| Alkali Bulrush | 11.4 | 9.1 | 8.9 | 7.4 | 7.7 | 7.4 |
| Peppergrass | 0.6 | 1.7 | 0.1 | 1.2 | 1.9 | 1.2 |
| Spearscale** | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 |
| **Total Brackish Dominant Species:** | **12.0** | **10.8** | **9.1** | **8.6** | **9.6** | **8.6** |
| Freshwater Marsh Vegetation | | | | | | |
| California Bulrush | 3.3 | 4.4 | 6.7 | 4.7 | 5.8 | 6.2 |
| Cattail | 7.6 | 7.8 | 8.4 | 10.8 | 9.8 | 9.5 |
| **Total Freshwater Dominant Species:** | **10.9** | **12.2** | **15.2** | **15.5** | **15.6** | **15.8** |
| **Total Segment Acreage** | **35.0** | **35.7** | **35.7** | **24.1** | **26.5** | **25.4** |

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

**Not a Dominant Species Category in 1996

Table D26. 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 | 2001 |
| Pickleweed | 0.0 | 0.5 | 0.2 | 0.1 | 0.1 | 0.0 | 0.1 |
| Cordgrass | 8.6 | 1.6 | 1.8 | 0.8 | 0.0 | 0.0 | 1.1 |
| Peripheral Halophytes | 0.0 | 0.3 | 1.4 | 4.0 | 3.4 | 1.6 | 0.6 |
| Total Saline Dominant Species: | **8.6** | **2.4** | **3.4** | **4.8** | **3.5** | **1.6** | **1.8** |
| Brackish Marsh Vegetation | | | | | | | |
| Alkali Bulrush | 47.7 | 53.7 | 49.8 | 61.9 | 57.0 | 55.8 | 59.2 |
| Peppergrass | 8.3 | 9.9 | 15.8 | 2.2 | 10.2 | 13.6 | 9.0 |
| Spearscale** | 0.0 | 0.0 | 0.1 | 0.2 | 0.0 | 0.1 | 0.0 |
| Total Brackish Dominant Species: | **56.0** | **63.5** | **65.7** | **64.3** | **67.2** | **69.5** | **68.3** |
| Freshwater Marsh Vegetation | | | | | | | |
| California Bulrush | 0.3 | 10.5 | 9.1 | 15.5 | 15.6 | 15.1 | 9.4 |
| Cattail | 0.0 | 0.3 | 0.4 | 0.5 | 0.6 | 0.5 | 1.4 |
| **Total Freshwater Dominant Species:** | **0.3** | **10.8** | **9.5** | **16.0** | **16.2** | **15.6** | **10.8** |
| **Total Segment Acreage** | **64.9** | **77.8** | **78.9** | **85.7** | **90.3** | **86.9** | **80.9** |

***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 | 2001 |
| Pickleweed | 20.1 | 14.8 | 12.1 | 9.0 | 9.3 | 6.6 | 8.0 |
| Cordgrass | 14.3 | 5.6 | 6.8 | 4.6 | 2.3 | 1.7 | 5.7 |
| Peripheral Halophytes | 0.0 | 2.2 | 4.3 | 5.8 | 5.6 | 4.4 | 0.0 |
| **Total Saline Dominant Species:** | **34.4** | **22.5** | **23.2** | **19.4** | **17.2** | **12.7** | **13.6** |
| Brackish Marsh Vegetation | | | | | | | |
| Alkali Bulrush | 24.6 | 48.4 | 47.2 | 58.7 | 65.5 | 62.2 | 61.6 |
| Peppergrass | 10.8 | 10.0 | 9.5 | 3.9 | 11.0 | 13.3 | 13.2 |
| Spearscale** | 0.0 | 0.0 | 0.3 | 0.1 | 0.1 | 0.0 | 0.0 |
| **Total Brackish Dominant Species:** | **35.4** | **58.3** | **57.0** | **62.6** | **76.6** | **75.5** | **74.8** |
| Freshwater Marsh Vegetation | | | | | | | |
| California Bulrush | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.4 | 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** | **0.3** | **0.4** | **0.0** |
| **Total Segment Acreage** | **69.8** | **81.1** | **80.6** | **82.0** | **94.3** | **88.6** | **88.5** |

***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 | 2001 |
| Pickleweed | 23.5 | 26.5 | 23.1 | 19.7 | 21.0 | 24.7 | 26.4 |
| Cordgrass | 15.5 | 8.0 | 9.8 | 10.7 | 13.0 | 3.3 | 12.3 |
| Pickleweed-Cordgrass Mix | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 |
| Alkali Heath | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 |
| Saltgrass | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.3 | 0.0 |
| Peripheral Halophytes | 3.1 | 1.5 | 2.6 | 2.9 | 3.7 | 2.5 | 0.3 |
| **Total Saline Dominant Species:** | **42.1** | **36.0** | **35.5** | **33.3** | **37.7** | **32.9** | **39.1** |
| Brackish Marsh Vegetation | | | | | | | |
| Alkali Bulrush | 0.0 | 1.5 | 1.7 | 6.5 | 5.5 | 11.6 | 4.3 |
| Peppergrass | 1.3 | 2.0 | 0.0 | 0.0 | 0.0 | 1.1 | 3.3 |
| Spearscale** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total Brackish Dominant Species:** | **1.3** | **3.4** | **1.7** | **6.5** | **5.5** | **12.7** | **7.6** |
| 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** | **43.4** | **39.4** | **37.7** | **40.8** | **46.8** | **45.7** | **46.7** |

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

**Not a Dominant Species Category in 1996

**APPENDIX E.**
**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. | | |

**APPENDIX F.**
**DOMINANT SPECIES CATEGORIES, MARSH TYPE,**
**AND**
**VEGETATION ASSOCIATIONS FOR 1989 AND 2001.**

| | HABITAT TYPE | VEGETATION ASSOCIATIONS | |
|---|---|---|---|
| | | 1989 | 2001 |
| Cordgrass | Salt | Cordgrass | Cordgrass<br>Cordgrass/Spearscale<br>Cordgrass/Alkali Bulrush<br>Cordgrass/Pickleweed<br>Cordgrass/Saltgrass |
| Pickleweed | Salt | Pickleweed<br>Pickleweed, Alkali Heath, Fat Hen | Pickleweed<br>Pickleweed/Spearscale<br>Pickleweed/Cordgrass<br>Pickleweed/Peppergrass<br>Pickleweed/Alkali Bulrush<br>Pickleweed/Saltgrass<br>Pickleweed/Gumplant<br>Pickleweed/Alkali Heath |
| Pickleweed-Cordgrass Mix | Salt | • | Pickleweed-Cordgrass Mix |
| Alkali Heath | Salt | • | Alkali Heath<br>Alkali Heath/Alkali Bulrush<br>Alkali Heath/Peppergrass<br>Alkali Heath/Spearscale |
| Gumplant | Salt | • | Gumplant<br>Gumplant/Cordgrass<br>Gumplant/Pickleweed<br>Gumplant/Peppergrass |
| Saltgrass | Salt | • | Saltgrass |
| | | | Saltgrass/Pickleweed |
| Saltgrass-Gumplant Mix | Salt | • | Saltgrass-Gumplant Mix |
| Jaumea | Salt | • | Jaumea |
| Peripheral Halophytes | Salt | Fat Hen, Alkali Heath | Peripheral Halophytes |
| | | | Peripheral Halophytes/Peppergrass<br>Peripheral Halophytes/Upland Species<br>Russian Thistle<br>Russian Thistle/Saltgrass |
| Alkali Bulrush | Brackish | Alkali Bulrush | Alkali Bulrush<br>Alkali Bulrush/Pickleweed<br>Alkali Bulrush/Peppergrass<br>Alkali Bulrush/Spearscale<br>Alkali Bulrush/Cordgrass<br>Alkali Bulrush/California Bulrush |

| | | | |
|---|---|---|---|
| | | | Alkali Bulrush/Cattail |
| Peppergrass | Brackish | Peppergrass | Peppergrass<br>Peppergrass/Pickleweed<br>Peppergrass/Alkali Bulrush<br>Peppergrass/Spearscale |
| | | | Peppergrass/Peripheral Halophytes<br>Peppergrass/California Bulrush<br>Peppergrass/Upland Species |
| Spearscale | Brackish | • | Spearscale<br>Spearscale/Pickleweed<br>Spearscale/lkali Bulrush<br>Spearscale/Peppergrass<br>Spearscale/Peripheral Halophytes |
| California Bulrush | Fresh | • | California Bulrush<br>California Bulrush/Knotweed<br>California Bulrush/Cattail<br>California Bulrush/Alkali Bulrush<br>California Bulrush/Peppergrass |
| Cattail | Fresh | • | Cattail<br>Cattail/California Bulrush |
| | | | Cattail/Alkali Bulrush |
| Knotweed | Fresh | • | Knotweed<br>Knotweed/California Bulrush |
| Giant Reed | Fresh | • | Giant Reed |

• Not a Dominant Species Category in Analysis Year