

**2012
Vegetation Map Update For
Suisun Marsh,
Solano County, California**

A Report to the California Department of Water Resources

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**Prepared by:
Vegetation Classification and Mapping Program
Biogeographic Data Branch
California Department of Fish & Wildlife**



**Rachelle Boul, Vegetation Ecologist
Todd Keeler-Wolf, Senior Vegetation Ecologist**



Executive Summary

This report summarizes the methods and results of the 2012 Suisun Marsh triennial vegetation map update. This is part of an ongoing monitoring project that the Biogeographic Data Branch (BDB) of the California Department of Fish and Wildlife (CDFW), in collaboration with the Department of Water Resources (DWR) and the CDFW Bay Delta Region (BDR), started in 1961 to track changes in the Suisun Marsh vegetation over time and to fulfill specific permit requirements, the Suisun Marsh Plan of Protection (1984), and the Suisun Marsh Preservation Agreement (1986). This is the fifth update using the current mapping standards that were originally implemented 1999. All of the vegetation maps (starting with the 1999 map), including the 2012 map on which this report is based, can be viewed and downloaded using the online CDFW Biogeographic Information and Observation System (BIOS) and the links to the associated reports included in the metadata. The reports can also be downloaded from the CDFW website ([here](#)). For more detailed information regarding the history and evolution of this project see Appendix A.

The final 2012 vegetation map contains 20,629 polygons covering 69,259 acres. The polygons range from 0.006 acres to 3,062 acres and average 3.36 acres. A total of 2,696 vegetation polygons covering 9,389 acres are tidally influenced and 17,922 polygons covering 56,536 acres are not naturally affected by tide.

Using the primary and secondary Salt Marsh Harvest Mouse (SMHM) habitat types listed in the Bay Delta Conservation Plan (California Department of Water Resources 2013) as the potential habitat for SMHM, the 2012 triennial vegetation update suggests that there are 47,901 acres of potential habitat in Suisun Marsh. Over 80% of this habitat is within the leveed areas of the Marsh, which have seen a 2.4% decrease in potential habitat since 1999. A 2.4–10% decrease in potential habitat can be seen in three of the four management regions. Region 3, the exception, showed a 6.1% habitat increase. The tidal areas of the Marsh have seen a considerable increase in potential SMHM habitat since 1999, marsh-wide (a 30.5% increase) and within all four management regions (between 20–37% increase).

Although this mapping effort does not distinguish between the native and non-native forms, the 2012 map suggests that the expansion of *Phragmites australis* is the largest threat to native species diversity in Suisun Marsh. *Phragmites australis* has increased more than threefold since 1999, expanding by at least 15% every three years. More than 50% of the *P. australis* occurs in management region 4. Stands dominated by *Lepidium latifolium* have shown a marsh-wide

decrease in total acreage since 1999, but show a 63% increase in the tidal habitats of the Marsh. *Arundo donax*, *Carpobrotus edulis*, and *Cortaderia selloana* have remained fairly stable, having increased by only one acre or, in the case of *Cortaderia selloana*, actually decreasing in coverage since 1999. The varying results for *Centaurea* spp., *Conium maculatum*, and *Foeniculum vulgare* have lead us to question the interpretability of these vegetation types within the Marsh. It is important to note that 2012 was the first year in which the invasive *Salsola soda* was mapped in the Marsh.

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Introduction

Background

The Suisun Marsh is located in Solano County, CA and is part of the San Francisco Bay/ Sacramento–San Joaquin River Delta estuary ecosystem (Figure 1). It is one of the largest contiguous brackish marshes remaining in the United States, covering over 69,000 acres of tidal and managed seasonal wetlands. This Marsh is a key wintering area for waterfowl and supports a number of sensitive plant and animal species.



Figure 1: The location of the Suisun Marsh study area. The Marsh is situated in the northeastern reaches of San Francisco Bay, just west of the Delta, in Solano County.

As part of the monitoring program in the Plan of Protection for Suisun Marsh and as required in the 1981 US Fish and Wildlife Service Biological opinion, a Triennial Vegetation Survey is necessary to monitor changes in Salt Marsh Harvest Mouse

(SMHM) habitat. The current methodology for this survey was adopted in 1999 (Keeler-Wolf et al. 2000) and uses aerial photography in combination with ground verification to document the overall vegetation composition of the Marsh and to monitor SMHM habitat. The survey methodology is designed to meet the goal of documenting changes in preferred habitat for the SMHM as well as to gather vegetation information to be used for a variety of other purposes. These may include correlating management activities with vegetation changes, gathering data to support the use of a GIS format that will allow queries and overlaying of additional information, and creation of a base map for future studies. This methodology is based on work by the Department of Fish and Wildlife, Vegetation Classification and Mapping Program (VegCAMP) and has been widely used throughout the state. The updated methodologies also led to the creation of an updated vegetation classification which was based on quantitative vegetation sampling and followed the National Vegetation Classification (NVC) standards (Appendix B). The vegetation classification was then used to create a vegetation key (Appendix C) and a mapping classification (Appendix D). While the mapping classification is based on the vegetation classification, the mapping classification is limited by what is discernable from the aerial imagery. It also includes mapping units that are not currently accepted NVC vegetation types and mapping units that represent land use or non-vegetated types. Since the 1999 map was produced, there have been updates in 2000, 2003, 2006, and 2009. This report documents changes based on the 2012 vegetation map update.

The 2000 remap effort (Vaghti and Keeler-Wolf 2001) was an exploratory change detection study designed to define significant change for vegetation in the Suisun Marsh ecosystem. Less than 1% of the polygons were shown to have changed between June 16, 1999 and July 2, 2000. These minor changes included a net loss of 65 acres for *Salicornia pacifica* vegetation types, an 18 acre increase in vegetation dominated by *Lepidium latifolium*, and a 143 acre decrease in Annual Grasses. From this exploratory change detection it was determined that the map update process would occur every three years. For more information see the 2000 Suisun Marsh Vegetation Mapping Change Detection report, which can be found [here](#).

The 2003 remap effort (Vaghti and Keeler-Wolf 2004) showed a 16.8% change in the vegetation across the entire study area since the 1999 product. Medium Wetland Graminoids, *Bolboschoenus maritimus*, Short Wetland Herbs, Medium Wetland Herbs, and *Bolboschoenus maritimus* – *Salicornia pacifica* were the five types with the greatest increase in acreage. *Distichlis spicata*, *Salicornia*, *Distichlis spicata* – Annual Grasses, *Distichlis spicata* – *Salicornia pacifica*, and Open Water were the five types with the greatest decrease in acreage over the study period. Also determined was a 16.7% change in leveed wetland vegetation and a 17.2% change in tidal wetland vegetation.

The 2003 Suisun Marsh Vegetation Mapping Change Detection report can be found [here](#)

The 2006 remap study (Boul and Keeler-Wolf 2008) used the 1999 vegetation map as the baseline and followed the 2000 and 2003 change detection methodology. Several vegetation changes found in this 2006 update are of note: 1) the 174% increase in flooded wetlands (due to severe storms resulting in levee breaches), 2) the net loss of 945 acres of *Salicornia pacifica* vegetation types since 1999, 3) the net gain of 780 acres of *Phragmites australis* since 1999, 580 acres of which have been established since 2003, and 4) the acreage decrease or stabilization of several of the non-native species of concern. The 2006 Vegetation Map Update report can be found [here](#). Several issues with the remapping process and change detection protocol were brought to light and VegCAMP suggested that changes to the protocol be made and implemented for the 2009 vegetation remap (Appendix A).

The 2009 remap study (VegCAMP 2012) used an updated protocol (also used for this 2012 vegetation remap) developed to accommodate advances in available technology and mitigate for past inconsistencies (Appendix A). The 2009 remap showed that potential Salt Marsh Harvest Mouse habitat (*Salicornia pacifica* dominated vegetation) had increased since 1999 and that two non-native species of concern, *Phragmites australis* and *Lepidium latifolium*, were still increasing within the Marsh. Interestingly, in the leveed areas of the Marsh, both *Phragmites australis* and *Salicornia pacifica* vegetation seemed to be increasing the most where, in 2006, there had been open water. The 2009 Vegetation Map Update report can be found [here](#).

2012 Methods

2012 Field Data Collection

There was a large field effort for this mapping cycle that included the collection of 320 reconnaissance points that captured data for 564 vegetation polygons (see Appendix E for a sample of the Reconnaissance Field Form and Protocol). The 2012 effort also marked the second permanent plot resample since the original plots were sampled in 1999 (the first resample was in 2006). Of the original 198 permanent field plots, 98 were resampled this cycle (VegCAMP 2014). In total, the field data collected in 2012 provided information for over 4.5% (or 3,146 acres) of the total mapping area. All of the data were collected between July and September of 2012.

Spatial accuracy in the 2012 aerial images

In 2009, staff from the DWR's Mapping & Photogrammetry Section measured the positions of permanent residual features identified both in photographs and on the ground using Garmin 76CSx handheld GPS units. The published accuracy for these units is typically less than 5 meters. A total of 51 control points were measured and used to process the 2009 imagery, which resulted in an ortho-mosaic that closely agreed with NAIP digital orthorectified quarter quadrangle (DOQQ) aerial photography. The same method and control points were used to process the 2012 imagery in order to produce vegetation maps that are spatially comparable. Refer to VegCAMP (2012) for a complete description of the methods used for improving the spatial accuracy of the imagery.

2012 Aerial Photograph Interpretation and heads-up-digitizing

To create the 2012 Suisun Marsh vegetation map, vegetation was interpreted from the true color imagery that was flown at 1:9600 on June 19, 2012 and delivered to VegCAMP in January 2013. Polygons were delineated using heads-up digitizing (i.e., a photo interpreter manually drew polygons around each stand of vegetation) in ArcMAP 10.1 and polygon attributes were recorded within a personal geodatabase.

Mapping Rules and Attributes

All attributes were interpreted using the Suisun Marsh 2012 imagery as the base imagery.

The photo interpreters did, however, use all available ancillary information to make the best decision for each attribute. Information was obtained from sources such as field surveys, reconnaissance points, and field photos from all mapping years. Several other imagery sources were used as ancillary data, including the 2012 NAIP, 2012 NAIP CIR, all imagery available through Google Earth, Bing, and Digital Globe, and the 1999, 2003, 2006, and 2009 Suisun Marsh imagery. The 2009 Suisun Marsh vegetation map was also referenced often.

Mapping Rules

Minimum mapping unit (mmu): Typically the minimum mapping size is 0.25 acre. However, the photo interpreters use their best judgment to determine if a polygon below 0.25 acres was worthy of delineation. A new occurrence of any non-native species of concern, such as *Phragmites australis*, *Arundo donax*, *Carpobrotus edulis*, *Eucalyptus* spp., and *Lepidium latifolium*, would be an example of when a polygon smaller than 0.25 acre would be appropriate.

Minimum mapping width: There are many long narrow polygons within the Suisun Marsh study area, most of which are roads, ditches, levees and sloughs. The minimum mapping width is typically 10 feet; however, if small sections of a polygon fall below the minimum width, the polygon would not be split.

Map Attributes

The vegetation mapping classification used for this project is based on the vegetation classification created in 1999 (Keeler-Wolf et al. 2000) (Appendix B). The names of the mapping units have been updated over the years to reflect current nomenclature and/or current understanding of vegetation classification. See Appendix D for a list of all the mapping types and a crosswalk of the various iterations since 1999. In addition to the mapping unit, several other attributes were assigned to each polygon, including: percent vegetation cover, average vegetation height, degree of human disturbance, method of interpretation, habitat, and management region. For more information about each attribute, see Appendix F.

Methods for Analysis

As requested by DWR and with Bay-Delta Region (BDR) agreement, the vegetation within Suisun Marsh was broken into two different categories; leveed wetlands and tidal

wetlands. Tidal wetlands (including muted tidal wetlands) are those areas naturally affected by regular tidal fluctuation. These areas may or may not be vegetated with vascular or non-vascular plants, and may or may not have any evidence of human modification such as ditches, excavations, interrupted levees or berms, etc. The leveed wetlands are those areas that are completely enclosed and are totally restricted from natural tidal influence.

To determine the areas within the Marsh that are tidally influenced versus areas that are leveed (or managed), the habitat shapefile (Suisun_Regions_habitats_ver2) that was created by CDFW in 2008 was used as a reference. This file was created using the Bay Area Aquatic Resources Inventory (BAARI) Basemap (SFEI 2011) from the San Francisco Estuary Institute (SFEI) (see metadata [here](#)) and is updated with input from CDFW and SRCD staff familiar with Suisun Marsh each map year to make it as current as possible. However, due to its coarse scale and poor spatial accuracy, a simple spatial analysis in ArcMap 10.1 cannot be performed. Rather, we decided that a cleaner approach would be to include the “habitat” distinction as an attribute for each polygon. To determine the tidal areas in 2012, the polygons that were contained completely within the “tidal” habitat polygons from the 2008 CDFW shapefile were given the habitat attribute “tidal”. Those polygons that intersected the outline of the “tidal” habitat polygons from the 2008 CDFW Suisun_Regions_habitats_ver2 shapefile were examined by the photo interpreter to determine if they were tidally influenced or leveed and were attributed accordingly. Sloughs were attributed separately as “sloughs.” All remaining polygons were considered leveed and therefore given a habitat attribute “leveed.” The same procedure was applied to the 1999 and 2009 vegetation maps in order to compare them to the 2012 map.

Suisun Marsh is also broken up geographically into four management regions (Figure 2). These regions are described in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan and were received by VegCAMP from the CDFW Water Branch in the form of a shapefile. Much like the habitat shapefile, the management region shapefile was drawn at a coarse scale with poor spatial accuracy. Therefore, a combination of spatial queries and photo interpretation was performed to accurately attribute each polygon with the correct management region in which it resides.

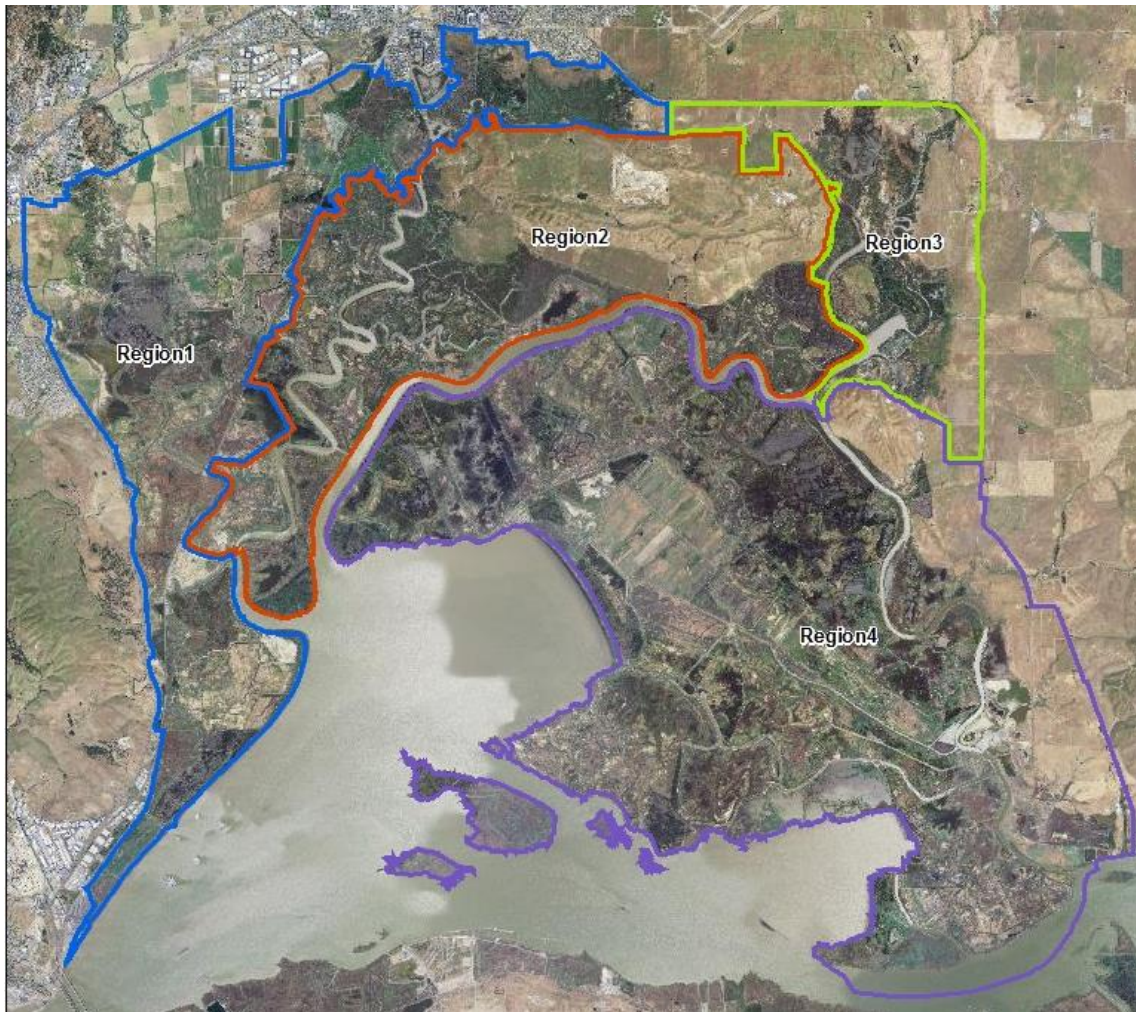


Figure 2: Suisun Marsh in Solano County, California showing the four management regions.

The polygons were analyzed for changes that occurred between 1999 and 2012, and 2009 and 2012 for the ten non-native stand-forming species of concern (e.g., species that when dominant can be mapped as semi-natural vegetation as per Sawyer et al. 2009). The analysis was performed marsh-wide (total area, leveed areas, and tidal areas) and within the four management regions (total area, leveed habitats, and tidal habitats) (Figure 2). The ten non-native species of concern are as follows: *Arundo donax*, *Carpobrotus edulis*, *Centaurea solstitialis*, *Conium maculatum*, *Cortaderia selloana*, *Eucalyptus* species, *Foeniculum vulgare*, *Lepidium latifolium*, *Phragmites australis* (presumably the non-native strain), and *Salsola soda* (see sidebar). These species are represented by 19 vegetation mapping units where at least one of these species occurs as dominant or co-dominant. These mapping units (mu) are: (102) *Arundo donax* Association; (421) *Carpobrotus edulis* Alliance; (413) *Centaurea (solstitialis, melitensis)* Alliance; (402) *Conium maculatum* Association; (133) *Juncus*

arcticus var. *balticus* – *Conium maculatum* Association; (202) *Cortaderia (jubata, selloana)* Alliance; (800) *Eucalyptus (globulus, camaldulensis)* Alliance; (801) *Eucalyptus globulus* Association; (403) *Foeniculum vulgare* Association; (324) *Lepidium latifolium* Alliance; (323) *Lepidium latifolium* – *Distichlis spicata* Association; (127) *Schoenoplectus americanus* – *Lepidium latifolium* Association; (134) *Juncus arcticus* var. *balticus* – *Lepidium latifolium* Association; (220) *Festuca perennis* – *Lepidium latifolium* Association; (103) *Phragmites australis* Association; (104) *Phragmites australis* – *Schoenoplectus* spp. Association; (105) *Phragmites australis* – *Xanthium strumarium* Mapping Unit; (129) *Typha (angustifolia, latifolia, domingensis)* – *Phragmites australis* Association; (366) *Salsola soda* Mapping Unit.

Salsola soda

This weed has a [California Invasive Plant Council Inventory rating of Moderate](#), although marsh managers have seen an alarming increase of this species in some areas in recent years. It is a tenacious, invasive, exotic species of concern that has only recently shown up in Suisun Marsh. It's possible that very small patches of this species were present in the marsh before the 2012 vegetation remap, but 2012 was the first year that it was field sampled, positively identified, and formed obvious mappable stands. It is important to track the movement and expansion of this species.

At the time of the 2000 and 2003 Suisun Marsh vegetation change detection, less specific information was known about the habitat requirements for the protected Salt Marsh Harvest Mouse in Suisun Marsh (*Reithrodontomys raviventris halicoetes*). The ten *Salicornia pacifica* (or “pickleweed”) vegetation types or mapping units were collectively considered important habitat for the SMHM in 2003. These include: (138) *Bolboschoenus maritimus* – *Salicornia pacifica* Association; (148) *Distichlis spicata* – *Salicornia pacifica* Association; (346) *Salicornia pacifica* Association; (347) *Salicornia pacifica* – Annual Grasses Association; (348) *Salicornia pacifica* – *Atriplex prostrata*

Association; (350) *Salicornia pacifica* – *Crypsis schoenoides* Association; (356) *Salicornia pacifica* – *Sesuvium verrucosum* Association; (361) *Salicornia pacifica* Alliance; (364) *Salicornia pacifica* – *Echinochloa crus-galli* – *Polygonum* – *Xanthium strumarium* Association; and (365) *Salicornia pacifica* – *Cotula coronopifolia* Association. Since then, biologists have gained a better understanding of the habitat requirements of the Salt Marsh Harvest Mouse (SMHM) and have broadened the definition of what is considered SMHM habitat considerably. According to the Bay Delta Conservation Plan Section 2A.14.7.2 Habitat Model Description, 91 of the 139 mapping types are considered either primary or secondary habitat for the SMHM (CDWR 2013). For this analysis we considered all of these types to be potential habitat. See Appendix G for the full list of mapping units that are considered potential habitat.

Vegetation change detection analysis for SMHM habitat and non-native species of concern was performed marsh-wide (separately for the total area, leveed areas, and tidal areas) and for each of the four management regions shown in Figure 2 (separately for the total area, leveed areas, and tidal areas). The percent change (acreage) was calculated using the following formula:

$$\frac{(2012 \text{ Acreage} - 2009 \text{ Acreage})}{2009 \text{ Acreage}} * 100$$

Results

The final 2012 vegetation map contains 20,629 polygons, which is 21% more polygons than the 2009 vegetation map (16,212 polygons) and 34% less polygons than the 1999 vegetation map (31,061 polygons). After clipping the mapped areas to the project boundary, the total acreage mapped in 2012 was 69,259 acres, in 2009 was 69,299 acres, and in 1999 was 68,730 acres. The discrepancy between the total areas mapped from year to year is the result of several factors: First, the older vegetation layers (1999-2006) focused on mapping only the wetland vegetation, which means that the area mapped did not necessarily extend to the edge of the project boundary. Second, as mentioned in Appendix A, the compounding inaccuracies that resulted from combining the spatial shifts in the imagery from 1999 to 2006 and the flaws of the original remap protocol (basing the current polygons on a modified copy of the old polygons) would have made the edge of the mapped area shift from year to year. Once the mapped area is clipped using the spatially fixed project boundary, the total area mapped each year is thus slightly different. This discrepancy will be partially mitigated for in the 2015 vegetation remap by going back and filling in the old vegetation maps so that the entire project area is mapped for each year.

Vegetation Change Analysis

Salt Marsh Harvest Mouse Habitat

Refer to Appendix G for the full list of vegetation mapping units that are considered Salt Marsh Harvest Mouse habitat for this report.

Marsh-wide: Figure 3, Appendix H

Of the 69,259 acres of vegetation mapped in the Marsh in 2012, 69% (or 47,901 acres) is considered potential SMHM habitat, a percentage which has remained fairly stable since 1999 (Figure 3). From 1999 to 2012 there was less than 1% change in potential habitat acreage overall (Appendix H). For all three mapping years the majority of the potential habitat is located in the leveed areas of the Marsh, which contains 82-86% of the total potential SMHM habitat (Appendix H). Overall, there has been a 3.9% decrease in potential SMHM habitat in the leveed areas and a 30.5% increase in potential SMHM habitat in the tidal areas of the Marsh (Appendix H).

By management region: Figure 3, Figure 4, Appendix H

Region 1:

As of 2012, Management Region 1 contains approximately 28% of all of the SMHM habitat (13,280 acres) (Figure 3), which is a 3.9% decrease since 1999 (Appendix H).

The vast majority of the SMHM habitat is found in the leveed area of this region (10,858.4 acres) (Figure 4), where it has decreased by nearly 10% (or 1,195 acres) since 1999 (Appendix H). However, in the tidal areas, the SMHM habitat has increased by 37% (or 645.2 acres) since 1999 (Appendix H).

Region 2:

Though Management Region 2 comprises almost 25% of the study area, only 15% (or 7,554.4 acres) of the 2012 potential SMHM habitat is located here (Figure 3), which is up by 5.1% (or 369.7 acres) since 1999 (Appendix H). Over 70% (or 5,357.6 acres) of the potential SMHM habitat of this region is in the leveed areas (Figure 4), which has decreased by 1.7% (or 95.1 acres) (Appendix H). The potential SMHM habitat in the tidal areas of this region has increased by 26.8% (or 464.9 acres) since 1999 (Appendix H).

Region 3:

Because Management Region 3 is the smallest of all the management regions (encompassing approximately 10% of the study area), it is not surprising that it contains the least amount of potential SMHM habitat. Approximately 8% (or 3,706.17 acres) of the entire potential SMHM habitat in the Marsh is within this region, which has increased by 8.1% (or 278.4 acres) since 1999 (Figure 3). There are 3,099.1 acres of potential habitat in the leveed areas and 607.1 acres in the tidal areas of this region (Figure 4), both of which have increased since 1999 (179.2 acres and 99.3 acres, respectively). However there has been a 7.7% decrease (or 259.7 acres) since 2009 in the leveed areas (Appendix H).

Region 4:

Nearly half (45.64%) of the study area is included in Management Region 4 and, likewise, nearly half (48.8%, or 23,360.4 acres) of the potential SMHM habitat in the Marsh is contained within this management region (Figure 2). Eighty-six percent (or 20,098.4 acres) of the potential habitat in this region is located in the leveed areas (Figure 4), which has decreased since 1999 by 2.4% (or 488.4 acres) but has increased since 2009 by 3.5% (or 682.9 acres) (Appendix H). The potential SMHM habitat in the tidal areas of this region has increased by 30.5% (or 763.2 acres) since 1999, which brings it up to 3,262 acres in 2012.

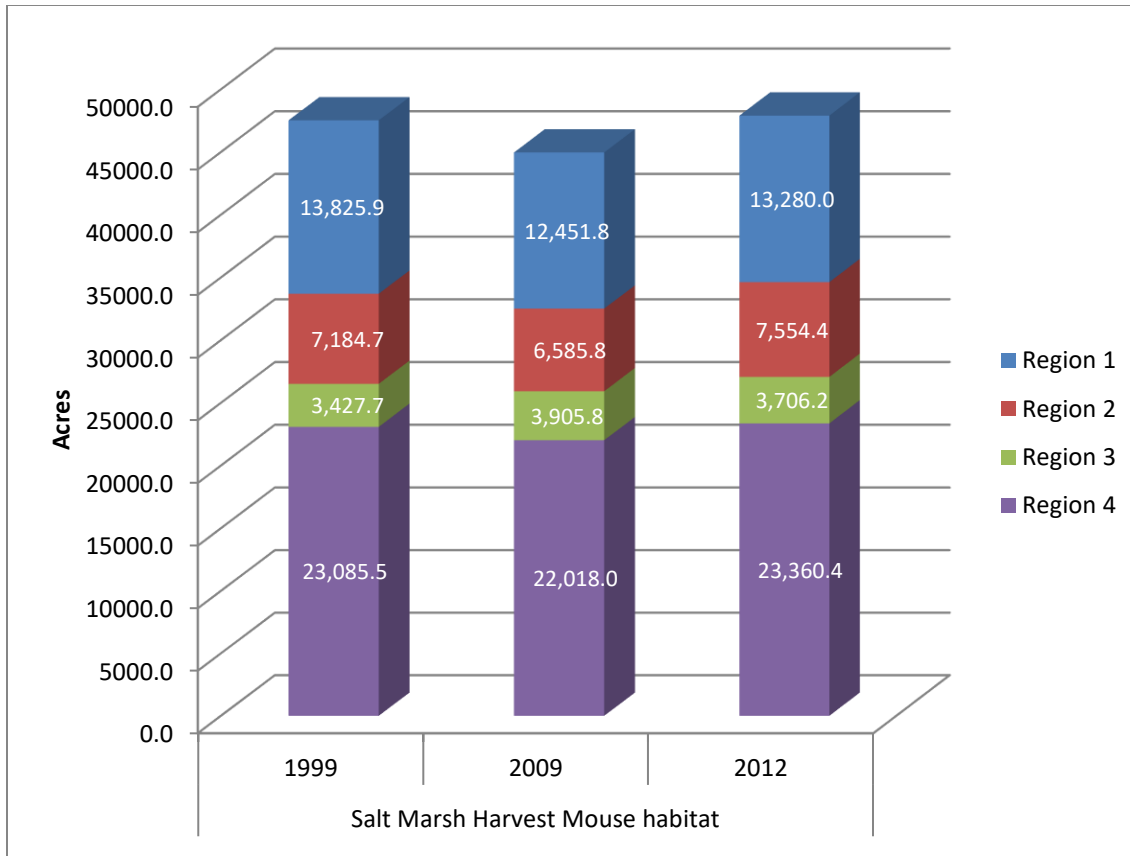


Figure 3: The acreage and distribution across the four management regions for the potential Salt Marsh Harvest Mouse habitat mapped within the Suisun Marsh triennial vegetation maps in 1999, 2009, and 2012.



Figure 4: The acreage for the potential Salt Marsh Harvest Mouse habitat mapped within the Suisun Marsh triennial vegetation maps in 1999, 2009, and 2012 for the four management regions and marsh wide, showing the proportion of tidal and leveed habitats for each.

Non-Native Species of Concern

All of the results are presented in Appendix I, but are summarized or highlighted in the discussion below.

Marsh-wide: Figure 5, Appendix I.

Phragmites australis is by far the species of concern that is the most wide-spread and has increased the most quickly in the Marsh since 1999 (Figure 5). Since 1999, *P. australis* has increased by 216% (or 1,869 acres) over the entire Marsh, having started with 863 acres in 1999 and covering 2,731 acres in 2012 (Figure 5). Although as of 2012 *P. australis* is almost twice as abundant in the leveed Marsh (1,796.4 acres) compared to the tidal Marsh (935 acres), in both habitat types it has more than doubled since 1999; up by 130% (or 529 acres) in the tidal areas and 294% (1,340 acres) in the

leveed areas (Figure 5). Interestingly, in the years since the 2009 remap *P. australis* has increased more rapidly in the tidal areas (39.3%) than the leveed areas (6.7%), but during the previous change detection (2006-2009) the opposite pattern was observed (Figure 5).

Lepidium latifolium is the second most abundant non-native species of concern, currently dominating 787 acres of the Marsh (Figure 5). It is down by 243.7 acres since its peak coverage in 2003, when it was 1,030.4 acres. This peak acreage was nearly cut in half by 2006, when it was at its lowest coverage in the Marsh (588.3 acres). Likewise, in the leveed areas there was a considerable decrease (281 acres) in *L. latifolium* acreage between 2003 (864 acres) and 2006 (583 acres), and it has continued to very slowly decline since then with 529 acres in 2009 and 504 acres in 2012. In the tidal areas of the Marsh *L. latifolium* has increased by 62% (or 108 acres) since 1999, but had decreased by 33.2% (or 139.9 acres) since 2009 (Figure 5).

Marsh-wide, stands dominated by *Eucalyptus* spp. have increased from 208.8 acres in 1999 to 332.1 acres in 2012 for an increase of 59% (Figure 5). From 2009 to 2012 there has been a 58.7 acre increase (or 21.5%) (Appendix I). In the leveed areas of the Marsh, where most of the coverage occurs, *Eucalyptus* spp. has continued to consistently increase in cover over time (Figure 5). The total area covered by *Eucalyptus* spp. in the tidal areas, as expected, has remained low, starting with only 12.8 acres in 1999 and decreasing to 7.4 acres in 2012 (Figure 5).

The year 2012 is the first time that *Salsola soda* has been mapped in Suisun Marsh, with 4.8 acres mapped marsh-wide (all in the leveed areas) (Appendix I).

Arundo donax, *Carpobrotus edulis*, and *Cortaderia selloana* show very little change in the Marsh since 1999 and still remain fairly restricted (Figure 5). *A. donax* covers 5.7 acres, which is only a 1 acre increase since 1999 (Appendix I). Similarly *C. edulis* now covers 8.2 acres total, increasing by 1.1 acres. *C. selloana* has decreased by 4.2 acres since 1999 (Appendix I). *Centaurea* spp., *Conium maculatum*, and *Foeniculum vulgare* have all shown a decrease in coverage (Appendix I).

By management region: Figure 6, Figure 7, Figure 8, Appendix I

The growth trends of the non-native species of concern within the four management regions generally reflect the marsh-wide changes, with *Phragmites australis*, *Lepidium latifolium*, and, *Eucalyptus* spp. being the major players and *Arundo donax*, *Carpobrotus edulis*, and *Cortaderia selloana* being restricted to only one or two management regions with very little change.

Region 1:

At 18,243.2 acres, Management Region 1 is just over 25% of the study area. Twenty-two percent of the *Phragmites australis*, 35% of the *Lepidium latifolium*, 40% of the *Eucalyptus* spp., 64% of the *Cortaderia selloana*, 20% of the *Carpobrotus edulis*, and 35% of the *Arundo donax* occur within this management region (Figure 6, Figure 7).

Phragmites australis has increased in this region by 410.4 acres since 1999; 174.4 of those acres have come in within the last 3 years (Appendix I). In total there are 600.3 acres of *P. australis* in this region, split fairly evenly between the leveed and tidal habitats (277.6 acres and 322.7 acres respectively) (Figure 8). Of particular interest is that there is a higher proportion of *P. australis* in the tidal wetlands of this region than in the other regions (Figure 8).

Although over a third of all the vegetation dominated by *Lepidium latifolium* in the Marsh occurs in this region (278.7 acres), it has decreased in both the tidal (37.7%) and leveed (14.6%) habitats since 2009 (Appendix I). However, since the beginning of the triennial remapping effort the *L. latifolium* in the tidal habitats of this region has still increased by 55.6% (or 27.1 acres) (Figure 8).

All of the 131.6 acres of *Eucalyptus* spp. in this region are found in the leveed habitats, where the type has increased by 66.3% (or 52.5 acres) since 2009 and 149.1% (or 78.8 acres) since 1999 (Figure 8). This region also contains the first known mappable stands of *Salsola soda* within the Marsh. The 4.8 acres are located within the leveed habitats of the region (Figure 8).

Region 2:

Management Region 2 comprises 17,110.4 acres of the Marsh, or almost 25% of the study area. Interestingly, as of 2012 *Phragmites australis* and *Lepidium latifolium* have almost equal cover within this region (336 acres and 346.4 acres, respectively), though *P. australis* started with less than half the coverage that *L. latifolium* started with in 1999 (Figure 8). From 1999 to 2012 *P. australis* increased by 223% (or 232 acres) and since 2009 it has increased by 10.3% (or 31.3 acres) (Appendix I). Though the relative acreage distribution of *P. australis* has remained the same across the leveed and tidal habitats of this region since 1999 (75-80% in the leveed habitats and 20-25% in the tidal habitats) the total acreage has increased in both of the habitats (Figure 8).

Over 40% of all the vegetation dominated by *Lepidium latifolium* in the Marsh is contained within this region (Figure 6). Overall it has increased by 30% since 1999, but has shown a slight decrease of 5.7% since 2009 (Appendix I). All of the 2009–2012

decrease occurred in the tidal habitats of this region, where coverage has dropped by 16.7% (or 40 acres). Despite this decrease, *L. latifolium* acreage has doubled in the tidal areas since 1999 (from 98.7 acres in 1999 to 200.4 acres in 2012) (Figure 8). In the leveed habitats there has been an overall 12.9% decrease since 1999, but a 15.2% increase from 2009 to 2012 (Appendix I).

Eucalyptus spp. covers 30 acres of this management region, most of which are in the leveed habitats (Figure 8). This coverage has decreased by almost 4 acres since 2009 (Appendix I). All the other non-native species of concern have little to no presence within this region and have shown no change (Figure 7).

Region 3:

Management Region 3 is the smallest of the four management regions at 6,970.5 acres, or approximately 10% of the total mapping area. As in all the regions, *Phragmites australis* is the most abundant species of concern (Figure 8), covering 189.3 acres in 2012, which is a 249.4% (or 135.2 acre) increase since 1999 (Appendix I). The majority of this increase has occurred in the leveed habitats of this region, where it has increased from 50.6 acres in 1999 to 166.4 acres in 2012 (Appendix I).

Eucalyptus spp. is the only other non-native species of concern that has shown any substantial change since 1999 within this region. Although only 2% of the total acreage of this species occurs here, it has increased from 1.6 acres in 1999 to 7.1 acres in 2012. All but 0.3 acre is located within the leveed habitats of the region (Figure 8).

Region 4:

With Management Region 4 being the largest of the regions at 37,650.6 acres, or nearly half of the total mapping area (45.64%), it's not surprising that almost 60% (or 1,505.8 acres) of the total *Phragmites australis* in the Marsh is in this region (Figure 6). In 1999 there were 514.4 acres of *P. australis* within this region, split almost evenly between the tidal and leveed habitats (Figure 8). Since then, there has been a 212.1% increase, having expanded considerably more in the leveed habitats, where it went from 237.1 acres in 1999 to 1,111.8 acres in 2012, an 874.7 acre increase (Figure 8). Most of this growth occurred before 2009; there was a less than 1% increase between 2009 and 2012 of *P. australis* in the leveed areas of this region (Figure 8). In the tidal habitats coverage has increased by 216.6 acres since 1999, 124.6 of those acres having come in since 2009 (Appendix I). So, while there is considerably more *P. australis* in the leveed habitats than in the tidal habitats of this region, the recent growth (within the last three years) has almost exclusively taken place in the tidal habitats (Figure 8).

Stands of vegetation that are dominated by *Lepidium latifolium* have decreased in this region by 61.2% (or 251.6 acres), having gone from 411 acres in 1999 to 159.4 acres in 2012 (Figure 8). The *L. latifolium* in the leveed habitats of this region, which is where a majority of the infestation exists, has decreased by 60% since 1999 (or 230.9 acres) (Figure 8). The tidal habitats started with only 26.2 acres of *L. latifolium* in 1999 and it has decreased by 90.6% to only 5.5 acres in 2012 (Figure 8).

Currently, approximately half of all the *Eucalyptus* spp. that occurs in the Marsh is in the leveed habitats of this management region, which has increased by 43.1% (or 48.1 acres) since 1999 and 6.9% (or 10.3 acres) since 2009 (Figure 8). However, the tidal habitats of this management region have shown a 64.3% (or 6.2 acre) decrease in *Eucalyptus* spp. coverage since 1999 and an 11.5% (or 0.4 acre) decrease since 2009 (Figure 8).

Arundo donax has increased by less than 1 acre since 1999 within this management region, but 65% of all the *A. donax* in the Marsh is located here (Figure 7). *Carpobrotus edulis* shows a decrease of less than 1 acre in this region since 1999, but again, 80% of the total acreage of this species occurs here (Figure 7). *A. donax* and *C. edulis* are both occurring mostly in the leveed habitats within this region (Appendix I). *Cortaderia selloana*, found mostly in the tidal habitats of this region, has also shown a very minimal increase of less than 1 acre since 1999 (Appendix I).

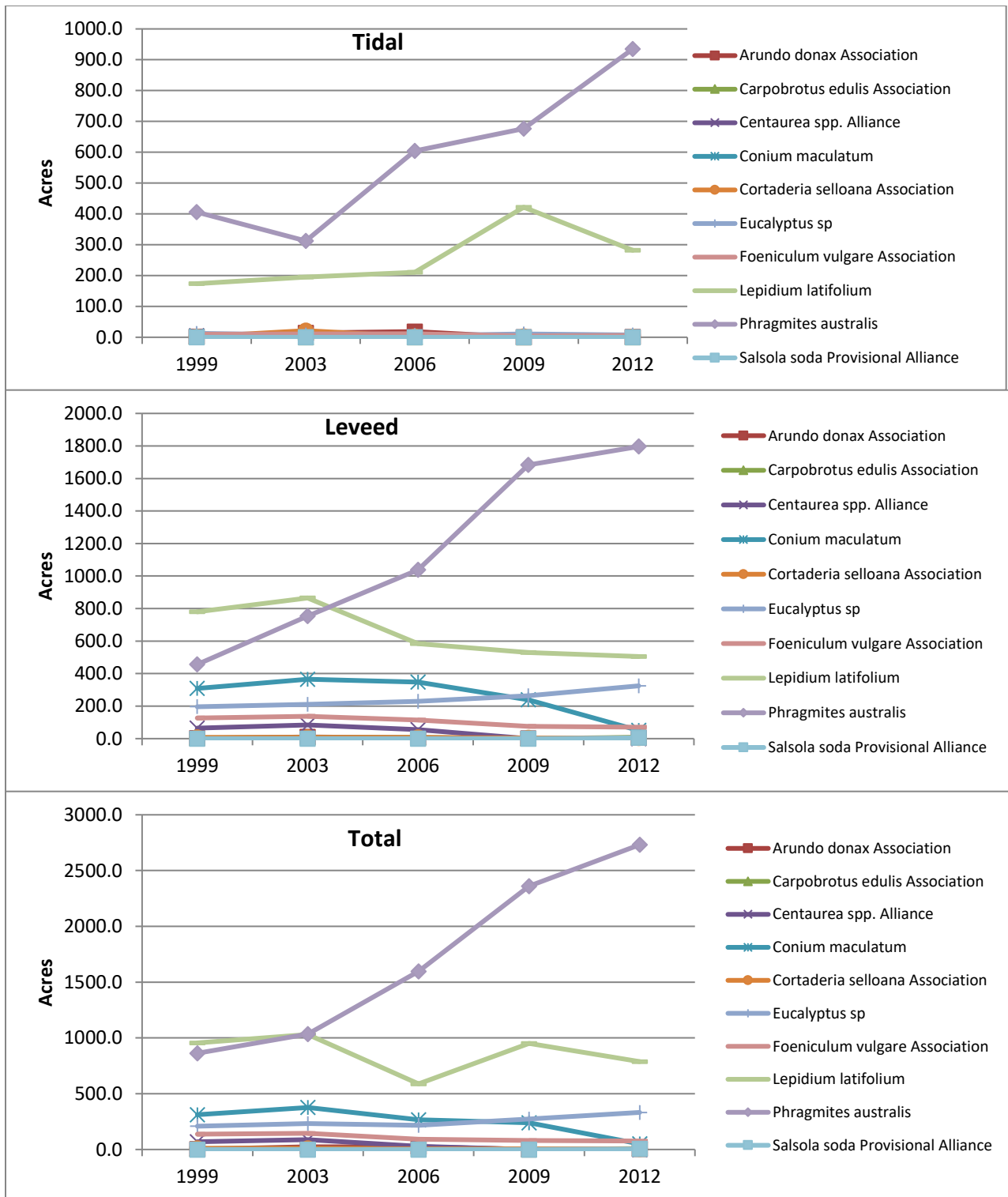


Figure 5: The acreage trend from 1999 to 2012 of the non-native species of concern in Suisun Marsh. Note the different scales in each graph. The types that are dominated by *Arundo donax*, *Carpobrotus edulis*, and *Cortaderia selloana* show very little change between 1999 and 2012; they are likely limited naturally marsh-wide due to their preference for levee-edge upland settings. *Centaurea* spp., *Conium maculatum*, and

Foeniculum vulgare are difficult to differentiate from each other and from other weedy types that tend to occur with them, so these vegetation types show unreliable changes. Also, *Salsola soda* is a new invading non-native that has, so far, only been seen in the leveed areas of the marsh.

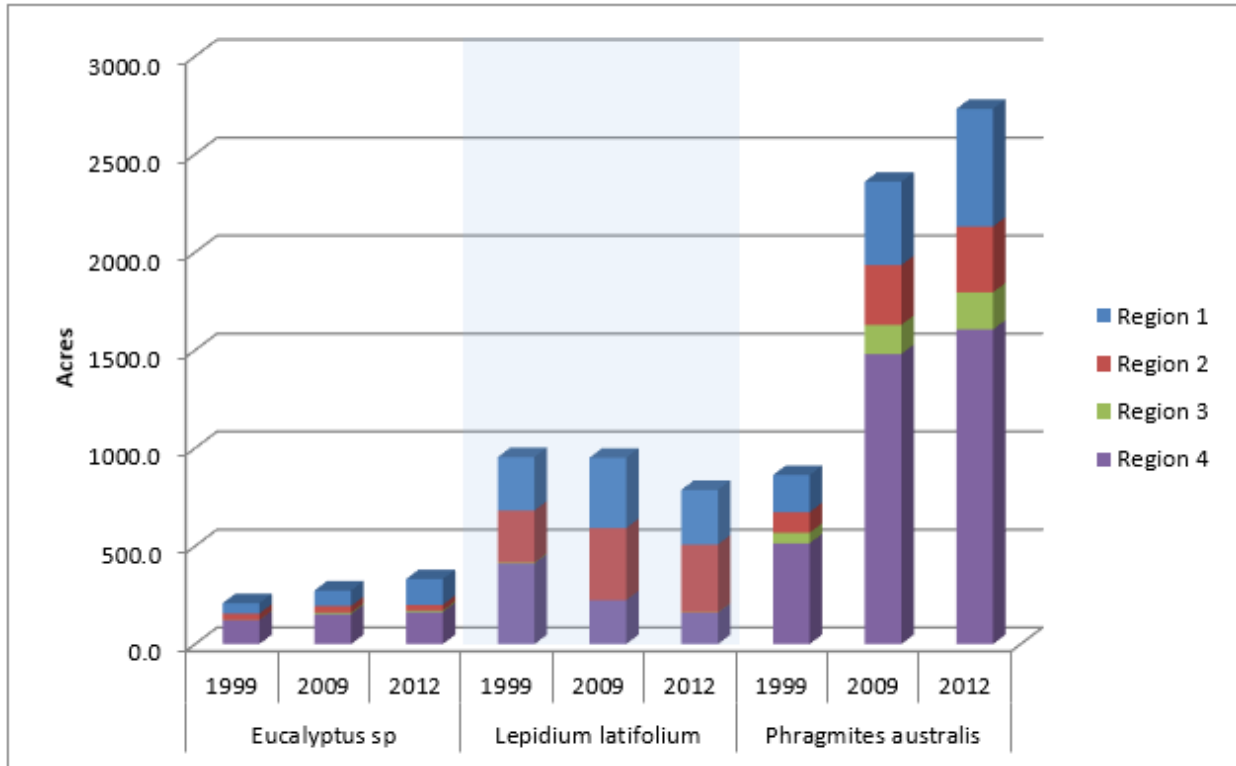


Figure 6: The acreage distribution of the most abundant non-native species of concern in Suisun Marsh in 1999, 2009, and 2012 across each of the four management regions.

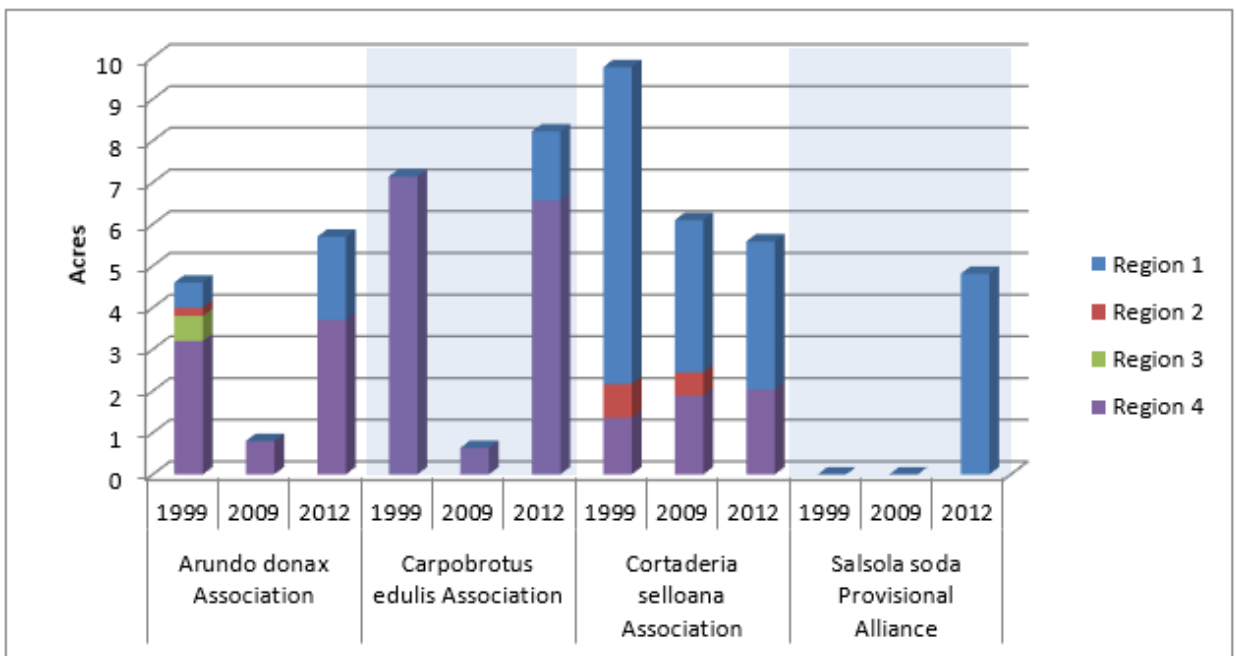


Figure 7: The acreage distribution of the less abundant non-native species of concern in Suisun Marsh in 1999, 2009, and 2012 across each of the four management regions.

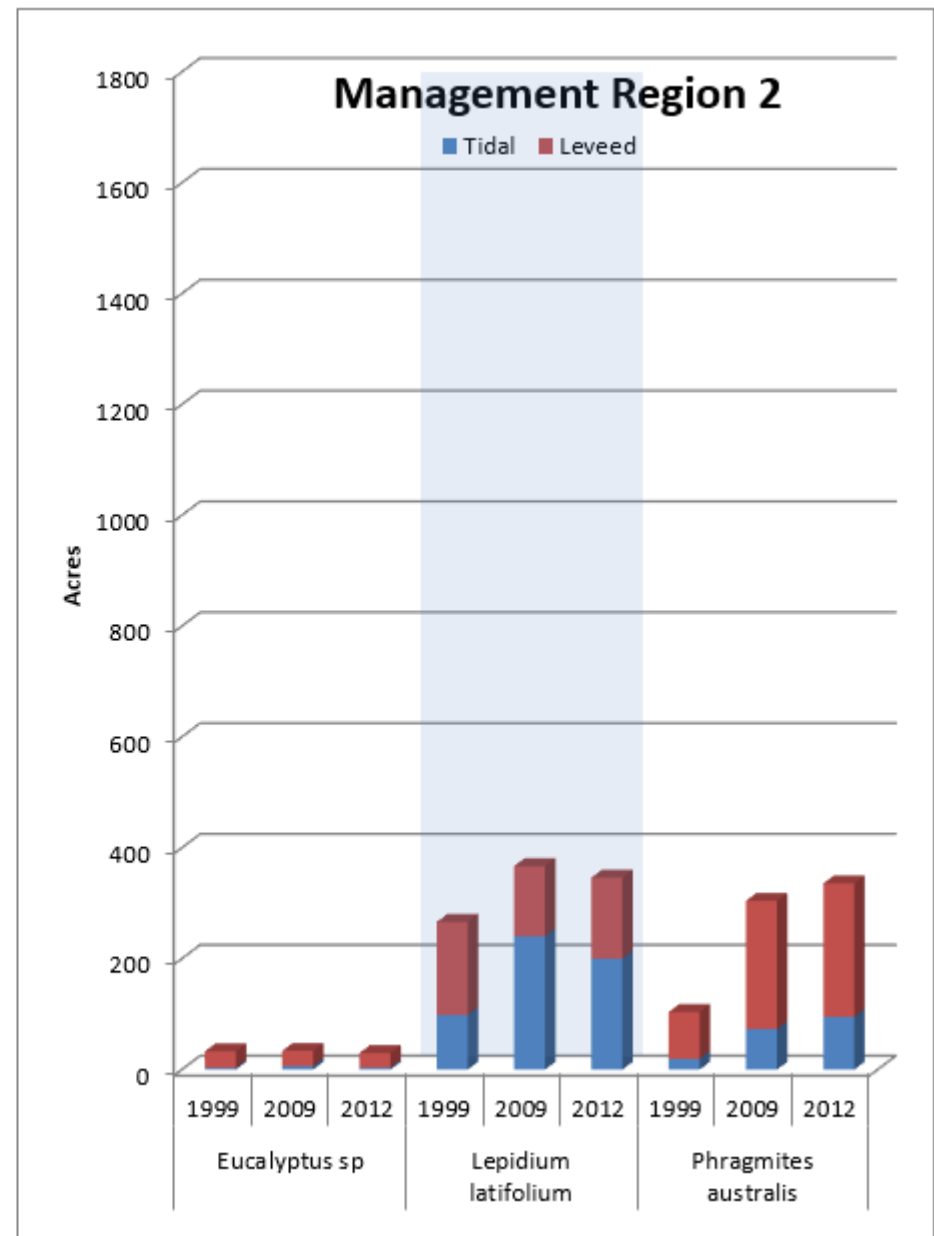
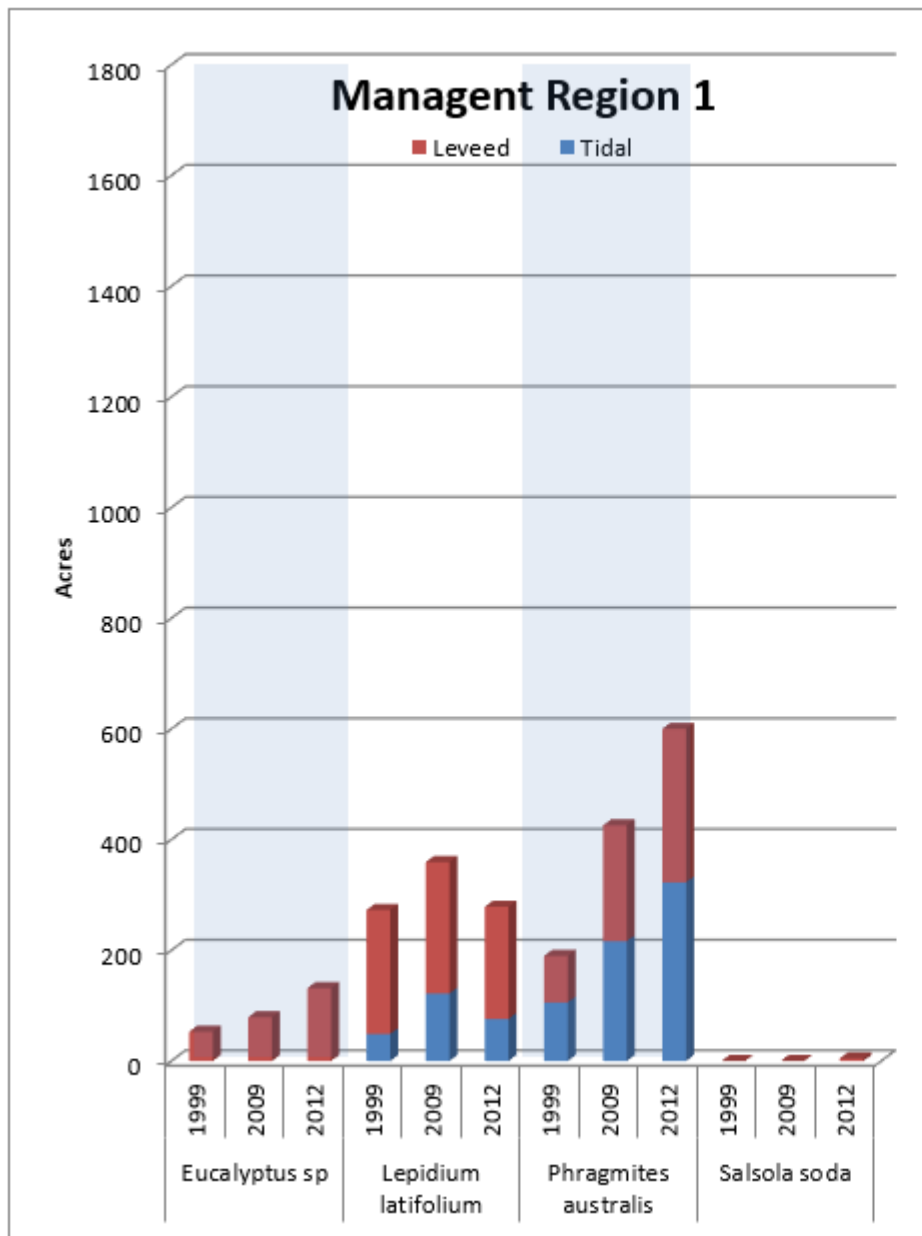


Figure 8: The acreages of noteworthy non-native species of concern in Suisun Marsh in 1999, 2009, and 2012 for each of the four

management regions showing the proportion of each type that occurs in the tidal habitats and leveed habitats of the region. Note that the acreage scale for management region 4 is much larger than that of the other figures.

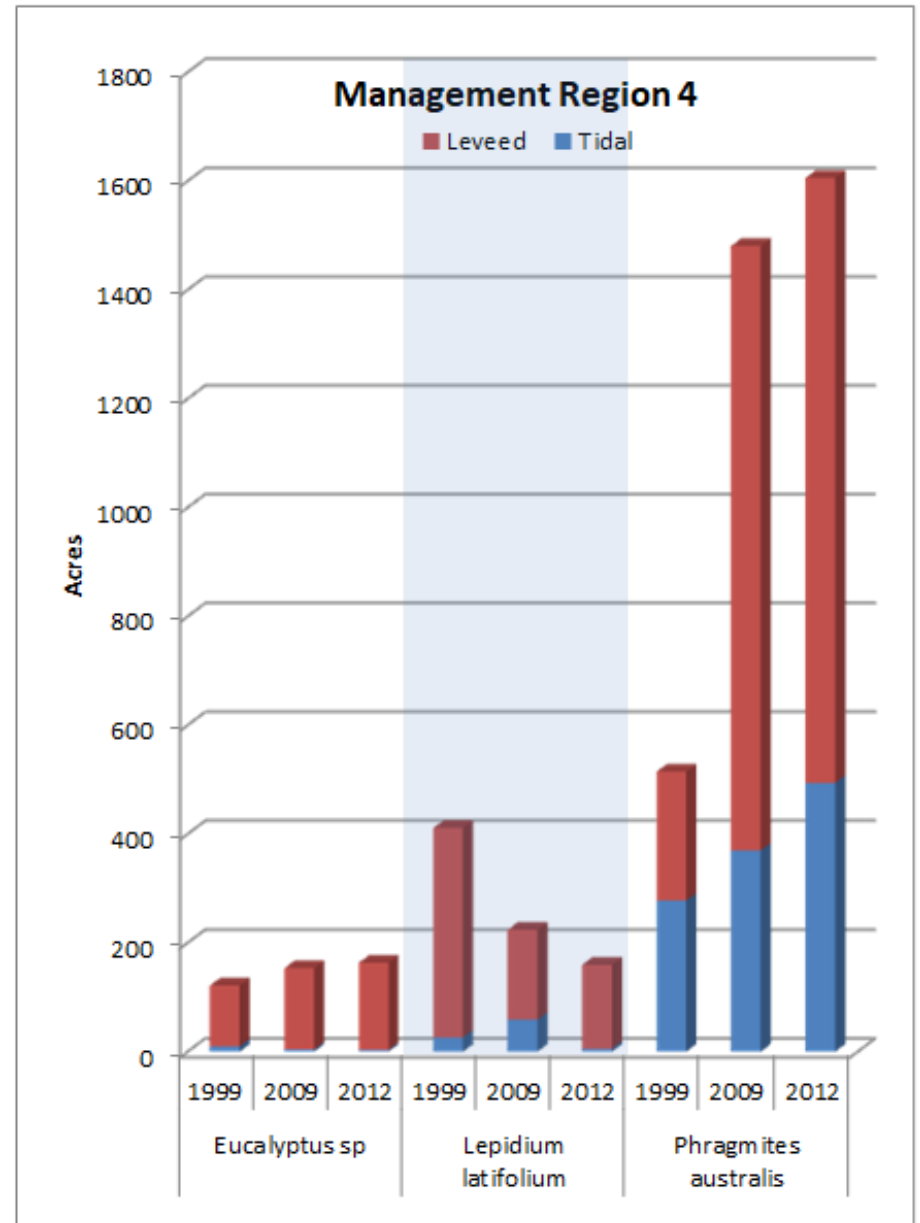
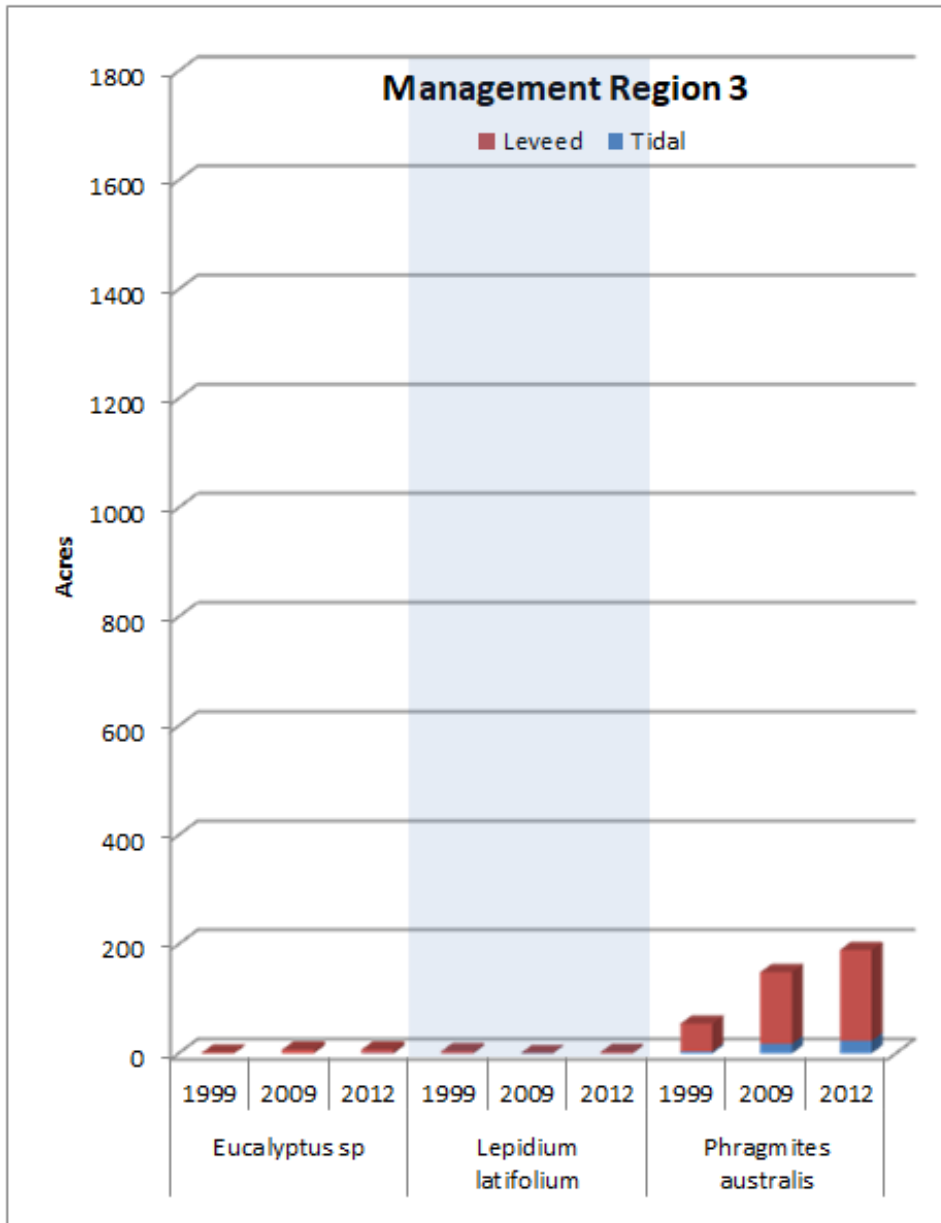


Figure 8 (continued): The acreages of noteworthy non-native species of concern in Suisun Marsh in 1999, 2009, and 2012 for each of the four management regions showing the proportion of each type that occurs in the tidal habitats and leveed habitats of the region.

Note that the acreage scale for each management region is different, and the scale for Management Region 4 is much larger than that of the other figures.

Discussion, Conclusions and Recommendations

For this analysis and report we have used a broad interpretation of what constitutes potential Salt Marsh Harvest Mouse habitat (Appendix G) for the years 1999, 2009, and 2012. While this is likely a more accurate approach than what was used previously, it does “mute” the perceived change in potential habitat. The percentage of the Marsh vegetation which is considered potential habitat for the endangered SMHM (currently 69%) has changed minimally since 1999, so there appears to be little impending threat to habitat for this species in Suisun Marsh, at least as broadly defined for this study.

Unfortunately, *Phragmites australis* is increasing rapidly and shows no sign of slowing its invasion. Many land managers in the Marsh have recognized this and have implemented several methods to control this species, including the application of herbicide, mowing, disking, and burning. The Suisun Resource Conservation District (Suisun RCD) operates a Pest Weed Control Program (<http://www.suisunrcd.org/programs.html#pest>) that provides assistance to private land owners in the Marsh who are trying to control specific invasive weeds, including *P. australis*. Suisun RCD maintains annual records of these treatment applications. Comparing these treatment data with the triennial vegetation map updates would be useful in helping to determine if these treatments have been effective. Until these data, or other management data for this species, are analyzed, we cannot say anything definitive regarding the efficacy of existing management practices. However, it is apparent that left untreated, *P. australis* will continue to expand and displace native vegetation in Suisun Marsh.

One location where the expansion of *Phragmites australis* and the resulting displacement of native vegetation are particularly visually obvious is the tidally influenced CDFW Goodyear Slough Unit in the southwestern area of the Marsh (Figure 9). This pattern can also be seen in a leveed area of the Marsh on Joice Island (Figure 10) where *P. australis* is spreading along small water courses in the interior of the island, which is seasonally flooded.



Figure 9: Vigorous spread of *Phragmites australis* from 1999 to 2012 in an area of the Goodyear Slough Unit of CDFW's Grizzly Island Wildlife Area Complex, within the Suisun Marsh Management Region 1, along the edge of Suisun Bay near Industrial Way in Benicia, CA. The site is strongly tidally influenced and the *P. australis* has expanded inward a few hundred meters from the bay, displacing nearly 100 acres of native vegetation between the bay and the railroad tracks to the northwest.



Figure 10: The spread of *Phragmites australis* from 1999 to 2012 in an area of Suisun Marsh Management Region 2, on Joice Island, between Suisun Slough and Montezuma Slough. The site is leveed and not subject to tidal influence. Large patches of *P. australis* which were present around the edges of the island in 1999 have expanded, and smaller patches have appeared along water courses in the interior of the island that are flooded seasonally.

Like *Phragmites australis*, *Lepidium latifolium* is a widespread non-native weed in the Marsh that can displace native vegetation. However, the photo interpretability of *L. latifolium* relies on the distinctive white flowers being present at the time that the aerial imagery is flown. While we mitigate for this limitation by having the imagery flown in June (mid-flowering period), genetic and site variability are such that all the *L. latifolium* in the Marsh does not flower at once. This means that not all of the vegetation dominated by *L. latifolium* is being accounted for. Therefore, while there has been great effort in some locations in the Marsh to control the spread of *Lepidium latifolium* and, according to the analysis done in this report, it is apparently decreasing as a stand-forming vegetation type, it is unknown if the species is decreasing overall in

the Marsh. It will be more useful to look at the long-term trend of this type rather than to look at the variation from map-year to map-year.

The types that are dominated by *Arundo donax*, *Carpobrotus edulis*, and *Cortaderia selloana* have shown very little change between 1999 and 2012. This may seem strange considering the nature of these perennial invasive species, as they tend to spread rapidly in other habitats and locations throughout the United States. However, all of these species are much lower in acreage than the previously mentioned exotics. We can assume that these exotic stands of vegetation are limited naturally marsh-wide due to their preference for levee-edge upland settings. These three species are all more “upland transitional” types than several species mentioned above. It is also difficult to derive meaningful statistical trends based on such low acreages.

The results for the changes in *Centaurea* spp., *Conium maculatum*, and *Foeniculum vulgare* may be somewhat unreliable due to inconsistent photo-interpretability. It is likely that the maps are showing a decrease or no increase in these types due to the likelihood that they are being mapped to a higher level in the hierarchy. These types are difficult to differentiate from each other and from other weedy types that tend to occur with them. Again, most of these types tend to be on the upland end of the moisture gradient and are more likely to occur in managed wetlands with reduced water in the given year they are mapped.

Salsola soda is now in the Marsh and, while only a few acres of this type were mapped in 2012, observation suggests that it has spread rapidly and occurs more extensively as a sub-dominant species around the vicinity in which it was mapped.

Potential future uses of the triennial vegetation map update

Over the past century, sea level has risen nearly eight inches along the California coast, and general circulation model scenarios suggest very substantial increases in sea level as a significant impact of climate change over the coming century (Pacific Institute 2012).

Data collected and summarized for the 2012 third resample (VegCAMP 2014) suggest that there have been some areas that have become dominated by obligate wetland plants since they were first sampled in 1999. This might imply that current sea level rise is already having an impact on the vegetation in Suisun Marsh. However, there is no clear predictable pattern to these trends due to the confounding effects of water management in leveed portions of the Marsh as a whole. As more resamples and remapping occur over time, these patterns may become clearer.

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Appendix A

History and Evolution of the Suisun Marsh Triennial Vegetation Mapping Project

History of the Suisun Marsh Triennial Vegetation Mapping Project

In 1977, the Suisun Marsh Preservation Act was enacted and required that the Suisun Marsh be managed for its wildlife resources. Consequently, the Plan of Protection for the Suisun Marsh (Plan of Protection) was developed. In 1981 the U.S. Fish and Wildlife Service (USFWS) produced a Section 7 Biological Opinion (BO) for the Plan of Protection. Their BO accepted the monitoring program in the Plan of Protection and added specific conservation measures to protect Salt Marsh Harvest Mouse (SMHM) habitat.

As part of the monitoring program in the Plan of Protection, a Triennial Vegetation Survey was developed to document the overall vegetation composition of the marsh and to monitor SMHM habitat by the use of aerial photography in combination with ground verification. Prior to the final Plan of Protection, an initial vegetation survey was conducted in 1981 to provide a baseline for the future Triennial survey. However, since completion of the Suisun Marsh Salinity Control Gates as described in the Plan of Protection was delayed until 1988, the 1988 survey was the closest to the start of facility operation. However, the 1981 survey can be used for a pre-gate operation base line. The Triennial Vegetation Survey was carried out in the Suisun Marsh in 1981, 1988, 1991, and 1994 to document any changes in vegetation composition over time.

There were some concerns about the methodology used and the lack of useful maps from the 1988, 1991, and 1994 surveys. These concerns have led to the proposed change in methodology. Additional criticism of the past methodology included not using a habitat classification system such as that used in the California Wildlife Habitat Relationship System, and using inappropriate methods for calculating the acreages of each habitat type. In 1996, an interagency technical committee was convened to review the current survey methodology and recommended a more detailed monitoring system for vegetation changes within the marsh. Consequently, in July 1997 the committee agreed to implement a new survey methodology for the 1998 vegetation survey.

This new methodology was based on work by the Department of Fish and Game, Wildlife and Habitat Data Analysis (now Biogeographic Data) Branch. It has been conducted at Anza-Borrego Desert State Park, Point Reyes National Seashore, Yosemite National Park, Sequoia–Kings Canyon National Park, Joshua Tree National Park, and the Mojave Desert. The survey methodology is designed to meet the goal of documenting changes in preferred habitat for the Salt Marsh Harvest Mouse, as well as gather the vegetation information in such a way that it can be used for a variety of other purposes. These may include: correlating management activities with vegetation changes; gathering data to support the use of a GIS format that will allow queries and

overlaying of additional information such as soil type, ownership, and hydrology; and creation of a base map for future studies.

Evolution of the Suisun Marsh Triennial Vegetation Mapping Protocol

The changes that have been made to the Suisun Marsh triennial vegetation mapping protocol have largely been due to changes in available technology and our evolving understanding of vegetation classification. The intention of the changes has only been to make the map as useful and repeatable as possible while still meeting the original goals and requirements of the project.

Protocol 2000-2006

The 1999 vegetation map was created by hand drawing lines with a .2 mm water-soluble pen directly on mylar sheets taped to the photo diapositives. The mylar sheets were then scanned and “rubber sheeted” to create a digital version. Subsequent vegetation maps were digitally edited. Map updates were made by modifying the lines to reflect the changes shown in the most current aerial imagery. When a change in size or shape of a polygon was detected, the changed portion was digitally cut and then merged with the appropriate adjacent polygon or made into a new polygon. Therefore, with this protocol, all subsequent map updates are based on the previous map update, which are all ultimately based off of the 1999 vegetation map.

The following changes were considered significant and consistently interpretable, and were updated:

- A greater than 20% change in acreage of an existing small polygon (< 0.5-1 acre)
- A greater than 10% change in acreage of a mid-sized polygon (1-5 acres)
- A greater than 5% change in a large polygon (>5 acres)
- A type conversion of a vegetation polygon dominated by perennial species. Type conversion, as defined here, occurs when a previously mapped vegetation type dominated by perennial species has changed based on the decision rules set forth in the vegetation mapping unit key (Appendix C), or when an annual species dominated vegetation type is converted to a perennial vegetation type.
- A persistent physical change has altered any vegetation polygon and partially or entirely replaced it with a non-vegetated area (non-vegetated areas include buildings, dredged ditches, new levees, roads, or other human engineered structures).
- A change in management style, which includes a conversion or restoration from an actively managed situation (annual burning, disking, plowing, flooding, or other management practice which annually disturbs the vegetation) to a passively managed or non-managed situation.

The following changes were considered non-significant and/or unreliably interpretable and were not assessed:

- Conversions of one annual vegetation type to another annual type were not considered because of the vagaries of climate on annual vegetation.
- Polygons that are regularly heavily managed by annual burning, disking, flooding, or other means were not considered. These changes, unless they show some direction (e.g., from passive management to active, or vice versa), are considered regular management perturbations and maintain the same general vegetation pattern through regular disturbance.

Current protocol (2009–current)

The current protocol involves the creation of a new map in which the vegetation is interpreted from aerial imagery and polygons are digitizing using heads-up digitizing. A photo interpreter manually draws polygons around each stand of vegetation in the most recent version of ArcMAP available and records the map attributes within a Microsoft Access Personal Geodatabase. Because this new protocol starts with an empty GIS data file and is not based on the manipulation of an already existing shapefile, several of the mapping rules and attributes used in the old protocol that referred to the manipulation of a shapefile no longer apply.

Justification for changing to the current protocol

There were several reasons for changing the map update and vegetation change detection protocol: 1) inconsistencies in imagery orthorectification, 2) unforeseen flaws in the original protocol, and 3) advances in available technology.

Inconsistencies in imagery orthorectification. In preparation for the 2009 updating process the imagery flown specifically for the Suisun Marsh mapping from 1999 through 2009 was compared with the intention of summarizing a consistent time series of change over the 4 intervals (1999–2000, 2000–2003, 2003–2006, 2006–2009). However, VegCAMP staff found that none of the datasets matched up spatially. The 2006 and 2009 imagery were very close to each other but were about 7 meters off from the 2009 orthomosaics provided by the National Agriculture Imagery Program (NAIP), which was considered the most regionally accurate standard. The 1999 imagery was very close to the 2009 NAIP and the 2003 Suisun imagery was approximately 15 meters shifted from all the other imagery sets. Because the past protocol included making a copy of the previously updated shapefile (which matched the imagery for the time) and updating it according to the new imagery (which was shifted 7 to 15m from the previous imagery), errors were compounded. The non-linear shift in imagery would confound a number of useful analyses such as description of individual shifts in size and shape of stands of different marsh vegetation, or trends in number and acreage of different types of marsh habitat within and between different marsh management zones.

Unforeseen flaws in the original protocol. The protocol used for the 1999 vegetation map was the standard method used for delineating and digitizing vegetation

polygons at the time. However, this process created some discrepancies between the shapefile and the imagery. The “rubber sheeting” process resulted in inconsistent shifts in the line work that were perpetuated with each update and further complicated by the imagery orthorectification shifts. The updated protocol allows for each remap to be a stand-alone, spatially accurate product.

Advances in available technology. Today there is much more spatially accurate georeferenced imagery that can be used directly in a GIS. Now, instead of the extra time-consuming and error-compounding step of first delineating manually and then scanning and correcting the drawn polygons, we can digitize polygons directly over the imagery using a computer. By adopting the new protocol of remapping from scratch every time, we eliminate the types of errors that compound with each update.

Implementation of an adaptive protocol that allows for future advances in technology:

When envisioning a protocol for a project that will potentially last for many years we must consider the inevitable change in technology and our understanding of vegetation. Some major effects of changing technology on this project are discussed above and more will undoubtedly arise in the future. There have also been shifts in our understanding of vegetation classification and how that translates to a mapping classification. For this reason, it is important to have an adaptable protocol. It needs to be a protocol that does not build on the previous version so as not to get caught using old technology or ideas just because “that’s what we did before.” By creating a separate and distinct vegetation map for each update we are still able to compare them from year to year while freeing us up to use the most current information and technology available.

Testing efficiency

In exploring the changes to the protocol in 2009, VegCAMP performed a time efficiency test. Using ArcMap 9.3, a portion of the marsh (~230 acres) was mapped the old way (cutting and merging pieces of old polygons until the new polygons look fairly close to the current vegetation boundaries) and the same portion was mapped from scratch. The thinking was that it may take longer to map from scratch, but it would be more spatially accurate, it would look better, and we can stop compounding errors.

What was learned: It was quicker, easier, more concise and more accurate to draw polygons from scratch. It is much slower and more difficult to cut many portions of a polygon and merge them with other various polygons than to just draw the polygon the way the photo interpreter sees it. In addition, just as you set a minimum map unit size based on time and money available, the photo interpreter must also limit the number of cuts and merges for the same reason. So, not only did the old protocol prove to be more time consuming, but the resulting vegetation map had inconsistent line-work.

Summary of effects of this decision: To plan for more accurate comparisons that are more independent of improving technologies, we decided to discontinue modification of polygons, but instead map *de novo* with each update. The benefit is that there will no longer be an ever-compounding issue of using incorrectly referenced original information and partially modified polygons to make all future comparisons. However, the short term negative effect will be that the 2009 and subsequent maps cannot be directly compared to the previous editions on a polygon-by-polygon basis. To do so would require working backwards and modifying all 3 previous iterations of the map, essentially de-coupling the original map produced in 2000 from the following individual updates. This would be very costly, but would ultimately provide a more valuable long-term time sequence. Although polygon-by-polygon comparisons between pre-2009 maps and subsequent maps is not possible until such remapping is done, we can still compare changes in acreage and numbers of polygons of different vegetation classes between all editions of the map.

Appendix B

Suisun Marsh Vegetation Classification and Hierarchy

The vegetation and mapping classification hierarchy of Suisun Marsh is compliant with the United States National Vegetation Classification (USNVC) as of 2012. The vegetation types are listed below within the full eight levels of the USNVC hierarchy. Each type that has been used in any Suisun Marsh map is followed by its mapping code in parentheses.

The original vegetation classification for Suisun Marsh was created in 1999. Since then, a great deal of vegetation work has been done in California, and the state and national hierarchies have been refined. Although many alliances and associations from the original classification are equivalent to types in the current USNVC hierarchy, some have no comparable current types. These unmatched vegetation types are labeled “mapping units” and are placed within the appropriate alliances and groups in the hierarchy structure below.

Some of the original mapping units were defined too broadly to fit into the alliance and association levels of the current hierarchy. However, they do approximate some of the upper levels. For instance, although the Medium Upland Graminoids Mapping Unit does not fit into the species-oriented alliance structure, it can be considered part of the California Annual and Perennial Grassland Macrogroup. These broadly defined mapping units are listed with their corresponding USNVC vegetation types under “Legacy Mapping Units” at the end of the hierarchy.

The Suisun Marsh mapping units are not currently accepted in the USNVC because there is not enough field data to support them. In the future, when the Suisun Marsh vegetation field data is reanalyzed with a larger data set, these mapping units will either be confirmed as distinct types or renamed to better fit an existing type. In future maps, the broadly defined mapping units will not be used, but will be replaced by the corresponding USNVC vegetation types.

The USNVC hierarchy is composed of eight levels, organized into three upper, three middle, and two lower levels as shown below:

Level	Example
Upper	
Level 1 - Class	Forest and Woodland
Level 2 - Subclass	Temperate Forest
Level 3 - Formation	Warm Temperate Forest
Middle	
Level 4 - Division	Madrean Forest and Woodland
Level 5 - Macrogroup	California Forest and Woodland
Level 6 - Group	Californian Broadleaf Forest and Woodland
Lower	
Level 7 - Alliance	<i>Quercus agrifolia</i>
Level 8 - Association	<i>Quercus agrifolia</i> / <i>Salix lasiolepis</i>

1. Forest and Woodland Class

a. Temperate Forest Subclass

i. Warm Temperate Forest Formation

1. Madrean Forest and Woodland Division

a. California Forest and Woodland Macrogroup

i. Californian Broadleaf Forest and Woodland Group

1. *Quercus agrifolia* Alliance (901)

- a. *Quercus agrifolia* Association (902)
- b. *Quercus agrifolia* / *Salix lasiolepis* Association (705)
- 2. *Quercus lobata* Alliance (903)

ii. Cool Temperate Forest Formation

1. North American Introduced Evergreen Broadleaf and Conifer Forest Division

a. Introduced North American Mediterranean Woodland and Forest Macrogroup

- i. no subdivision at group level
 - 1. *Eucalyptus (globulus, camaldulensis)* Semi-Natural Alliance (800)
 - a. *Eucalyptus globulus* Semi-Natural Association (801)
 - 2. *Ailanthus altissima* Semi-Natural Alliance (911)

b. Southwestern North American Riparian, Flooded and Swamp Forest Macrogroup

- i. Southwestern North American Riparian Evergreen and Deciduous Woodland Group
 - 1. *Salix laevigata* Alliance (701)
 - a. *Salix laevigata* / *Salix lasiolepis* Association (702)
- ii. Southwestern North American Riparian/Wash Scrub Group
 - 1. *Salix exigua* Alliance
 - a. *Salix exigua* Association (502)
 - 2. *Rosa californica* Alliance
 - a. *Rosa californica* Association (604)
 - b. *Rosa californica* – *Baccharis pilularis* Association (605)
- iii. Southwestern North American Introduced Riparian Scrub Group
 - 1. *Arundo donax* Semi-Natural Alliance
 - a. *Arundo donax* Semi-Natural Association (102)

2. Temperate Flooded and Swamp Forest Mesomorphic Shrub and Herb Vegetation Class

a. Mediterranean Scrub and Grassland Subclass

i. Mediterranean Grassland and Forb Meadow Formation

1. California Grassland and Meadow Division

a. California Annual and Perennial Grassland Macrogroup

- i. Mediterranean California Naturalized Annual and Perennial Grassland Group (227)
 - 1. *Brassica nigra* and Other Mustards Semi-Natural Alliance
 - a. *Brassica nigra* Semi-Natural Association (406)
 - b. *Raphanus sativus* Semi-Natural Association (405)
 - 2. *Bromus (diandrus, hordeaceus)* – *Brachypodium distachyon* Semi-Natural Alliance (232)
 - 3. *Centaurea (solstitialis, melitensis)* Semi-Natural Alliance (413)
 - 4. *Conium maculatum* – *Foeniculum vulgare* Semi-Natural Alliance
 - a. *Conium maculatum* Semi-Natural Association (402)
 - b. *Foeniculum vulgare* Semi-Natural Association (403)
 - 5. *Cortaderia (jubata, selloana)* Semi-Natural Herbaceous Alliance (202)
 - 6. *Festuca perennis* Semi-Natural Alliance (218)
 - a. *Festuca perennis* – *Lepidium latifolium* Semi-Natural Association (220)
 - b. *Festuca perennis* – *Lotus corniculatus* Semi-Natural Association¹ (344)
 - c. *Festuca perennis* – *Rumex* spp. Mapping Unit (222)
 - d. *Hordeum marinum* – *Festuca perennis* Mapping Unit (234)
 - 7. *Elytrigia pontica* Mapping Unit (211)

¹ Formerly named *Lotus corniculatus* Mapping Unit

8. *Cynodon dactylon* Mapping Unit (161)
9. *Agrostis avenacea* Mapping Unit (228)
10. *Vulpia* spp. – *Euthamia occidentalis* Mapping Unit (235)

3. Mesomorphic Shrub and Herb Vegetation Class

a. Temperate and Boreal Shrubland and Grassland Subclass

i. Temperate Grassland, Meadow, and Shrubland Formation

1. Vancouverian and Rocky Mountain Grassland and Shrubland Division

a. Western North American Temperate Grassland and Meadow Macrogroup

i. Vancouverian and Rocky Mountain Naturalized Perennial Grassland Group

1. *Phalaris aquatica* Herbaceous Semi-Natural Alliance

a. *Phalaris aquatica* Herbaceous Semi-Natural Association (223)

b. Vancouverian Lowland Grassland and Shrubland Macrogroup

i. Naturalized Non-Native Deciduous Scrub Group

1. *Rubus armeniacus* Shrubland Semi-Natural Alliance (606)

ii. Temperate and Boreal Scrub and Herb Coastal Vegetation Formation

1. Pacific Coast Scrub and Herb Littoral Vegetation Division

a. Vancouverian Coastal Dune and Bluff Macrogroup

i. California Coastal Evergreen Bluff and Dune Scrub Group

1. *Baccharis pilularis* Shrubland Alliance (602)

a. *Baccharis pilularis* / Annual Grass-Herb Association (603)

ii. California–Vancouverian Semi-Natural Littoral Scrub and Herb Vegetation Group

1. *Carpobrotus edulis* or Other Ice Plants Herbaceous Semi-Natural Alliance (421)

iii. Temperate and Boreal Freshwater Marsh Formation

1. Western North American Freshwater Marsh Division

a. Western North American Freshwater Marsh Macrogroup

i. Arid West Freshwater Emergent Marsh Group

1. *Typha* (*angustifolia*, *domingensis*, *latifolia*) Herbaceous Alliance (122)

a. *Typha* (*angustifolia*, *latifolia*, *domingensis*) Association (123)

b. *Typha* (*angustifolia*, *latifolia*, *domingensis*) (dead stalks) Mapping Unit (125)

c. *Typha* (*angustifolia*, *latifolia*, *domingensis*) – *Echinochloa crus-galli* Association (120)

d. *Typha* (*angustifolia*, *latifolia*, *domingensis*) – *Distichlis spicata* Association (126)

e. *Typha* (*angustifolia*, *latifolia*, *domingensis*) – *Phragmites australis* Association (129)

f. *Typha* (*angustifolia*, *latifolia*, *domingensis*) – *Schoenoplectus americanus* Association (121)

2. *Schoenoplectus californicus* Herbaceous Alliance (115)

a. *Schoenoplectus californicus* – *Schoenoplectus acutus* Association (116)

b. *Schoenoplectus californicus* – *Schoenoplectus acutus* / *Rosa californica* Association (162)

c. *Schoenoplectus (acutus, californicus)* – *Typha (angustifolia, latifolia, domingensis)* Mapping Unit (157)

d. *Schoenoplectus (acutus, californicus)* – Wetland Herbs Mapping Unit (158)

3. *Phragmites australis* Herbaceous Alliance

- a. *Phragmites australis* Association (103)
 - b. *Phragmites australis* – *Schoenoplectus* spp. Association (104)
 - c. *Phragmites australis* – *Xanthium strumarium* Mapping Unit (105)
 - 4. *Calystegia sepium* – *Euthamia occidentalis* Mapping Unit (330)
 - ii. Vancouverian Coastal/Tidal Marsh and Meadow Group
 - 1. *Potentilla anserina* Alliance (338)
- b. Western North America Vernal Pool Macrogroup**
 - i. Californian Mixed Annual/Perennial Freshwater Vernal Pool/Swale Bottomland Group
 - 1. *Grindelia (stricta)* Provisional Herbaceous Alliance (321)
- c. Western North America Wet Meadow and Low Shrub Carr Macrogroup**
 - i. Californian Warm Temperate Marsh/Seep Group
 - 1. *Juncus arcticus* (var. *balticus*, *mexicanus*) Herbaceous Alliance (131)
 - a. *Juncus arcticus* var. *balticus* Association (132)
 - b. *Juncus arcticus* var. *balticus* – *Conium maculatum* Association (133)
 - c. *Juncus arcticus* var. *balticus* – *Lepidium latifolium* Association (134)
 - d. *Juncus arcticus* var. *balticus* – *Potentilla anserina* Association (135)
 - 2. *Leymus triticoides* Alliance (215)
 - ii. Naturalized Warm-Temperate Riparian And Wetland Group
 - 1. *Lepidium latifolium* Herbaceous Semi-Natural Alliance (324)
 - a. *Lepidium latifolium* – *Distichlis spicata* Semi-Natural Association (323)
 - 2. *Persicaria lapathifolia* – *Xanthium strumarium* Provisional Herbaceous Alliance (328)
 - a. *Polygonum* spp. – *Xanthium strumarium* – *Echinochloa crus-galli* Mapping Unit (329)
 - 3. *Crypsis schoenoides* Mapping Unit (155)
 - 4. *Polypogon monspeliensis* Mapping Unit (238)
 - 5. *Rumex* spp. Mapping Unit (336)
 - 6. *Salsola soda* Mapping Unit (366)
- iv. Temperate and Boreal Salt Marsh Formation**
 - 1. Temperate and Boreal Pacific Coastal Salt Marsh Division**
 - a. North American Pacific Coastal Salt Marsh Macrogroup**
 - i. Temperate Pacific Tidal Salt and Brackish Meadow Group
 - 1. *Bolboschoenus maritimus* Herbaceous Alliance (136)
 - a. *Bolboschoenus maritimus* Association (137)
 - b. *Bolboschoenus maritimus* – *Salicornia pacifica* Association (138)
 - c. *Bolboschoenus maritimus* – *Sesuvium verrucosum* Association (139)
 - 2. *Distichlis spicata* Herbaceous Alliance (156)
 - a. *Distichlis spicata* Association (141)
 - b. *Distichlis spicata* – Annual Grasses Association (142)
 - c. *Distichlis spicata* – *Juncus arcticus* var. *balticus* (*J. arcticus* var. *mexicanus*) Association (145)
 - d. *Distichlis spicata* – *Lotus corniculatus* Mapping Unit (147)
 - e. *Distichlis spicata* – *Salicornia pacifica* Association (148)
 - f. *Distichlis spicata* – *Schoenoplectus americanus* Mapping Unit (149)
 - g. *Distichlis spicata* – *Cotula coronopifolia* Association (153)
 - h. *Distichlis spicata* – *Bolboschoenus maritimus* Mapping Unit (154)
 - i. *Distichlis spicata* – *Juncus balticus* – *Triglochin* spp. – *Glaux maritima* Mapping Unit (160)
 - 3. *Salicornia pacifica* (*Salicornia depressa*) Herbaceous Alliance (361)

- a. *Salicornia pacifica* Association (346)
- b. *Salicornia pacifica* – Annual Grasses Association (347)
- c. *Salicornia pacifica* – *Atriplex prostrata* Association (348)
- d. *Salicornia pacifica* – *Crypsis schoenoides* Association (350)
- e. *Salicornia pacifica* – *Sesuvium verrucosum* Association (356)
- f. *Salicornia pacifica* – *Echinochloa crus-galli* – *Polygonum* – *Xanthium strumarium* Association (364)
- g. *Salicornia pacifica* – *Cotula coronopifolia* Association (365)
- 4. *Spartina foliosa* Herbaceous Alliance (163)
- ii. Western North American Disturbed Alkaline Marsh and Meadow Group
 - 1. *Atriplex prostrata* – *Cotula coronopifolia* Herbaceous Semi-Natural Alliance (339)
 - a. *Cotula coronopifolia* Semi-Natural Association (342)
 - b. *Atriplex prostrata* Semi-Natural Association (311)
 - c. *Atriplex prostrata* – *Distichlis spicata* Semi-Natural Association (312)
 - d. *Atriplex prostrata* – *Bolboschoenus maritimus* Semi-Natural Association (315)
 - e. *Atriplex prostrata* – *Sesuvium verrucosum* Semi-Natural Association (316)
 - f. *Atriplex prostrata* – Annual Grasses Semi-Natural Association (337)
 - 2. *Sesuvium verrucosum* Herbaceous Alliance
 - a. *Sesuvium verrucosum* Association (357)
 - b. *Sesuvium verrucosum* – *Distichlis spicata* Association (358)
 - c. *Sesuvium verrucosum* – *Festuca perennis* Association (359)
 - d. *Sesuvium verrucosum* – *Cotula coronopifolia* Association (362)
 - 3. *Spergularia marina* Provisional Herbaceous Alliance
 - a. *Spergularia marina* – *Cotula coronopifolia* Mapping Unit (360)

2. Western North American Interior Alkali–Saline Wetland Division

a. Warm Semi-Desert/Mediterranean Alkali–Saline Wetland Macrogroup

- i. Southwestern North American Alkali Marsh/Seep Vegetation Group
 - 1. *Schoenoplectus americanus* Herbaceous Alliance (111)
 - a. *Schoenoplectus americanus* Association (114)
 - b. *Schoenoplectus americanus* – *Potentilla anserina* Association (112)
 - c. *Schoenoplectus americanus* – *Schoenoplectus californicus* – *Schoenoplectus acutus* Association (113)
 - d. *Schoenoplectus americanus* – *Lepidium latifolium* Association (127)
- ii. Southwestern North American Salt Basin and High Marsh Group
 - 1. *Atriplex lentiformis* Shrubland Alliance (514)
 - 2. *Frankenia salina* Herbaceous Alliance (320)
 - a. *Frankenia salina* – *Agrostis avenacea* Association (317)
 - b. *Frankenia salina* – *Distichlis spicata* Association (318)

4. Hydromorphic Vegetation (Aquatic Vegetation) Class (370)

a. Saltwater Aquatic Vegetation Subclass

i. Marine and Estuarine Saltwater Aquatic Vegetation Formation

1. Temperate Pacific Saltwater Aquatic Vegetation Division

a. Temperate Pacific Intertidal Shore Macrogroup

- i. Temperate Pacific Intertidal Flat Group
 - 1. *Stuckenia (pectinata)* – *Potamogeton* spp. Alliance
 - a. *Stuckenia pectinata* Association (371)

b. Freshwater Aquatic Vegetation Subclass

i. Freshwater Aquatic Vegetation Formation

1. North American Freshwater Aquatic Vegetation Division

a. Western North American Freshwater Aquatic Vegetation Macrogroup

i. Naturalized Temperate Pacific Freshwater Vegetation Group

1. *Ludwigia (hexapetala, peploides)* Provisional Herbaceous Semi-Natural Alliance (164)

5. Agriculture & Developed Vegetation Class

a. Herbaceous Agricultural Vegetation Subclass

i. Row & Close Grain Crop Formation² (225)

ii. Fallow Field and Weed Vegetation Formation

1. Cropland Fallow Field Division

a. Fallow Field Macrogroup³ (2)

b. Herbaceous & Woody Developed Vegetation Subclass

i. Other Developed Vegetation Formation

1. Other Developed Vegetation Division

a. Tree Developed Vegetation Macrogroup

- i. Temperate Tree Developed Vegetation Group⁴ (910)

Non-Vegetation Mapping Units

- Bare Ground Mapping Unit (1)
- Parking Lot Mapping Unit (3)
- Road Mapping Unit (4)
- Structure Mapping Unit (5)
- Slough Mapping Unit (6)
- Tidal Mudflat Mapping Unit (7)
- Railroad Track Mapping Unit (8)
- Ditch Mapping Unit (9)
- Trail Mapping Unit (10)
- Open Water Mapping Unit (11)
- Freshwater Drainage Mapping Unit (12)
- Water Treatment Pond Mapping Unit (13)
- Urban Area Mapping Unit (14)

Legacy Mapping Units

Californian Broadleaf Forest and Woodland Group

- Oaks Mapping Unit (900)

Southwestern North American Riparian Evergreen and Deciduous Woodland Group

- Willow Trees Mapping Unit (700)

Temperate Tree Developed Vegetation Group (910)

- Fraxinus latifolia* Planted Stands Mapping Unit (912)

Southwestern North American Riparian/Wash Scrub Group

- Tall Wetland Shrubs Mapping Unit (501)
- Medium Wetland Shrubs Mapping Unit (510)

California Annual and Perennial Grassland Macrogroup

² Formerly named Cultivated Annual Graminoid Mapping Unit

³ Formerly named Fallow Discard Field Mapping Unit

⁴ Formerly named Landscape Trees Mapping Unit

Perennial Grass Mapping Unit (226)

Annual Grasses Mapping Unit (231)

Mediterranean California Naturalized Annual and Perennial Grassland Group (227)

Tall Upland Graminoids Mapping Unit (201)

Medium Upland Graminoids Mapping Unit (210)

Short Upland Graminoids Mapping Unit (230)

Tall Upland Herbs Mapping Unit (401)

Medium Upland Herbs Mapping Unit (410)

Short Upland Herbs Mapping Unit (420)

California Coastal Evergreen Bluff and Dune Scrub Group

Medium Upland Shrubs Mapping Unit (601)

Arid West Freshwater Emergent Marsh Group

Tall Wetland Graminoids Mapping Unit (101)

Western North America Wet Meadow and Low Shrub Carr Macrogroup

Medium Wetland Graminoids Mapping Unit (130)

Temperate and Boreal Salt Marsh Formation

Wetland Herbs Mapping Unit (300)

Tall Wetland Herbs Mapping Unit (301)

Medium Wetland Herbs Mapping Unit (310)

North American Pacific Coastal Salt Marsh Macrogroup

Short Wetland Graminoids Mapping Unit (140)

Short Wetland Herbs Mapping Unit (340)

Hydromorphic Vegetation (Aquatic Vegetation) Class

Floating-leaved Wetland Herbs Mapping Unit (370)

Appendix C

Key to Vegetation in Suisun Marsh

This vegetation key was created for vegetation types mapped and sampled in Suisun Marsh and is based on the vegetation classification developed in 1999 that followed the standards of the United States National Vegetation Classification (USNVC) as of 1999. Since then, a great deal of vegetation work has been done in California, and the state and national hierarchies have been refined. Although many alliances and associations from the original classification are equivalent to types in the current USNVC hierarchy, some have no comparable current types. These unmatched vegetation types are labeled “mapping units”.

The Suisun Marsh mapping units are not currently accepted in the USNVC because there is not enough field data to support them. In the future, when the Suisun Marsh vegetation field data is reanalyzed with a larger data set, these mapping units will either be confirmed as distinct types or renamed to better fit an existing type. In future maps, the broadly defined mapping units will not be used, but will be replaced by the corresponding USNVC vegetation types. The corresponding USNVC names for these broader level types can be found in the Suisun Marsh Vegetation Classification and Hierarchy (Appendix B).

This key is intended for use as a guide to the identification of field-based and image interpretation-based vegetation assessments. Each type that has been used in any Suisun Marsh map is followed by its mapping code in parentheses.

Mapping Key Terms and Concepts

Stand: The basic physical unit of plant communities in a landscape. It has no set size. Some vegetation stands are very small, such as certain wetland types, and some may be several square kilometers in size, such as certain forest types. A stand is defined by two main unifying characteristics:

1. It has compositional integrity. Throughout the stand, the combination of species is similar. The stand is differentiated from adjacent stands by a discernible boundary that may be abrupt or occur indistinctly along an ecological gradient.
2. It has structural integrity. It has a similar history or environmental setting that affords relatively similar horizontal and vertical spacing of plant species. For example, a hillside forest originally dominated by the same species that burned on the upper part of the slopes but not the lower would be divided into two stands. Likewise, a sparse woodland occupying a slope with very shallow rocky soils would be considered a different stand from an adjacent slope with deeper, moister soil and a denser woodland or forest of the same species.

The structural and compositional features of a stand are often combined into a term called homogeneity. For an area to meet the requirements of a stand, it must be homogeneous at the scale being considered.

United States National Vegetation Classification (USNVC): A central organizing framework for how all vegetation in the United States is inventoried and studied, from broad scale formations (biomes) to fine scale plant communities. The purpose of the USNVC is to produce uniform statistics about vegetation resources across the nation, based on vegetation data gathered at local, regional, or national levels.

The hierarchy units in the USNVC from highest to lowest (i.e., broadest to finest) are:

1. Class
2. Subclass
3. Formation
4. Division
5. Macrogroup
6. Group
7. Alliance
8. Association

Alliance: Plant communities based on dominant/diagnostic species of the uppermost or dominant stratum. Accepted alliances are part of the USNVC hierarchy.

Association: The most botanically detailed or finest-scale plant community designation based on dominant species and multiple co- or sub-dominant indicator species from any strata. Associations are part of the USNVC hierarchy.

Plant community nomenclature: Species separated by "-" are within the same stratum; species separated by "/" are in different strata. The number that follows some plant community names is the Mapping Code used for labeling plant community polygons for the associated GIS-based plant community map.

Cover: The primary metric used to quantify the importance/abundance of a particular species or a particular vegetation layer within a stand. It is measured by estimating the aerial extent of the living plants, or the bird's-eye view looking from above, for each category. Cover in this mapping project uses the concept of "porosity" or foliar cover rather than "opacity" or crown cover. Thus, field crews are trained to estimate the amount of light versus shade produced by the canopy of a plant or a stratum by taking into account the amount of shade it casts excluding the openings it may have in the interstitial spaces (e.g., between leaves or branches). This is assumed to provide a more realistic estimate of the actual amount of shade cast by the individual or stratum which, in turn, relates to the actual amount of light available to individual species or strata beneath it. However, as a result cover estimates can vary substantially between leaf-on versus leaf-off conditions.

Absolute cover: The actual percentage of the surface area of the survey that is covered by a species or physiognomic group (trees, shrubs, herbaceous), as in "*Salicornia pacifica* covers 10% of the area being surveyed." Absolute cover of all species or physiognomic groups, when added together, may total greater than 100%, because this is not a proportional number and plants can overlap each other. For example, a stand could have 25% tree cover in the upper layer, 40% shrub cover in the middle layer, and 50% herbaceous cover on the ground. However, when aerial interpretation is being

used, the maximum absolute value is 100%, since lower levels of vegetation cannot be seen through the overstory on aerial photographs.

Relative cover: The percentage of surface area within a survey area that is covered either by one species relative to other species within the same physiognomic stratum (tree, shrub, herbaceous) or one stratum relative to the total vegetation cover in a polygon. Thus, 50% relative cover of *Distichlis spicata* in the herb layer means that *D. spicata* comprises half the cover of all herbaceous species within a stand, while 50% relative shrub cover means that shrubs make up half the cover of all vegetation within a stand. Relative cover values are proportional numbers that, when added together, total 100% for all the species within a stratum or each stratum within a stand of vegetation.

Dominance: Dominance refers to the preponderance of vegetation cover in a stand of uniform composition and site history. It may refer to cover of an individual species as in "dominated by *Salicornia pacifica*," or it may refer to dominance by a physiognomic group, as in "dominated by herbs." When we use the term in the key, a species is dominant if it is in relatively high cover in each stand, however, see "dominance by layer," below.

Strongly dominant: A species in the dominant life form stratum has 60% or greater relative cover.

Co-dominant: Co-dominance refers to two or more species in a stand with similar cover. Specifically, each species has between 30% to 60% relative cover. For example in a coastal scrub stand with 5% *Baccharis pilularis*, 4% *Frangula californica*, and 3% *Rubus ursinus* (total 13% shrub cover), technically only the *Baccharis* ($5/13 = 39\%$ relative cover) and the *Frangula* ($4/13 = 31\%$ relative cover) would be co-dominant because *Rubus* would only have 23% relative cover ($3/13 = 23\%$).

Consistent/Characteristic/Diagnostic species: Should be present in at least 80% of the stands of the type, with no restriction on cover. Relatively even spacing throughout the stand is important particularly in vegetation with low total cover since an even distribution of the diagnostic species is a much better indicator than overall cover. Characteristic species that are evenly distributed are better indicators of a type than species with higher cover and patchy distribution.

Dominance by layer: Tree, shrub, and herbaceous layers are considered physiognomically distinct. A vegetation type is considered to belong to a certain physiognomic group if it is dominated by one layer. Layers are prioritized in order of height. If the tallest layer is dominant and characteristic (see definitions above) across multiple stands of one type, the alliance is usually named by the dominant and/or characteristic species of the tallest layer. Average covers within the dominant layer reflect the "modal" concept of the health/age/environment of a particular vegetation type. For example, a higher average cover of woody plants within a stand not recently affected by disturbance reflects a mode of general availability of water, nutrition, and equitable climate, while lower average cover under similar conditions would reflect lower availability of these things.

Woody plant: A vascular plant species that has a noticeably woody stem (e.g., shrubs and trees). It does not include herbaceous species with woody underground portions such as tubers, roots, or rhizomes.

Tree: A one-stemmed woody plant that normally grows to be greater than 5 meters tall. In some cases, trees may be multi-stemmed (ramified due to fire or other disturbance) but the height of mature plants typically exceeds 5 meters. If less than 5 meters tall, undisturbed individuals of these species are usually single-stemmed. Certain species that resemble shrubs sometimes but may be trees in other areas (e.g., *Aesculus californica*) are, out of statewide tradition or by the USNVC, called trees. It behooves one to memorize which species are “traditionally” placed in one life-form or another. We use the accepted lifeforms in the USNVC or the PLANTS Database (USDA NRCS 2015) to do this.

Emergent: A plant (or vegetation layer) is considered emergent if it has a low cover and rises above a layer with more cover in the stand. For example, individual *Pseudotsuga menziesii* trees may comprise an emergent tree layer of 2% cover over dense *Gaultheria shallon* and *Rubus parviflorus* in the shrub understory; the stand would be considered within the *Gaultheria shallon* – *Rubus (ursinus)* Shrubland Alliance because the total tree cover is <10% and the shrub cover is >10%. Medium to tall shrubs are not considered emergent over shorter shrubs, but short trees are considered emergent over tall shrubs.

Shrub: A multi-stemmed woody plant that is usually 0.2–5 meters tall. Definitions are blurred at the low and high ends of the height scales. At the tall end, shrubs may approach tree-size based on disturbance frequencies (e.g., old-growth re-sprouting chaparral species such as *Cercocarpus montanus*, *Fremontodendron californicum*, *Prunus ilicifolia*, and so forth, may frequently attain "tree size," but are still typically multi-stemmed and are considered shrubs in this key). At the short end, woody perennial herbs or sub-shrubs of various species are often difficult to categorize into a consistent life-form (e.g., *Eriogonum latifolium*, *Lupinus chamissonis*); in such instances, we refer to the PLANTS Database or “pick a lane” based on best available definitions.

Subshrub: A multi-stemmed plant with noticeably woody stems less than 0.5 meter tall. May be easily confused with a perennial herb or small shrub. We lump them into the “shrub” category in stand tables and descriptions of vegetation types.

Shrub-characterized vegetation: Shrubs (including sub-shrubs) are evenly distributed throughout the stand, providing a consistent (even if sparse) structural component; the stand cannot be characterized as a tree stand; and one or both of the following criteria are met: (1) shrubs influence the distribution or population dynamics of other plant species; (2) shrubs play an important role in ecological processes within the stand. For the purposes of this project, shrub alliances have at least 10% absolute shrub cover.

Herbaceous plant: Any species of plant that has no main woody stem development; includes grasses, forbs, and perennial species that die back each year.

Herb-characterized vegetation: Herbs are evenly distributed throughout the stand, providing a consistent (even if sparse) structural component and play an important role

in ecological processes within the stand. The stand cannot be characterized as a tree or shrub stand.

Botanical nomenclature: We use the PLANTS Database in vegetation mapping as our standard for botanical names. In certain cases, if a plant is recognized by *The Jepson Manual (second edition)*, but not PLANTS Database, we default to the Jepson name.

Key to Main Vegetation Divisions:

1. **Herbaceous Vegetation:** Vegetation dominated by non-woody herbaceous species including grasses, graminoids, and broad-leaved herbaceous species. Tall shrub species, if present, are of lower cover than herbs (<10%). Subshrubs, if present, may form significant cover (up to 30%), but are never taller than dominant herbaceous vegetation. Trees, if present, compose <10% cover.

2. **Shrub Vegetation:** Vegetation dominated by woody shrubs or sub-shrubs. Trees, if present, generally have <10% cover in the stand, herbaceous species may total higher cover than shrubs, but are shorter in stature. Shrubs are always at least 10% cover.

3. **Tree Vegetation:** Vegetation dominated by trees (at least 5 m tall). Tree canopy may be as low as 10% over denser sub-canopies of shrub and herbaceous species.

1. **Herbaceous Vegetation:**

a. **Vegetation dominated by grass or grass-like species**

- i. Upland grasslands generally not associated with saturated soil or tidal influence throughout the growing season, shrubs generally less than 10% cover or, if more, sub-shrubs are over-topped by the dominant grass species. If *Distichlis spicata* and/or *Salicornia pacifica* are present at greater than 10% relative cover then go to the sections for those alliances.

Mediterranean Californian Naturalized Annual and Perennial Grassland Group (227)

1. Grasslands dominated by annual grass species with no more than 15% relative cover of native perennial species present in any stand. Dominant species include *Hordeum murinum*, *Bromus* spp., *Festuca perennis*, and *Avena* spp.

California Annual and Perennial Grassland Macrogroup¹

- a. Vegetation dominated by the annual non-native Italian ryegrass (*Festuca perennis*), although other non-native annual grasses (*Bromus hordeaceus*, *Hordeum* spp.) may be present in lower cover. A common alliance of disked fields and managed uplands in the Marsh, generally considered upland, but stands may be flooded or saturated for short periods in the winter and early spring.

***Festuca perennis* Semi-Natural Alliance (218)**

- i. *Festuca perennis* co-occurs in stands with significant amounts (>1 – <50% cover) of *Lepidium latifolium*

***Festuca perennis* – *Lepidium latifolium* Semi-Natural Association (220)**

- ii. *Festuca perennis* occurs with significant portion of *Rumex crispus* or other *Rumex* species; does not have significant *Lepidium latifolium* cover.

***Festuca perennis* – *Rumex* spp. Mapping Unit (222)**

¹ Formerly called Annual Grasses Mapping Unit (231)

b. Stands dominated by annual non-native *Bromus* spp. (mainly *B. hordeaceus*) and *Hordeum* (including *H. marinum* and *H. murinum*) generally occur in more upland settings than the *Festuca perennis* Alliance.

***Bromus (diandrus, hordeaceus) – Brachypodium distachyon* Semi-Natural Alliance (232)**

c. Stands dominated by either *Hordeum murinum* or *H. marinum* but with a significant (>10 %) mixture of *Festuca perennis*.

***Hordeum marinum – Festuca perennis* Mapping Unit (234)**

d. Stands dominated by annual species of *Vulpia* (typically *V. myuros*, rattail fescue) intermixed with a taller scattered emergent overstory of western goldenrod (*Euthamia occidentalis*).

***Vulpia* spp. – *Euthamia occidentalis* Mapping Unit (235)**

e. Annual grass-dominated mapping unit distinguished by heavily managed site history. Species are various, but are planted, mowed and/or cultivated regularly.

Row & Close Grain Crop Formation (225)²

2. Grasslands and stands of graminoids (grass-like species) with at least 50% relative cover of perennial species.

California Annual and Perennial Grassland Macrogroup³

a. Upland perennial grassland stands averaging between 0.5 m and 1 m in height.

Mediterranean California Naturalized Annual and Perennial Grassland Group (227)⁴

i. Stands dominated (>50% relative cover) by the native creeping ryegrass *Leymus triticoides*. Stands are generally narrow bands of wetland-upland borders including natural ecotones between *Distichlis spicata* Alliance and *Festuca perennis* Alliance, *Bromus–Hordeum* Association, or other annual grass stands. Also occurs along levee tops and margins of marsh adjacent to vegetation of intermittent flooding zone.

***Leymus triticoides* Alliance (215)**

ii. Stands dominated (> 50% relative cover) by the introduced perennial bunchgrass *Agrostis avenacea*. Scattered throughout the marsh, usually in small stands in open disturbed areas, usually associated with other non-native annual species.

***Agrostis avenacea* Mapping Unit (228)**

b. Upland grassland stands dominated by tall perennial grasses generally >1 m in height.

² Formerly called Cultivated Annual Graminoid Mapping Unit

³ Formerly called Perennial Grass Mapping Unit (226)

⁴ Formerly called Medium Upland Graminoids Mapping Unit (210)

**Mediterranean California Naturalized Annual and Perennial
Grassland Group (227)⁵**

- i. Stands dominated by the very large, tall, non-native pampas grass *Cortaderia selloana*. Stands are generally small but conspicuous, and occur in moist areas in the ecotone between wetlands and uplands. Some stands occur in wetlands.

Cortaderia (jubata, selloana) Semi-Natural Herbaceous Alliance (202)

- ii. Stands dominated strongly by the large non-native tall wheatgrass *Elytrigia pontica*, typically planted in upland or intermittently flooded alkaline fields within the marsh, as at Grizzly Island.

Elytrigia pontica Mapping Unit (211)

- iii. Stands dominated by the tall bunch grass Canary Grass *Phalaris aquatica*. Usually small stands along levees, but may occur in larger upland stands adjacent to the marsh (e.g., Rush Ranch).

Phalaris aquatica Herbaceous Semi-Natural Association (223)

- c. A mapping unit defined by short (<0.5 m) perennial grass/graminoid dominance of unknown composition.

**Mediterranean California Naturalized Annual and Perennial
Grassland Group (227)⁶**

- ii. Wetland grasslands and stands dominated or co-dominated by graminoids (*Juncus* spp., *Carex* spp., *Schoenoplectus* spp., *Typha* spp.). Occurs in conditions where substrate is intermittently, temporarily, or permanently saturated or flooded throughout the growing season. Some stands have a significant broad-leaf herbaceous component, but in all stands, the portion of the total vegetative cover composed of grasses/graminoids is nearly equal to, or greater than, that of broad-leaf herbs.

- 1. Stands dominated or co-dominated by grasses and graminoids generally between 0.5 m and 1 m tall. A mapping unit with unspecified species dominance.

**Western North America Wet Meadow and Low Shrub Carr
Macrogroup⁷**

- a. Stands dominated by rabbit's foot grass, *Polypogon monspeliensis*, usually in vernal wet areas in borders between wetland and upland vegetation, but may occur in areas with saturated ground through the early summer months. This mapping unit includes all stands of *Polypogon*. May have various subordinate species of herbs and grasses, but *Polypogon* is >50% relative cover.

Polypogon monspeliensis Mapping Unit (238)

⁵ Formerly called Tall Upland Graminoids Mapping Unit (201)

⁶ Formerly called Short Upland Graminoids Mapping Unit (230)

⁷ Formerly called Medium Wetland Graminoids Mapping Unit (130)

b. Vegetation dominated by the stoloniferous (clonal) rush *Juncus balticus* (including some individuals more closely resembling *Juncus mexicanus*), often associated with other taller or shorter herbaceous species. Usually in temporarily saturated wetlands not inundated for extensive periods.

***Juncus arcticus* (var. *balticus*, *mexicanus*) Herbaceous Alliance (131)**

- i. Stands strongly dominated by *Juncus balticus* with low cover of other species.

***Juncus arcticus* var. *balticus* Association (132)**

- ii. *Conium maculatum* (poison hemlock) forms an overstory of varying cover (sometimes approaching cover of the underlying *Juncus*) generally in disturbed fields and wetland borders.

***Juncus arcticus* var. *balticus* – *Conium maculatum* Association (133)**

- iii. *Juncus balticus* forms the principal ground layer with the often somewhat taller non-native *Lepidium latifolium* (perennial pepperweed) as a principal associate. Found in both managed and unmanaged sites, uncommon.

***Juncus arcticus* var. *balticus* – *Lepidium latifolium* Association (134)**

- iv. Stands with a taller graminoid layer of *Juncus balticus* with a sparse to dense short herbaceous understory characterized by *Potentilla anserina* (may include several other native herbs).

***Juncus arcticus* var. *balticus* – *Potentilla anserina* Association (135)**

c. Vegetation of seasonally wet flats and pond bottoms, dominated (>50% relative cover) by *Bolboschoenus maritimus* (alkali bulrush) in the taller herb/graminoid layer. May include short herbs or grasses with near equal or higher cover than the taller *B. maritimus*. Some stands also include the similar species *Bolboschoenus robustus*, or hybrids between the two.

***Bolboschoenus maritimus* Herbaceous Alliance (136)**

- i. Vegetation strongly dominated by *Bolboschoenus maritimus* (alkali bulrush) with no other species with significant cover.

***Bolboschoenus maritimus* Association (137)**

- ii. Vegetation with an overstory of *Bolboschoenus maritimus* and/or *B. robustus* with a shorter layer of *Salicornia pacifica* at higher or lower cover. If both *Sesuvium* and *Salicornia* are present in near equal cover, then *Salicornia* is considered the indicator species.

***Bolboschoenus maritimus* – *Salicornia pacifica* Association (138)**

- iii. Vegetation with an overstory of *Bolboschoenus maritimus* and/or *B. robustus* with a shorter, nearly equal or lower cover of *Sesuvium verrucosum* (sea purslane). If both *Salicornia* and *Sesuvium* are present, then the cover of *Sesuvium* must greatly exceed that of *Salicornia* for *Sesuvium* to be the indicator species.

***Bolboschoenus maritimus* – *Sesuvium verrucosum* Association (139)**

d. Vegetation of tidally inundated mudflats, dominated by the native cordgrass *Spartina foliosa*, localized at the southwest edge of Suisun Marsh.

***Spartina foliosa* Herbaceous Alliance (163)**

2. Stands dominated by annual or perennial grasses less than 0.5 m tall. May include taller overstory grass or herbaceous species, but these are not the dominant species.

North American Pacific Coastal Salt Marsh Macrogroup⁸

a. Short annual grass-dominated stands dominated by the low annual swamp timothy *Crypsis schoenoides*. Found in winter and vernal flooded flats and pools. Vegetation is generally scattered, with intervening small to large openings of dry, cracked mud during summer.

***Crypsis schoenoides* Mapping Unit (155)**

b. Stands usually dominated (>50% relative cover) by salt grass, *Distichlis spicata*, or if not dominant, salt grass has higher cover than any other single species.

***Distichlis spicata* Herbaceous Alliance (156)**

i. Stands strongly dominated by salt grass with no other species greater than 5% cover.

***Distichlis spicata* Association (141)**

ii. Stands with an overstory of *Atriplex prostrata* covering at least 40% relative cover and an understory of *Distichlis spicata* (salt grass) which may approach or even exceed *A. prostrata* in total cover.

***Atriplex prostrata* – *Distichlis spicata* Semi-Natural Association (312)**

iii. Stands of salt grass with the annual *Cotula coronopifolia* (brass-buttons) as a subordinate species.

***Distichlis spicata* – *Cotula coronopifolia* Association (153)**

iv. Stands of salt grass with *Juncus balticus* (or *J. mexicanus*) as principal subordinate species (>5% relative cover).

***Distichlis spicata* – *Juncus arcticus* var. *balticus* (*J. arcticus* var. *mexicanus*) Association (145)**

v. Stands of salt grass with *Lotus corniculatus* (bird's foot trefoil) as major subordinate species.

***Distichlis spicata* – *Lotus corniculatus* Mapping Unit (147)**

vi. Stands of salt grass with pickleweed (*Salicornia pacifica*) as major subordinate species. *Salicornia* may be from 1/3 to almost equal cover of *Distichlis*.

***Distichlis spicata* – *Salicornia pacifica* Association (148)**

vii. Salt grass is the major low grass species with emergent *Schoenoplectus americanus* (three square) conspicuous, but less than 40% cover.

***Distichlis spicata* – *Schoenoplectus americanus* Mapping Unit (149)**

viii. Salt grass is the major short ground cover with a sparse to intermittent overstory of cattails (typically *Typha angustifolia*, but may include *T. latifolia* and/or *T. domingensis*).

⁸ Formerly called Short Wetland Graminoids Mapping Unit (140)

Typha (angustifolia, latifolia, domingensis) – Distichlis spicata
Association (126)

- ix. Salt grass is the major ground cover, associated with a variety of native tidal marsh species including *Juncus balticus*, *Triglochin maritima*, *Glaux maritima*, *Jaumea carnosa*, and *Limonium californicum*.

Distichlis spicata – Juncus balticus – Triglochin spp. – Glaux maritima
Mapping Unit (160)

- x. Salt grass and alkali bulrush co-dominate.

Distichlis spicata – Bolboschoenus maritimus
Mapping Unit (154)

- xi. Stands composed of a mixture of salt grass and non-native annual grasses. *Distichlis* may be dominant or share dominance (as low as 40% relative cover) with annual grass species (primarily *Polypogon*, *Festuca perennis*, and/or *Hordeum* spp.). Annuals generally cover at least 10%.

Distichlis spicata – Annual Grasses
Association (142)

- c. Stands dominated by the low, introduced Bermuda grass *Cynodon dactylon*. Generally associated with human structures or disturbed levee tops, occasional throughout the marsh.

Cynodon dactylon
Mapping Unit (161)

3. Stands dominated (at least 10% cover over a sometimes greater cover of shorter herbs and graminoids) by tall (generally >1 m) wetland grasses and graminoids, including cattails (*Typha* spp.), tules and bulrushes (*Schoenoplectus* spp.), and reeds (*Arundo donax* and *Phragmites australis*).

Arid West Freshwater Emergent Marsh Group⁹

- a. Vegetation dominated by California bulrush *Schoenoplectus californicus* and/or the ecologically and morphologically similar giant bulrush, *Schoenoplectus acutus*. Locally *S. californicus* appears to be more abundant than *S. acutus*, but both appear frequently in the same stands. Occasionally *Typha* spp. may occur in equal or higher cover than the *Schoenoplectus* spp., but *Schoenoplectus californicus* or *Schoenoplectus acutus* always has at least 10% relative cover.

Schoenoplectus californicus
Herbaceous Alliance (115)

- i. Stands dominated by *Schoenoplectus acutus* and/or *S. californicus* with little (<20% relative cover) or no other species present.

Schoenoplectus californicus – Schoenoplectus acutus
Association (116)

⁹ Formerly called Tall Wetland Graminoids Mapping Unit (101)

- ii. Stands dominated in the overstory by *Schoenoplectus californicus* and/or *S. acutus* with a lower (down to 2%) to somewhat higher cover of *Typha angustifolia*, *T. latifolia*, and/or *T. domingensis*. May have up to 50% cover of wetland herbs (*Polygonum*, *Epilobium*, *Euthamia*, etc.).

Schoenoplectus (acutus, californicus) – Typha (angustifolia, latifolia, domingensis) Mapping Unit (157)

- iii. Stands dominated by *Schoenoplectus californicus* and/or *S. acutus* with an understory of >12% cover that is a varying mixture of mostly native perennial herbs, such as *Euthamia occidentalis*, *Aster lentus*, *A. subulatus*, *Artemisia douglasiana*, *Baccharis douglasiana*, *Achillea millefolium*, and *Stachys ajugoides*. May also include *Lepidium*.

Schoenoplectus (acutus, californicus) – Wetland Herbs Mapping Unit (158)

- iv. *Rosa californica* is present (as low as 5% cover) with *Schoenoplectus californicus* and/or *S. acutus*. Usually found along levees bordering sloughs and channels.

Schoenoplectus californicus – Schoenoplectus acutus / Rosa californica Association (162)

- b. Stands dominated by cattail species including *Typha angustifolia*, *T. latifolia*, and *T. domingensis*. The distinguishing features of these three species are often blurred in the marsh and there is frequent evidence of hybridization. Different *Typha* species are often found in the same stand and are considered ecologically equivalent. Throughout most of the marsh, narrow-leaved forms (*T. angustifolia/omingensis*) predominate.

Typha (angustifolia, domingensis, latifolia) Alliance (122)

- i. *Typha* species are strongly dominant.

Typha (angustifolia, latifolia, domingensis) Association (123)

- ii. *Typha* species are strongly dominant but only dead standing stalks are remaining.

Typha (angustifolia, latifolia, domingensis) (dead stalks) Mapping Unit (125)

- iii. *Typha* spp. dominate over a short understory of salt grass (*Distichlis spicata*). Generally occurs in managed wetlands where fields and ponds have had a combination of flooding and mechanical disturbance.

Typha (angustifolia, latifolia, domingensis) – Distichlis spicata Association (126)

- iv. Stands dominated by *Typha* spp. with lesser cover of the common reed *Phragmites australis*.

Typha (angustifolia, latifolia, domingensis) – Phragmites australis Association (129)

- v. Stands dominated by *Typha* spp. with a mixture of *Echinochloa crus-galli*, *Polygonum lapathifolium*, and/or *Xanthium strumarium*. Usually

occurs in managed wetland ponds that have held water late into the growing season.

Typha (angustifolia, latifolia, domingensis) – Echinochloa crus-galli Association (120)

- vi. *Typha* spp. dominate with three-square (*Schoenoplectus americanus*) as a common component. *S. americanus* may equal cover of *Typha* or be as low as 10% relative cover if no other tall graminoids are present. Found at the edges of tidal sloughs and ditches.

Typha (angustifolia, latifolia, domingensis) – Schoenoplectus americanus Association (121)

- c. Stands dominated (>50% relative cover) by the American bulrush (three-square), *Schoenoplectus americanus*. *S. americanus* stands generally occupy portions of the marsh that are saturated, but not permanently flooded, often along the upper reaches of tidally influenced sloughs, creeks, and ditches.

Schoenoplectus americanus Herbaceous Alliance (111)

- i. Stand is strongly dominated by *Schoenoplectus americanus* with no other species with significant cover.

Schoenoplectus americanus Association (114)

- ii. *Schoenoplectus americanus* is dominant in the overstory with a significant understory of *Lepidium latifolium*, which may approach *S. americanus* in total cover. Tends to replace native associations such as *S. americanus – Potentilla anserina* along small tidal creeks and channels.

Schoenoplectus americanus – Lepidium latifolium Association (127)

- iii. *Schoenoplectus americanus* is dominant in the overstory with native *Potentilla anserina* as the principal understory species; occurs along small tidal creeks and ditches in non-managed portions of the marsh.

Schoenoplectus americanus – Potentilla anserina Association (112)

- iv. *Schoenoplectus americanus* may dominate or be co-dominant with *Schoenoplectus californicus* and/or *S. acutus*, usually along deeper or wider sloughs and channels than the previous two associations.

Schoenoplectus americanus – Schoenoplectus californicus – Schoenoplectus acutus Association (113)

- d. Common reed (*Phragmites australis*) is the principal dominant species (>50% relative cover). Generally forming close-ranked clonal stands, the largest and most widespread occur in managed portions of the marsh.

Phragmites australis Herbaceous Alliance

- i. Stands strongly dominated by *Phragmites* without significant cover of any other species.

Phragmites australis Association (103)

- ii. *Phragmites* dominates (>50% relative cover) in association with *Schoenoplectus acutus* and/or *S. californicus*, generally along slough and larger channel banks throughout marsh.

***Phragmites australis* – *Schoenoplectus* spp. Association (104)**

- iii. Stands of *Phragmites* mixed with *Xanthium strumarium* (cocklebur). Usually found in managed wetland ponds and seasonally flooded flats.

***Phragmites australis* – *Xanthium strumarium* Mapping Unit (105)**

- e. Clonal dense stands of *Arundo donax* (giant reed), generally small and locally distributed near settlements and roads in marsh.

***Arundo donax* Association (102)**

b. Vegetation dominated by annual or perennial forbs

i. Upland stands.

1. Vegetation dominated by tall (>1 m) non-native annual forbs of uplands including species such as *Raphanus sativa*, *Brassica nigra*, and *Conium maculatum*. May have an understory of annual grasses with equal or higher cover (overstory needs to be at least 10% cover, evenly distributed over the stand). Disturbed fields, levees, railroad sidings.

Mediterranean California Naturalized Annual and Perennial Grassland Group (227)¹⁰

- a. Stands dominated by *Brassica nigra* (black mustard).

***Brassica nigra* Semi-Natural Association (406)**

- b. Stands dominated by *Conium maculatum* (poison hemlock).

***Conium maculatum* Semi-Natural Association (402)**

- c. Stands dominated by *Foeniculum vulgare* (fennel).

***Foeniculum vulgare* Semi-Natural Association (403)**

- d. Stands dominated by *Raphanus sativus* (wild radish).

***Raphanus sativus* Semi-Natural Association (405)**

2. Vegetation dominated by short herbs (< 0.5 m tall) found in upland portions of the mapping area.

Mediterranean California Naturalized Annual and Perennial Grassland Group (227)¹¹

- a. Vegetation dominated (>50% relative cover) by perennial non-native iceplant (*Carpobrotus edulis*), generally local in marsh area on levees and areas adjacent to buildings.

***Carpobrotus edulis* or Other Ice Plants Herbaceous Semi-Natural Alliance (421)**

3. Vegetation dominated by medium (0.5-1 m tall) upland herbs.

Mediterranean California Naturalized Annual and Perennial Grassland Group (227)¹²

Stands dominated (at least in summer) by yellow star thistle *Centaurea solstitialis*. Occurs in narrow upland belts, as on levee tops, or in broad expanses in uplands adjacent to the marsh, as in the Garibaldi Unit or

¹⁰ Formerly called Tall Upland Herbs Mapping Unit (401)

¹¹ Formerly called Short Upland Herbs Mapping Unit (420)

¹² Formerly called Medium Upland Herbs Mapping Unit (410)

Rush Ranch. Some stands occur within drier managed areas (Grizzly Island Wildlife Area, Montezuma Wetlands, private clubs).

Centaurea (solstitialis, melitensis) Semi-Natural Alliance (413)

- ii. Wetland stands having prolonged periods of inundation or soil saturation, although may be dry during the summer months.
 - 1. Vegetation dominated (>50% relative cover in tallest layer) by medium height (0.5-1 m) herbaceous wetland species.

Temperate and Boreal Salt Marsh Formation¹³

a. Species-rich stands characterized by the presence of *Calystegia sepium* and/or *Euthamia occidentalis*, but often including many other native and non-native wetland herbs such as *Achillea millefolium*, *Artemisia douglasiana*, and *Lepidium latifolium*. Found on the outboard side of a levee mingling with the *Schoenoplectus (acutus, californicus)*. If co-dominant with *Schoenoplectus (acutus, californicus)* then go to *Schoenoplectus californicus* Alliance.

***Calystegia sepium – Euthamia occidentalis* Mapping Unit (330)**

b. Stands dominated or characterized by *Atriplex prostrata* (fat hen). Generally found in managed temporarily or intermittently flooded saline or slightly saline wetlands. This is a late season species that is generally ephemeral and may wax and wane from year to year.

***Atriplex prostrata – Cotula coronopifolia* Herbaceous Semi-Natural Alliance (339)¹⁴**

- i. Stands strongly dominated by *Atriplex prostrata* (with few other species, none greater than 5% cover).

***Atriplex prostrata* Semi-Natural Association (311)**

- ii. Stands with an overstory of *Atriplex prostrata* (at least 40% relative cover) and an understory of *Distichlis spicata* (salt grass) which may approach or even exceed *A. prostrata* in total cover.

***Atriplex prostrata – Distichlis spicata* Semi-Natural Association (312)**

- iii. Stands with an overstory of *Atriplex prostrata* and an understory of annual non-native grasses including *Polypogon*, *Hordeum* spp., *Festuca perennis*, and *Bromus* spp. Annual grasses are >10% absolute cover.

***Atriplex prostrata – Annual Grasses* Semi-Natural Association (337)**

- iv. Stands characterized by a mixture of *Atriplex prostrata* and *Bolboschoenus maritimus* (alkali bulrush).

***Atriplex prostrata – Bolboschoenus maritimus* Semi-Natural Association (315)**

- v. Stands characterized by a mixture of *Atriplex prostrata* with a short understory of *Sesuvium verrucosum*.

***Atriplex prostrata – Sesuvium verrucosum* Semi-Natural Association (316)**

¹³ Formerly called Medium Wetland Herbs Mapping Unit (310)

¹⁴ Formerly called *Atriplex prostrata* Alliance.

c. Vegetation of regularly disturbed winter and vernal wet ponds and fields, usually on fine-grained clay-rich soils. *Xanthium strumarium*, *Persicaria lapathifolia*, or other knotweed species are dominant or co-dominant in the herbaceous layer

***Persicaria lapathifolia* – *Xanthium strumarium* Provisional Herbaceous Alliance (328)**

- i. Stand may be dominated by any of the three following species, but typically has *Polygonum lapathifolium* and *Echinochloa crus-galli* as the two main species. Occasionally *Xanthium strumarium* (cocklebur) may be rare or even absent.

***Polygonum* spp. – *Xanthium strumarium* – *Echinochloa crus-galli* Mapping Unit (329)**

d. *Frankenia salina* (alkali heath) is dominant or important, and may have equal or somewhat higher cover of *Distichlis* or annual grasses. Generally found in seasonally moist or intermittently flooded clayey saline soils.

***Frankenia salina* Herbaceous Alliance (320)**

- i. *Frankenia salina* is dominant with conspicuous tufts of *Agrostis avenacea*.

***Frankenia salina* – *Agrostis avenacea* Association (317)**

- ii. *Frankenia salina* is important, with lower to slightly higher cover of *Distichlis*.

***Frankenia salina* – *Distichlis spicata* Association (318)**

e. Stands dominated by the diffuse perennial herb *Grindelia stricta* var. *stricta* (gum plant). May contain a variety of subordinate species, some weedy, some native. Typically found on the edges of wetlands on slightly elevated or drier ground than adjacent vegetation, such as natural or constructed levees, road margins, etc.

***Grindelia (stricta)* Provisional Herbaceous Alliance (321)**

f. Stands dominated by the invasive *Lepidium latifolium* (perennial pepperweed); may occur in temporarily flooded, intermittently flooded, and saturated wetlands, typically in at least slightly saline soils. Appears to be expanding in the marsh and is particularly threatening to native tidal marsh vegetation such as *Schoenoplectus americanus*, *Juncus balticus*, and *Distichlis spicata* Alliance stands (as at Rush Ranch).

***Lepidium latifolium* Herbaceous Semi-Natural Alliance (324)**

- i. Stands dominated by *Lepidium latifolium* with an understory of salt grass.

***Lepidium latifolium* – *Distichlis spicata* Semi-Natural Association (323)**

g. Stands dominated by *Potentilla anserina* (silverweed). A relatively localized type of non-managed tidal marsh, often with a sparse overstory (1-15%) of *Juncus balticus* and/or *Schoenoplectus americanus*.

***Potentilla anserina* Alliance (338)**

h. Stands dominated by *Rumex* spp. (*Rumex crispus*, *R. pulcher*, *R. conglomeratus* are most common). Generally found in winter flooded and/or saturated fields and flats, often with near equivalent cover of annual grasses in the understory.

***Rumex* spp. Mapping Unit (336)**

i. Vegetation dominated or co-dominated by *Euthamia occidentalis* and *Vulpia* spp. Stands that key here will have near equivalent cover of both species. Stands that have more *Vulpia* cover can be keyed in the annual upland grass section.

***Vulpia* spp. – *Euthamia occidentalis* Mapping Unit (235)**

j. Stands dominated or co-dominated by *Salsola soda*. Large stands originated on the Hill Slough Unit.

***Salsola soda* Mapping Unit (366)**

2. Stands of wetland vegetation characterized by the dominance of short (<0.5 m) herbaceous species.

North American Pacific Coastal Salt Marsh Macrogroup¹⁵

a. Stands dominated or co-dominated by the non-native annual *Cotula coronopifolia* (brass buttons) and/or the native *Sesuvium verrucosum* (sea purslane). Usually of saline, temporarily flooded, often managed wetlands.

***Atriplex prostrata* – *Cotula coronopifolia* Herbaceous Semi-Natural Alliance (339)¹⁶**

i. Stands strongly dominated by *Cotula coronopifolia* with little or no significant cover from other species.

***Cotula coronopifolia* Semi-Natural Association (342)**

b. Stands dominated or co-dominated by the native annual herb *Sesuvium verrucosum* (sea purslane).

***Sesuvium verrucosum* Herbaceous Alliance**

i. *Sesuvium verrucosum* is dominant or important. Other herbs (non-grass) such as *Cotula coronopifolia* and *Spergularia marina* may form near equal cover.

***Sesuvium verrucosum* Association (357)**

ii. *Sesuvium verrucosum* is dominant with light to near equal cover of salt grass (*Distichlis spicata*).

***Sesuvium verrucosum* – *Distichlis spicata* Association (358)**

iii. *Sesuvium verrucosum* is dominant with *Cotula coronopifolia*. *Cotula* cover ranges from 1-20%.

***Sesuvium verrucosum* – *Cotula coronopifolia* Association (362)**

iv. *Sesuvium verrucosum* occurs with the annual grass *Festuca perennis*.

***Sesuvium verrucosum* – *Festuca perennis* Association (359)**

¹⁵ Formerly called Short Wetland Herbs Mapping Unit (340)

¹⁶ Formerly called *Cotula coronopifolia* Alliance

c. Stands dominated or co-dominated by the non-native, yellow-flowered *Lotus corniculatus* (bird's foot trefoil); often found at the edges of intermittently flooded wetlands; may occur with an equal or slightly higher cover of annual grasses such as *Festuca perennis* (e.g., up to 60% grass and 40% *Lotus*).

***Festuca perennis* – *Lotus corniculatus* Semi-Natural Association (344)¹⁷**

d. Stands dominated by *Spergularia marina* (salt marsh sand spurry) with *Cotula* as an associate.

***Spergularia marina* – *Cotula coronopifolia* Mapping Unit (360)**

e. Vegetation dominated (at least 10% cover over a sometimes higher cover of short annual or perennial grasses) by the native perennial salt marsh sub-shrubby or herbaceous pickleweed (*Salicornia pacifica*).

***Salicornia pacifica* (*Salicornia depressa*) Herbaceous Alliance (361)¹⁸**

i. Vegetation dominated solely by *Salicornia pacifica*; more than twice as much cover of *Salicornia* than of any other combination of species in the stand.

***Salicornia pacifica* Association (346)**

ii. Vegetation dominated by *Salicornia pacifica* with a variable amount of *Atriplex prostrata*. May include other species such as *Bolboschoenus maritimus* or *Bassia*, but these are usually of lower total cover than *A. prostrata*. A common type in managed wetlands.

***Salicornia pacifica* – *Atriplex prostrata* Association (348)**

iii. Vegetation dominated by *Salicornia pacifica* with an ephemeral annual component of *Cotula coronopifolia* (brass buttons), which may cover enough ground to co-dominate in the early growing season.

***Salicornia pacifica* – *Cotula coronopifolia* Association (365)**

iv. Vegetation dominated by *Salicornia pacifica* mixed with a short intermittent layer of *Crypsis schoenoides* (swamp timothy).

***Salicornia pacifica* – *Crypsis schoenoides* Association (350)**

v. Vegetation co-dominated by *Salicornia pacifica* and *Distichlis spicata*; either species may be > or = 30% relative cover.

***Distichlis spicata* – *Salicornia pacifica* Association (148)**

vi. Vegetation dominated by *Salicornia pacifica* but with a mixture of relatively tall non-native and native herbs and graminoids including *Echinochloa crus-galli*, *Polygonum lapathifolium*, and *Xanthium strumarium*. Typically found in managed wetlands.

***Salicornia pacifica* – *Echinochloa crus-galli* – *Polygonum* – *Xanthium strumarium* Association (364)**

¹⁷ Formerly called *Lotus corniculatus* Mapping Unit

¹⁸ Formerly called *Salicornia pacifica* Alliance

- vii. Tallest vegetation layer is dominated by *Salicornia pacifica* with a sparse to dense mixture of annual grasses (*Polypogon*, *Hordeum*, *Festuca perennis*, *Bromus* spp.) beneath.

***Salicornia pacifica* – Annual Grasses Association (347)**

- viii. Vegetation dominated or co-dominated by *Salicornia pacifica* with *Sesuvium verrucosum* (sea purslane) as a main subordinate species (at least 20% relative cover); may also include relatively high cover of *Cotula*.

***Salicornia pacifica* – *Sesuvium verrucosum* Association (356)**

- 3. Vegetation growing in standing water and supported by water (non-emergent). Includes a general mapping category for all undifferentiated floating-leaved hydrophytes.

Hydromorphic Vegetation (Aquatic Vegetation) Class¹⁹

- a. Floating masses strongly dominated by *Stuckenia pectinata* (narrow-leaved pondweed) occurring in diked brackish ponds, tidally influenced ditches or sloughs, and at the edges of the open bay.

***Stuckenia pectinata* Association (371)**

- b. Fresh water ponds and ditches dominated by *Ludwigia* spp.

***Ludwigia (hexapetala, peploides)* Provisional Herbaceous Semi-Natural Alliance (164)**

¹⁹ Formerly called Floating-leaved Wetland Herbs Mapping Unit (370)

2. Shrub-Dominated Vegetation:

- a. Scrub dominated by tall (>3 m), broad-leaved, winter-deciduous wetland species.
Southwestern North American Riparian/Wash Scrub Group²⁰

- i. Narrow-leaf willow (*Salix exigua*) is dominant, typically in narrow stringers of upper marsh along fresh water creeks and seeps.

***Salix exigua* Alliance**

1. *Salix exigua* is the sole dominant species in the shrub layer.

***Salix exigua* Association (502)**

- b. Scrub dominated by medium height (1-3 m) species.

Southwestern North American Riparian/Wash Scrub Group²¹

- c. A generalized mapping category for undifferentiated upland shrubs 1-3 m tall.

California Coastal Evergreen Bluff and Dune Scrub Group²²

- i. Scrub dominated by the medium-to-large-sized grayish shrub (up to 4 m in height), *Atriplex lentiformis* (quailbush). Generally occurs in small stands at borders of managed fields and intermittently flooded wetlands, usually associated with annual grasses and non-native herbs.

***Atriplex lentiformis* Shrubland Alliance (514)**

- ii. Vegetation characterized by the presence of *Rosa californica* (California wild rose) in the shrub stratum. *Rosa* may or may not be the dominant.

***Rosa californica* Alliance**

1. *Rosa californica* is dominant and conspicuous, often forming narrow briar patches along levees and roads, occasionally in lower lying portions of marsh

***Rosa californica* Association (604)**

2. *Rosa californica* and *Baccharis pilularis* co-occur in stand; either species may be dominant, but each has over 5% absolute cover.

***Rosa californica* – *Baccharis pilularis* Association (605)**

3. *Rosa californica* is present with *Schoenoplectus californicus* and/or *S. acutus*. Usually found along levees bordering sloughs and channels (including intertidal zone).

***Schoenoplectus californicus* – *Schoenoplectus acutus* / *Rosa californica* Association (162)**

in the *Schoenoplectus californicus* Alliance

- Baccharis pilularis* (coyotebush) is dominant, although other shrubs (other than *Rosa californica*) may co-occur (e.g., *Atriplex lentiformis*).

***Baccharis pilularis* Shrubland Alliance (602)**

4. *Baccharis pilularis* dominates, with an understory that is typically dominated by annual grasses (*Hordeum*, *Festuca perennis*, *Bromus* spp.).

***Baccharis pilularis* / Annual Grass-Herb Association (603)**

- iii. Vegetation dominated by the introduced *Rubus armeniacus* (Himalayan berry), often in narrow briar patches along levees and roads in marsh.

²⁰ Formerly called Tall Wetland Shrubs Mapping Unit (501)

²¹ Formerly called Medium Wetland Shrubs Mapping Unit (510)

²² Formerly called Medium Upland Shrubs Mapping Unit (601)

***Rubus armeniacus* Shrubland Semi-Natural Alliance (606)**

3. Tree-Dominated Vegetation:

a. Woodland or forest dominated by tree-sized wetland (>5 m) willows.

**Southwestern North American Riparian Evergreen and Deciduous
Woodland Group²³**

i. Stands dominated or co-dominated by *Salix laevigata*.

***Salix laevigata* Alliance (701)**

1. Willows include a mix of red willow (*Salix laevigata*) and Arroyo willow (*S. lasiolepis*). Generally found at the edges of the marsh along freshwater creeks.

***Salix laevigata* / *Salix lasiolepis* Association (702)**

b. Woodland or forest dominated by species of *Quercus* (oaks).

Californian Broadleaf Forest and Woodland Group²⁴

i. Oak stands dominated by *Quercus agrifolia* (coast live oak). Typically bordering freshwater creeks at upper reaches of marsh only.

***Quercus agrifolia* Alliance (901)**

1. *Quercus agrifolia* is the sole dominant tree species.

***Quercus agrifolia* Association (902)**

2. Arroyo willow (*Salix lasiolepis*) mixed with coast live oak (*Quercus agrifolia*).

***Quercus agrifolia* / *Salix lasiolepis* Association (705)²⁵**

ii. Oak stands dominated by *Quercus lobata* (valley oak), occasionally found along edges of creeks at upper edges of marsh.

***Quercus lobata* Alliance (903)**

c. Stands dominated by non-native or planted trees.

Landscape Trees Mapping Unit (910)

i. Woodland or forest stands dominated by introduced *Eucalyptus* spp.

***Eucalyptus (globulus, camaldulensis)* Semi-Natural Alliance (800)**

1. Planted stands dominated by *Eucalyptus globulus* (blue gum), the most common species of eucalyptus in the marsh.

***Eucalyptus globulus* Semi-Natural Association (801)**

ii. Stands dominated by *Ailanthus altissima*.

***Ailanthus altissima* Semi-Natural Alliance (911)**

iii. Stands dominated by planted *Fraxinus latifolia* trees

Temperate Tree Developed Vegetation Group (910)²⁶

²³ Formerly called Willow Trees Mapping Unit (700)

²⁴ Formerly called Oaks Mapping Unit (900)

²⁵ Formerly called *Salix lasiolepis* / *Quercus agrifolia* Association

²⁶ Formerly called *Fraxinus latifolia* Planted Stands Mapping Unit (912)

Appendix D

The vegetation mapping types and mapping units used to map Suisun Marsh

Type names have been updated due to species name changes and/or classification changes. “mu” is mapping unit (i.e., not a true vegetation classification unit). The *Jepson Manual: Vascular Plants of California, Second Edition* is the source for the species nomenclature for this project.

Vegetation Name Table

Mapping Code	1999-2006 Vegetation Name	2009 Vegetation Name	2012 Vegetation Name	Common Name
1	Bare Ground	Bare Ground mu	Bare Ground mu	Bare Ground
2	Fallow Disced Field	Fallow Disced Field mu	Fallow Disced Field mu	Fallow Disced Field
3	Parking Lot	Parking Lot mu	Parking Lot mu	Parking Lot
4	Road	Road mu	Road mu	Road
5	Structure	Structure mu	Structure mu	Structure
6	Slough	Slough mu	Slough mu	Slough
7	Tidal Mudflat	Tidal Mudflat mu	Tidal Mudflat mu	Tidal Mudflat
8	Railroad Track	Railroad Track mu	Railroad Track mu	Railroad Track
9	Ditch	Ditch mu	Ditch mu	Ditch
10	Trail	Trail mu	Trail mu	Trail
11	Open Water	Open Water mu	Open Water mu	Open Water
12	Freshwater Drainage	Freshwater Drainage mu	Freshwater Drainage mu	Freshwater Drainage
13	Water Treatment Pond	Water Treatment Pond mu	Water Treatment Pond mu	Water Treatment Pond
14	Urban Area	Urban Area mu	Urban Area mu	Urban Area mu
101	Tall Wetland Graminoids	Tall Wetland Graminoids mu	Tall Wetland Graminoids mu	Tall Wetland Graminoids

Mapping Code	1999-2006 Vegetation Name	2009 Vegetation Name	2012 Vegetation Name	Common Name
1	Bare Ground	Bare Ground mu	Bare Ground mu	Bare Ground
102	<i>Arundo donax</i>	<i>Arundo donax</i>	<i>Arundo donax</i> Association	Giant Reed
103	<i>Phragmites australis</i>	<i>Phragmites australis</i>	<i>Phragmites australis</i> Association	Common Reed
104	<i>Phragmites/Scirpus</i>	<i>Phragmites australis-Schoenoplectus (acutus, californicus)</i>	<i>Phragmites australis – Schoenoplectus</i> spp. Association	Common Reed-Bulrush (Hardstem Bulrush, California Bulrush)
105	<i>Phragmites/Xanthium</i>	<i>Phragmites australis-Xanthium strumarium</i>	<i>Phragmites australis – Xanthium strumarium</i> mu	Common Reed-Rough Cocklebur
111			<i>Schoenoplectus americanus</i> Alliance	Three-square Bulrush
112	<i>Scirpus americanus/Potentilla</i>	<i>Schoenoplectus americanus-Potentilla anserina</i>	<i>Schoenoplectus americanus – Potentilla anserina</i> Association	Three-square Bulrush-Cinquefoil
113	<i>Scirpus americanus/S. Californicus-S. acutus</i>	<i>Schoenoplectus americanus-Schoenoplectus (acutus, californicus)</i>	<i>Schoenoplectus americanus – Schoenoplectus californicus – Schoenoplectus acutus</i> Association	Three-square Bulrush-Bulrush (Hardstem Bulrush, California Bulrush)
114	<i>Scirpus americanus</i> (generic)	<i>Schoenoplectus americanus</i>	<i>Schoenoplectus americanus</i> Association	Three-square Bulrush
116	<i>Scirpus californicus/S. acutus</i>	<i>Schoenoplectus (acutus, californicus)</i>	<i>Schoenoplectus californicus – Schoenoplectus acutus</i> Association	Bulrush (Hardstem Bulrush, California Bulrush)

Mapping Code	1999-2006 Vegetation Name	2009 Vegetation Name	2012 Vegetation Name	Common Name
1	Bare Ground	Bare Ground mu	Bare Ground mu	Bare Ground
120	<i>Typha angustifolia</i> / <i>Polygonum-Xanthium-Echinochloa</i>	<i>Typha (angustifolia, latifolia, domingensis)</i> - <i>Polygonum spp.</i> - <i>Xanthium strumarium</i> - <i>Echinochloa crus-galli</i>	<i>Typha (angustifolia, latifolia, domingensis)</i> – <i>Echinochloa crus-galli</i> Association	Cattail (narrowleaf, broadleaf, southern)- Smartweed-Rough Cocklebur-Barnyard Grass
121	<i>Typha angustifolia</i> / <i>S. americanus</i>	<i>Typha (angustifolia, latifolia, domingensis)</i> - <i>Schoenoplectus americanus</i>	<i>Typha (angustifolia, latifolia, domingensis)</i> – <i>Schoenoplectus americanus</i> Association	Cattail (narrowleaf, broadleaf, southern)- Three-square Bulrush
122			<i>Typha (angustifolia, domingensis, latifolia)</i> Alliance	Cattail (narrowleaf, broadleaf, southern)
123	<i>Typha species</i> (generic)	<i>Typha (angustifolia, latifolia, domingensis)</i>	<i>Typha (angustifolia, latifolia, domingensis)</i> Association	Cattail (narrowleaf, broadleaf, southern)
125	<i>Typha angustifolia</i> (dead stalks)	<i>Typha (angustifolia, latifolia, domingensis)</i> (dead stalks)	<i>Typha (angustifolia, latifolia, domingensis)</i> (dead stalks) mu	Cattail (narrowleaf, broadleaf, southern)
126	<i>Typha angustifolia</i> / <i>Distichlis</i>	<i>Typha (angustifolia, latifolia, domingensis)</i> - <i>Distichlis spicata</i>	<i>Typha (angustifolia, latifolia, domingensis)</i> – <i>Distichlis spicata</i> Association	Cattail (narrowleaf, broadleaf, southern)-Salt grass
127	<i>Scirpus americanus</i> / <i>Lepidium</i>	<i>Schoenoplectus americanus</i> - <i>Lepidium latifolium</i>	<i>Schoenoplectus americanus</i> – <i>Lepidium latifolium</i> Association	Three-square Bulrush- Perennial Pepperweed
129	<i>Typha angustifolia</i> / <i>Phragmites</i>	<i>Typha (angustifolia, latifolia, domingensis)</i> - <i>Phragmites australis</i>	<i>Typha (angustifolia, latifolia, domingensis)</i> – <i>Phragmites australis</i> Association	Cattail (narrowleaf, broadleaf, southern)- Common Reed

Mapping Code	1999-2006 Vegetation Name	2009 Vegetation Name	2012 Vegetation Name	Common Name
1	Bare Ground	Bare Ground mu	Bare Ground mu	Bare Ground
130	Medium Wetland Graminoids	Medium Wetland Graminoids mu	Medium Wetland Graminoids mu	Medium Wetland Graminoids
132	<i>Juncus balticus</i>	<i>Juncus balticus</i>	<i>Juncus arcticus</i> var. <i>balticus</i> Association	Common Rush
133	<i>Juncus balticus/Conium</i>	<i>Juncus balticus-Conium maculatum</i>	<i>Juncus arcticus</i> var. <i>balticus</i> – <i>Conium maculatum</i> Association	Common Rush-Poison Hemlock
134	<i>Juncus balticus/Lepidium</i>	<i>Juncus balticus-Lepidium latifolium</i>	<i>Juncus arcticus</i> var. <i>balticus</i> – <i>Lepidium latifolium</i> Association	Common Rush-Perennial Pepperweed
135	<i>Juncus balticus/Potentilla</i>	<i>Juncus balticus-Potentilla anserina</i>	<i>Juncus arcticus</i> var. <i>balticus</i> – <i>Potentilla anserina</i> Association	Common Rush-Cinquefoil
139			<i>Bolboschoenus maritimus</i> Alliance	Alkali Bulrush
137	<i>Scirpus maritimus</i>	<i>Bolboschoenus maritimus</i>	<i>Bolboschoenus maritimus</i> Association	Alkali Bulrush
138	<i>Scirpus maritimus/Salicornia</i>	<i>Bolboschoenus maritimus-Salicornia pacifica</i>	<i>Bolboschoenus maritimus</i> – <i>Salicornia pacifica</i> Association	Alkali Bulrush-Pickleweed
139	<i>Scirpus maritimus/Sesuvium</i>	<i>Bolboschoenus maritimus-Sesuvium verrucosum</i>	<i>Bolboschoenus maritimus</i> – <i>Sesuvium verrucosum</i> Association	Alkali Bulrush-Western Sea-purslane
140	Short Wetland Graminoids	Short Wetland Graminoids mu	Short Wetland Graminoids mu	Short Wetland Graminoids
141	<i>Distichlis spicata</i>	<i>Distichlis spicata</i>	<i>Distichlis spicata</i> Association	Salt grass

Mapping Code	1999-2006 Vegetation Name	2009 Vegetation Name	2012 Vegetation Name	Common Name
1	Bare Ground	Bare Ground mu	Bare Ground mu	Bare Ground
142	<i>Distichlis</i> /Annual Grasses	<i>Distichlis spicata</i> -Annual grasses	<i>Distichlis spicata</i> – Annual Grasses Association	Salt grass-Annual grasses Association
145	<i>Distichlis</i> / <i>Juncus</i>	<i>Distichlis spicata</i> - <i>Juncus balticus</i>	<i>Distichlis spicata</i> – <i>Juncus arcticus</i> var. <i>balticus</i> Association	Salt grass-Common Rush
147	<i>Distichlis</i> / <i>Lotus</i>	<i>Distichlis spicata</i> - <i>Lotus corniculatus</i>	<i>Distichlis spicata</i> – <i>Lotus corniculatus</i> mu	Salt grass-Bird's-foot Trefoil
148	<i>Distichlis</i> / <i>Salicornia</i>	<i>Distichlis spicata</i> - <i>Salicornia pacifica</i>	<i>Distichlis spicata</i> – <i>Salicornia pacifica</i> Association	Salt grass-Pickleweed
149	<i>Distichlis</i> / <i>S. americanus</i>	<i>Distichlis spicata</i> - <i>Schoenoplectus americanus</i>	<i>Distichlis spicata</i> – <i>Schoenoplectus americanus</i> mu	Salt grass-Three-square Bulrush
153	<i>Distichlis</i> / <i>Cotula</i>	<i>Distichlis spicata</i> - <i>Cotula coronopifolia</i>	<i>Distichlis spicata</i> – <i>Cotula coronopifolia</i> Association	Salt grass-Brass buttons
154	<i>Distichlis</i> / <i>S. maritimus</i>	<i>Distichlis spicata</i> - <i>Bolboschoenus maritimus</i>	<i>Distichlis spicata</i> – <i>Bolboschoenus maritimus</i> mu	Salt grass-Alkali Bulrush
155	<i>Crypsis schoenoides</i>	<i>Crypsis schoenoides</i>	<i>Crypsis schoenoides</i> mu	Swamp Timothy
156	<i>Distichlis</i> (generic)	<i>Distichlis spicata</i>	<i>Distichlis spicata</i> Alliance	Salt grass
157	<i>Scirpus</i> (<i>californicus</i> or <i>acutus</i>)- <i>Typha</i> spp.	<i>Schoenoplectus</i> (<i>acutus</i> , <i>californicus</i>)- <i>Typha</i> (<i>angustifolia</i> , <i>latifolia</i> , <i>domingensis</i>)	<i>Schoenoplectus</i> (<i>acutus</i> , <i>californicus</i>) – <i>Typha</i> (<i>angustifolia</i> , <i>latifolia</i> , <i>domingensis</i>) mu	Bulrush (Hardstem Bulrush, California Bulrush)-Cattail (narrowleaf, broadleaf, southern)

Mapping Code	1999-2006 Vegetation Name	2009 Vegetation Name	2012 Vegetation Name	Common Name
1	Bare Ground	Bare Ground mu	Bare Ground mu	Bare Ground
158	<i>Scirpus (californicus or acutus)</i> /Wetland Herb	<i>Schoenoplectus (acutus, californicus)</i> -Wetland herbs	<i>Schoenoplectus (acutus, californicus)</i> – Wetland herbs mu	Bulrush (Hardstem Bulrush, California Bulrush)-Wetland herbs
160	<i>Distichlis-Juncus-Triglochin-Glaux</i>	<i>Distichlis spicata-Juncus balticus-Triglochin spp.-Glaux maritima</i>	<i>Distichlis spicata – Juncus balticus – Triglochin spp. – Glaux maritima</i> mu	Salt grass-Common Rush-Arrowgrass-Sea Milkwort
161	<i>Cynodon dactylon</i>	<i>Cynodon dactylon</i>	<i>Cynodon dactylon</i> mu	Bermuda Grass
162	<i>Scirpus (californicus or acutus)</i> /Rosa	<i>Schoenoplectus (acutus, californicus)</i> - <i>Rosa californica</i>	<i>Schoenoplectus californicus – Schoenoplectus acutus / Rosa californica</i> Association	Bulrush (Hardstem Bulrush, California Bulrush)-California Rose
202	<i>Cortaderia selloana</i>	<i>Cortaderia selloana</i>	<i>Cortaderia (jubata, selloana)</i> Alliance	Pampus Grass
210	Medium Upland Graminoids	Medium Upland Graminoids mu	Medium Upland Graminoids mu	Medium Upland Graminoids
211	<i>Elytrigia pontica</i>	<i>Elytrigia pontica</i>	<i>Elytrigia pontica</i> mu	Tall Wheat Grass
215	<i>Leymus</i> (generic)	<i>Leymus triticoides</i>	<i>Leymus triticoides</i> Alliance	Creeping Wild Rye
218	<i>Lolium</i> (generic)	<i>Lolium multiflorum</i>	<i>Festuca perennis</i> Alliance	Rye Grass
220	<i>Lolium/Lepidium</i>	<i>Lolium multiflorum-Lepidium latifolium</i>	<i>Festuca perennis – Lepidium latifolium</i> Association	Rye Grass-Perennial Pepperweed

Mapping Code	1999-2006 Vegetation Name	2009 Vegetation Name	2012 Vegetation Name	Common Name
1	Bare Ground	Bare Ground mu	Bare Ground mu	Bare Ground
222	<i>Lolium/Rumex</i>	<i>Lolium multiflorum-Rumex</i> spp.	<i>Festuca perennis – Rumex</i> spp. mu	Rye Grass-Dock
223	<i>Phalaris aquatica</i>	<i>Phalaris aquatica</i>	<i>Phalaris aquatica</i> Association	Harding Grass
225	Cultivated Annual Graminoid	Cultivated Annual Graminoid mu	Cultivated Annual Graminoid mu	Cultivated Annual Graminoid
226	Perennial Grass	Perennial Grass	Perennial Grass mu	Perennial Grass
227	Annual Grasses/Weeds	Annual Grasses/Weeds	Mediterranean CA Naturalized Annual And Perennial Grassland Group	Mediterranean CA naturalized annual and perennial grassland
228	<i>Agrostis avenacea</i>	<i>Agrostis avenacea</i>	<i>Agrostis avenacea</i> mu	Pacific Bent Grass
230	Short Upland Graminoids	Short Upland Graminoids mu	Short Upland Graminoids mu	Short Upland Graminoids
231	Annual Grasses generic	Annual Grasses generic	Annual Grasses mu	Annual Grasses generic
232	<i>Bromus</i> spp./ <i>Hordeum</i>	<i>Bromus</i> spp.- <i>Hordeum</i> spp.	<i>Bromus (diandrus, hordeaceus) – Brachypodium distachyon</i> Alliance	Brome-Barley
234	<i>Hordeum/Lolium</i>	<i>Hordeum</i> spp.- <i>Lolium multiflorum</i>	<i>Hordeum marinum – Festuca perennis</i> mu	Barley-Rye Grass
235	<i>Vulpia/Euthamia</i>	<i>Vulpia/Euthamia</i>	<i>Vulpia</i> spp. – <i>Euthamia occidentalis</i> mu	Rattail Fescue-Western Goldenrod
238	<i>Polypogon monspeliensis</i> (generic)	<i>Polypogon monspeliensis</i>	<i>Polypogon monspeliensis</i> mu	Rabbitsfoot Grass
300	Wetland Herbs	Wetland Herbs mu	Wetland Herbs mu	Wetland Herbs

Mapping Code	1999-2006 Vegetation Name	2009 Vegetation Name	2012 Vegetation Name	Common Name
1	Bare Ground	Bare Ground mu	Bare Ground mu	Bare Ground
301	Tall Wetland Herbs	Tall Wetland Herbs mu	Tall Wetland Herbs mu	Tall Wetland Herbs
310	Medium Wetland Herbs	Medium Wetland Herbs mu	Medium Wetland Herbs mu	Medium Wetland Herbs
311	<i>Atriplex triangularis</i>	<i>Atriplex prostrata</i>	<i>Atriplex prostrata</i> Association	Fat-hen
312	<i>Atriplex/Distichlis</i>	<i>Atriplex prostrata-Distichlis spicata</i>	<i>Atriplex prostrata – Distichlis spicata</i> Association	Fat-hen-Salt grass
315	<i>Atriplex/S. maritimus</i>	<i>Atriplex prostrata-Bolboschoenus maritimus</i>	<i>Atriplex prostrata – Bolboschoenus maritimus</i> Association	Fat-hen-Alkali Bulrush
316	<i>Atriplex/Sesuvium</i>	<i>Atriplex prostrata-Sesuvium verrucosum</i>	<i>Atriplex prostrata – Sesuvium verrucosum</i> Association	Fat-hen-Western Sea-purslane
317	<i>Frankenia/Agrostis</i>	<i>Frankenia salina-Agrostis</i>	<i>Frankenia salina – Agrostis avenacea</i> Association	Alkali Heath-Pacific Bent Grass
318	<i>Frankenia/Distichlis</i>	<i>Frankenia salina-Distichlis spicata</i>	<i>Frankenia salina – Distichlis spicata</i> Association	Alkali Heath-Salt grass
320	<i>Frankenia</i> (generic)	<i>Frankenia salina</i>	<i>Frankenia salina</i> Alliance	Alkali Heath
321	<i>Grindelia stricta</i> var. <i>stricta</i>	<i>Grindelia stricta</i> var. <i>stricta</i>	<i>Grindelia (stricta)</i> Alliance	Gumplant
323	<i>Lepidium/Distichlis</i>	<i>Lepidium latifolium-Distichlis spicata</i>	<i>Lepidium latifolium – Distichlis spicata</i> Association	Perennial Pepperweed-Salt grass

Mapping Code	1999-2006 Vegetation Name	2009 Vegetation Name	2012 Vegetation Name	Common Name
1	Bare Ground	Bare Ground mu	Bare Ground mu	Bare Ground
324	<i>Lepidium</i> (generic)	<i>Lepidium latifolium</i>	<i>Lepidium latifolium</i> Alliance	Perennial Pepperweed
328			<i>Persicaria lapathifolia</i> – <i>Xanthium strumarium</i> Alliance	Willow Weed-Rough Cocklebur
329	<i>Polygonum-Xanthium- Echinochloa</i>	<i>Polygonum</i> spp.- <i>Xanthium strumarium- Echinochloa crus-galli</i>	<i>Persicaria</i> spp. – <i>Xanthium strumarium</i> – <i>Echinochloa crus-galli</i> mu	Smartweed-Rough Cocklebur-Barnyard Grass
330	<i>Calystegia/Euthamia</i>	<i>Calystegia sepium- Euthamia occidentalis</i>	<i>Calystegia sepium</i> – <i>Euthamia occidentalis</i> mu	Hedge Bindweed- Western Goldenrod
336	<i>Rumex</i> (generic)	<i>Rumex</i> spp.	<i>Rumex</i> spp. mu	Dock
337	<i>Atriplex</i> /Annual Grasses	<i>Atriplex prostrata</i> -Annual Grasses	<i>Atriplex prostrata</i> – Annual Grasses Association	Fat-hen-Annual Grasses
338	<i>Potentilla anserina</i> (generic)	<i>Potentilla anserina</i>	<i>Potentilla anserina</i> Alliance	Cinquefoil
339	<i>Atriplex triangularis</i> (generic)	<i>Atriplex prostrata</i>	<i>Atriplex prostrata</i> – <i>Cotula coronopifolia</i> Alliance	Fat-hen
340	Short Wetland Herbs	Short Wetland Herbs mu	Short Wetland Herbs mu	Short Wetland Herbs
342	<i>Cotula coronopifolia</i>	<i>Cotula coronopifolia</i>	<i>Cotula coronopifolia</i> Association	Brass buttons
344	<i>Lotus corniculatus</i>	<i>Lotus corniculatus</i>	<i>Festuca perennis</i> – <i>Lotus corniculatus</i> Association	Bird's-foot Trefoil

Mapping Code	1999-2006 Vegetation Name	2009 Vegetation Name	2012 Vegetation Name	Common Name
1	Bare Ground	Bare Ground mu	Bare Ground mu	Bare Ground
346	<i>Salicornia virginica</i>	<i>Salicornia pacifica</i>	<i>Salicornia pacifica</i> Association	Pickleweed
347	<i>Salicornia</i> /Annual Grasses	<i>Salicornia pacifica</i> - Annual Grasses	<i>Salicornia pacifica</i> – Annual Grasses Association	Pickleweed-annual Grasses
348	<i>Salicornia</i> / <i>Atriplex</i>	<i>Salicornia pacifica</i> - <i>Atriplex prostrata</i>	<i>Salicornia pacifica</i> – <i>Atriplex prostrata</i> Association	Pickleweed-Fat-hen
350	<i>Salicornia</i> / <i>Crypsis</i>	<i>Salicornia pacifica</i> - <i>Crypsis schoenoides</i>	<i>Salicornia pacifica</i> – <i>Crypsis schoenoides</i> Association	Pickleweed-Swamp Timothy
356	<i>Salicornia</i> / <i>Sesuvium</i>	<i>Salicornia pacifica</i> - <i>Sesuvium verrucosum</i>	<i>Salicornia pacifica</i> – <i>Sesuvium verrucosum</i> Association	Pickleweed-Western Sea-purslane
357	<i>Sesuvium verrucosum</i>	<i>Sesuvium verrucosum</i>	<i>Sesuvium verrucosum</i> Association	Western Sea-purslane
358	<i>Sesuvium</i> / <i>Distichlis</i>	<i>Sesuvium verrucosum</i> - <i>Distichlis spicata</i>	<i>Sesuvium verrucosum</i> – <i>Distichlis spicata</i> Association	Western Sea-purslane- Salt grass
359	<i>Sesuvium</i> / <i>Lolium</i>	<i>Sesuvium verrucosum</i> - <i>Lolium multiflorum</i>	<i>Sesuvium verrucosum</i> – <i>Festuca perennis</i> Association	Western Sea-purslane- Rye Grass
360	<i>Spergularia</i> / <i>Cotula</i>	<i>Spergularia</i> - <i>Cotula</i> <i>coronopifolia</i>	<i>Spergularia marina</i> – <i>Cotula coronopifolia</i> Association	Sand-spurrey-Brass buttons
361	<i>Salicornia</i> (generic)	<i>Salicornia pacifica</i> Alliance Only	<i>Salicornia pacifica</i> Alliance	Pickleweed

Mapping Code	1999-2006 Vegetation Name	2009 Vegetation Name	2012 Vegetation Name	Common Name
1	Bare Ground	Bare Ground mu	Bare Ground mu	Bare Ground
364	<i>Salicornia/Polygonum-Xanthium-Echinochloa</i>	<i>Salicornia pacifica-Polygonum spp.-Xanthium strumarium-Echinochloa crus-galli</i>	<i>Salicornia pacifica – Echinochloa crus-galli – Polygonum – Xanthium strumarium</i> Association	Pickleweed-Smartweed-Rough Cocklebur-Barnyard Grass
365	<i>Salicornia/Cotula</i>	<i>Salicornia pacifica-Cotula coronopifolia</i>	<i>Salicornia pacifica – Cotula coronopifolia</i> Association	Pickleweed-Brass buttons
366			<i>Salsola soda</i> mu	Soda-saltwort
371	<i>Potamogeton pectinatus</i>	<i>Potamogeton pectinatus</i>	<i>Stuckenia pectinata</i> Association	Pondweed
401	Upland Herbs	Upland Herbs mu	Tall Upland Herbs mu	Upland Herbs
402	<i>Conium maculatum</i>	<i>Conium maculatum</i>	<i>Conium maculatum</i> Association	Poison Hemlock
403	<i>Foeniculum vulgare</i>	<i>Foeniculum vulgare</i>	<i>Foeniculum vulgare</i> Association	Sweet Fennel
405	<i>Raphanus sativus</i> (generic)	<i>Raphanus sativus</i>	<i>Raphanus sativus</i> Association	Radish
406	<i>Brassica nigra</i> (generic)	<i>Brassica nigra</i>	<i>Brassica nigra</i> Association	Black Mustard
410	Medium Upland Herbs	Medium Upland Herbs mu	Medium Upland Herbs mu	Medium Upland Herbs
413	<i>Centaurea</i> (generic)	<i>Centaurea</i> spp.	<i>Centaurea (solstitialis, melitensis)</i> Alliance	Knapweed, Star Thistle
421	<i>Carpobrotus edulis</i>	<i>Carpobrotus edulis</i>	<i>Carpobrotus edulis</i> Alliance	Iceplant
502	<i>Salix exigua</i>	<i>Salix exigua</i>	<i>Salix exigua</i> Association	Narrowleaf Willow

Mapping Code	1999-2006 Vegetation Name	2009 Vegetation Name	2012 Vegetation Name	Common Name
1	Bare Ground	Bare Ground mu	Bare Ground mu	Bare Ground
514	<i>Atriplex lentiformis</i> (generic)	<i>Atriplex lentiformis</i>	<i>Atriplex lentiformis</i> Alliance	Big Saltbrush
601	Medium Upland Shrubs	Medium Upland Shrubs mu	Medium Upland Shrubs mu	Medium Upland Shrubs
602			<i>Baccharis pilularis</i> Alliance	Coyote Brush
603	<i>Baccharis</i> /Annual Grasses	<i>Baccharis pilularis</i> /Annual Grasses	<i>Baccharis pilularis</i> / Annual Grass–Herb Association	Coyote Brush/Annual Grasses Association
604	<i>Rosa californica</i>	<i>Rosa californica</i>	<i>Rosa californica</i> Association	California Rose
605	<i>Rosa</i> / <i>Baccharis</i>	<i>Rosa californica</i> - <i>Baccharis pilularis</i>	<i>Rosa californica</i> – <i>Baccharis pilularis</i> Association	California Rose-Coyote Brush
606	<i>Rubus discolor</i>	<i>Rubus discolor</i>	<i>Rubus armeniacus</i> Alliance	Himalayan Blackberry
700	Willow Trees	Willow Trees	Willow Trees mu	Willow Trees
702	<i>Salix laevigata</i> / <i>S. lasiolepis</i>	<i>Salix laevigata</i> / <i>Salix lasiolepis</i>	<i>Salix laevigata</i> / <i>Salix lasiolepis</i> Association	Red Willow/Arroyo Willow
705	<i>Salix lasiolepis</i> / <i>Quercus agrifolia</i>	<i>Salix lasiolepis</i> / <i>Quercus agrifolia</i>	<i>Quercus agrifolia</i> / <i>Salix lasiolepis</i> Association	Arroyo Willow/Coast Live Oak
800	<i>Eucalyptus</i>	<i>Eucalyptus</i> mu	<i>Eucalyptus (globulus, camaldulensis)</i> Alliance	Gum Tree
801	<i>Eucalyptus globulus</i>	<i>Eucalyptus globulus</i>	<i>Eucalyptus globulus</i> Association	Blue Gum
900	Oaks	Oaks mu	Oaks mu	Oaks
901	<i>Quercus agrifolia</i>	<i>Quercus agrifolia</i>	<i>Quercus agrifolia</i> Alliance	Coast Live Oak

Mapping Code	1999-2006 Vegetation Name	2009 Vegetation Name	2012 Vegetation Name	Common Name
1	Bare Ground	Bare Ground mu	Bare Ground mu	Bare Ground
903	<i>Quercus lobata</i>	<i>Quercus lobata</i>	<i>Quercus lobata</i> Alliance	Valley Oak
910	Landscape Trees	Landscape Trees mu	Landscape Trees mu	Landscape Trees
911	<i>Ailanthus altissima</i>	<i>Ailanthus altissima</i>	<i>Ailanthus altissima</i> Alliance	Tree of Heaven
912	<i>Fraxinus latifolia</i>	<i>Fraxinus latifolia</i>	<i>Fraxinus latifolia</i> Planted Stands mu	Oregon Ash

**CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
PROTOCOL FOR RECONNAISSANCE FIELD FORM
(February 19, 2014)**

Introduction

This protocol describes the methodology for the reconnaissance technique as recorded in the Reconnaissance Field Form dated June 26, 2012. Reconnaissance surveys are complementary to relevés and rapid assessments, but collect only a small subset of the data gathered using the more detailed methods. Reconnaissance surveys are generally used as an aid to digital vegetation mapping, to determine the boundaries of a stand or to illustrate a particular plant signature. For more background on the relevé and rapid assessment sampling methods, see the relevé and rapid assessment protocols at www.cnps.org.

Definitions of fields in the form

I. LOCATIONAL/ENVIRONMENTAL DESCRIPTION

Date: Date of the sampling.

Surveyors: The full names of each person assisting should be provided for the first field form for the day. On successive forms, initials of each person assisting can be recorded. Please note: The person recording the data on the form should circle their name/initials.

Waypoint ID: The waypoint number assigned by a Global Positioning System (GPS) unit when marking and storing a waypoint for the sample location.

UID: the ID number of a reference point or polygon which this reconnaissance describes.

GPS name: The name/number assigned to each GPS unit.

Projected? Yes / No / Base: Circle the appropriate option:

Yes - The point is a projected, or offset point. The surveyor used a bearing and distance to project the point to match what they are describing with the survey

No - The surveyor is in the vegetation they are describing and the point is where the observer was standing for photographs and soil samples, if completed. This location can also be used as a base location for an offset survey.

Base - Base point only. This is where a surveyor was standing when taking an offset survey to describe vegetation not at that point. No plant data or vegetation description associated with this location.

Bearing (degrees): the compass bearing from the Base point to the Projected point.

Distance (meters): the distance in meters from the Base point to the Projected point, determined by use of a range finder.

Base UTM / projected UTM: if the point is projected, circle whether the UTM coordinates of the base point or the projected point have been recorded. These will generally be for the projected point.

UTM coordinates: Easting (UTME) and northing (UTMN) location coordinates using the Universal Transverse Mercator (UTM) grid. Record in writing the information from a GPS unit.

UTM zone: Universal Transverse Mercator zone. Zone 10 is for California west of the 120th longitude, zone 11 is for California east of 120th longitude, which is the same as the straight portion of California's eastern boundary.

PDOP: ± The accuracy of the GPS location, when taking the UTM field reading using positional dilution of precision (pdop).

Elev.: Recorded, in meters, from the GPS unit.

Size of stand (acres): Estimate the size of the entire stand in which the sample is taken and circle the appropriate range. As a measure, one acre is similar in size to a football field.

Camera/Photos: Write the name camera, JPG number, and direction of photos. *Take four photos in the main cardinal directions (N, E, S, W) clockwise from the north, from the GPS location.* If additional photos are taken in other directions, please note this information on the form.

II. HABITAT AND VEGETATION DESCRIPTION

Field alliance name: Name of alliance following the most recent Manual of California Vegetation (Sawyer J.O., Keeler-Wolf T., and Evens, J. 2009), using scientific nomenclature, *e.g.*, *Quercus agrifolia*. An alliance is based on the dominant or diagnostic species of the stand, and is usually of the uppermost and/or dominant height stratum. A dominant species covers the greatest area. A diagnostic species is consistently found in some vegetation types but not others. Please note: The field-assessed alliance name may not exist in the present classification, in which case you can provide a new alliance name in this field.

Total veg. cover %: The total cover of all vascular vegetation taking into consideration the porosity, or the holes, in the vegetation. This is an estimate of the

absolute vegetation cover, disregarding the overlap³¹ of the various tree, shrub, and/or herbaceous layers and species.

Comments: Briefly describe the stand age/seral stage, disturbance history, nature and extent of land use, and other site environmental and vegetation factors that will aid in the mapping effort.

Veg. ht class: Modal height for all vegetation. Estimate the mean height and circle the appropriate height range.

Disturb.: Estimate the amount of disturbance in the stand from human activity, such as roads, trails, disking, tilling, clearing, etc.

N/A = not applicable for this polygon type

None = no disturbance observed

Low = 0-33% of polygon affected by disturbance

Med = 34-66% of polygon affected by disturbance

High = >67% of polygon affected by disturbance

Species List and Coverage

List the species that are dominant or that are characteristically consistent throughout the stand. This list is used if there is some uncertainty in the field-assessed alliance name, so the most common species should be listed. In the interests of time and efficiency, this species list should not be exhaustive.

Strata:

T = Tree. A woody perennial plant that has a single trunk.

S = Shrub. A perennial, woody plant, that is multi-branched and doesn't die back to the ground every year.

H = Herb. An annual or perennial that dies down to ground level every year.

E = SEedling. A tree species clearly of a very young age that is < 1" dbh or has not reached breast height. Applies only to trees propagating from seed; re-sprouts are not recorded here even if they meet the size requirements.

A = SApling. 1" - <6" dbh and young in age, OR small trees that are <1" dbh, are clearly of appreciable age, and are kept short by repeated browsing, burning, or other disturbance. Includes trees that are re-sprouting from roots or stumps following fire, logging or other disturbance. These re-sprouts may exhibit a shrubby form, with multiple small trunks, but are species that are generally considered trees. If a majority of the trunks are >6" dbh, then the re-sprouts would be recorded under the "Tree" stratum.

N = Non-vascular. Includes moss, lichen, liverworts, hornworts, cryptogamic crust, and algae.

³¹ Porosity reduces the total cover of the canopy. Overlapping strata should not be included in the total cover percent; for instance, if a shrub is growing under a tree, only the cover of the tree will be added into the total; the cover of the shrub will be disregarded, except for the amount by which it fills in the porosity of the tree canopy.

When one or more tree species are regenerating, the Tree, Seedling and/or Sapling strata may be noted on the same line, e.g.:

Strata	Species	%Cover	C
T/E/A	Quercus douglasii	40/<1/<1	

Species: Use Jepson Manual nomenclature. When uncertain of an identification (which you intend to confirm later) use parentheses to indicate what part of the determination needs to be confirmed. For example, you could write out *Brassica (nigra)* if you are sure it is a *Brassica* but you need further clarification on the specific epithet.

% cover: provide the % absolute aerial cover for each species listed. All species percent covers may total over 100% because of overlap.

If a species collection is made, it should be indicated in the blank column next to “% cover” with a “C” (for collected). If the species is later keyed out, cross out the species name or description and write the keyed species name in pen on the data sheet. Do not erase what was written in the field, because this information can be used if specimens get mixed up later. If the specimen is then thrown out, the “C” in the collection column should be crossed out. If the specimen is kept but is still not confidently identified, add a “U” to the “C” in the collection column (CU = collected and unconfirmed). In this case the unconfirmed species epithet should be put in parentheses [e.g. *Hordeum (murinum)*]. If the specimen is kept and is confidently identified, add a “C” to the existing “C” in the collection column (CC = Collected and confirmed).

Appendix F

2012 vegetation mapping attributes and descriptions

All attributes were interpreted using the Suisun Marsh 2012 imagery as the base imagery. The photo interpreter should, however, use all available ancillary information in order to make the best call for each attribute. Information may be obtained from sources such as field survey and reconnaissance points from all mapping years, field photos from all mapping years and/or any imagery available (including map services such as Bing, Google Earth and Digital Globe).

Veg_2012: Photo interpreted vegetation type as of 2012.

VegCode_1: The mapping code associated with vegetation name (see Appendix B).

Cov_2012: Percent bird's-eye cover of total living vascular vegetation within a vegetation stand, broken into the following classes:

N/A: Use when the polygon is labeled with a type that is not actually vegetation (i.e., roads, sloughs, structures, urban areas, but not bare ground, which gets attributed since it may have up to 10% cover).

<2%

2-10%

10-25%

25-50%

50-75%

>75%.

Dist_2012: The percent of the polygon that has been affected by human disturbance (including disking, plowing, mowing).

N/A: Use when the polygon is labeled with a type that is not actually vegetation (i.e., roads, sloughs, structures, urban areas).

Not evident: No disturbances are visible from the aerial imagery and there is no field data.

Low: less than 33% of the polygon is affected.

Medium: between 33% and 66% of the polygon is affected.

High: More than 66% of the polygon is affected.

None: No disturbances are visible. This should only be used when there is on the ground data that says there is no disturbance to the vegetation (otherwise use "Not evident").

Note that Bare Ground gets a disturbance attribute. Many of the bare ground areas in Suisun are due to flooding late into the season, so do not base the disturbance of these areas on altered hydrologic regime, since that is what causes them. However, do base it on the amount of roads/grading, etc.

Ht_2012: Average height of the dominant vegetation within the polygon

N/A: Use when the polygon is labeled with a type that is not actually vegetation (i.e., roads, sloughs, structures, urban areas, but not bare ground, which gets attributed since it may have up to 10% cover).

<0.5 meters

0.5-1 meter

- 1-2 meters
- 2-5 meters
- 5-10 meters
- >10 meters

Notes_2012: Any additional useful information.

ID_2012: This field identifies the method in which the photo interpreter used to determine the attributes for that polygon.

- Photo interpretation
- Reconnaissance
- Sampled in 2006
- Field Checked (post map)
- Sampled in 2012

Habitat:

Tidal (1): Tidal wetlands (including muted tidal) are those areas naturally affected regularly by tidal fluctuation. The area may or may not be vegetated with vascular or non-vascular plants and may or may not have any evidence of human modification such as ditches, excavations, interrupted levees, or berms etc.

Leveed (2): leveed wetlands are those areas that are completely enclosed and are totally restricted from any natural tidal influence.

Slough (3):

MgmtRegion: Each polygon falls within one of the four management Regions described in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan (http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=781) and is attributed accordingly.

- 1
- 2
- 3
- 4

Appendix G

Salt Marsh Harvest Mouse habitat by vegetation mapping type

Mapping Code	Mapping type	Potential Habitat
1	Bare Ground mu	No
2	Fallow Disced Field mu	No
3	Parking Lot mu	No
4	Road mu	No
5	Structure mu	No
6	Slough mu	No
7	Tidal Mudflat mu	No
8	Railroad Track mu	No
9	Ditch mu	No
10	Trail mu	No
11	Open Water mu	No
12	Freshwater Drainage mu	No
13	Water Treatment Pond mu	No
14	Urban Area mu	No
101	Tall Wetland Graminoids mu	Yes
102	<i>Arundo donax</i> Association	No
103	<i>Phragmites australis</i> Association	Yes
104	<i>Phragmites australis</i> – <i>Schoenoplectus</i> spp. Association	Yes
105	<i>Phragmites australis</i> – <i>Xanthium strumarium</i> mu	No
111	<i>Schoenoplectus americanus</i> Alliance	Yes
112	<i>Phragmites australis</i> – <i>Xanthium strumarium</i> mu	Yes
113	<i>Schoenoplectus americanus</i> – <i>Schoenoplectus californicus</i> – <i>Schoenoplectus acutus</i> Association	Yes
114	<i>Schoenoplectus americanus</i> Association	Yes
116	<i>Schoenoplectus californicus</i> – <i>Schoenoplectus acutus</i> Association	Yes
120	<i>Typha (angustifolia, latifolia, domingensis)</i> – <i>Echinochloa crus-galli</i> Association	No
121	<i>Typha (angustifolia, latifolia, domingensis)</i> – <i>Schoenoplectus americanus</i> Association	Yes
122	<i>Typha (angustifolia, domingensis, latifolia)</i> Alliance	No
123	<i>Typha (angustifolia, latifolia, domingensis)</i> Association	No
125	<i>Typha (angustifolia, latifolia, domingensis)</i> (dead stalks) mu	No
126	<i>Typha (angustifolia, latifolia, domingensis)</i> – <i>Distichlis spicata</i> Association	No
127	<i>Schoenoplectus americanus</i> – <i>Lepidium latifolium</i> Association	Yes
129	<i>Typha (angustifolia, latifolia, domingensis)</i> – <i>Phragmites australis</i> Association	Yes
130	Medium Wetland Graminoids mu	Yes
132	<i>Juncus arcticus</i> var. <i>balticus</i> Association	Yes

Mapping Code	Mapping type	Potential Habitat
133	<i>Juncus arcticus</i> var. <i>balticus</i> – <i>Conium maculatum</i> Association	Yes
134	<i>Juncus arcticus</i> var. <i>balticus</i> – <i>Lepidium latifolium</i> Association	Yes
135	<i>Juncus arcticus</i> var. <i>balticus</i> – <i>Potentilla anserina</i> Association	Yes
137	<i>Bolboschoenus maritimus</i> Association	Yes
138	<i>Bolboschoenus maritimus</i> – <i>Salicornia pacifica</i> Association	Yes
139	<i>Bolboschoenus maritimus</i> Alliance	Yes
139	<i>Bolboschoenus maritimus</i> – <i>Sesuvium verrucosum</i> Association	Yes
140	Short Wetland Graminoids mu	Yes
141	<i>Distichlis spicata</i> Association	Yes
142	<i>Distichlis spicata</i> – Annual Grasses Association	Yes
145	<i>Distichlis spicata</i> – <i>Juncus arcticus</i> var. <i>balticus</i> Association	Yes
147	<i>Distichlis spicata</i> – <i>Lotus corniculatus</i> mu	No
148	<i>Distichlis spicata</i> – <i>Salicornia pacifica</i> Association	Yes
149	<i>Distichlis spicata</i> – <i>Schoenoplectus americanus</i> mu	Yes
153	<i>Distichlis spicata</i> – <i>Cotula coronopifolia</i> Association	Yes
154	<i>Distichlis spicata</i> – <i>Bolboschoenus maritimus</i> mu	Yes
155	<i>Crypsis schoenoides</i> mu	Yes
156	<i>Distichlis spicata</i> Alliance	Yes
157	<i>Schoenoplectus (acutus, californicus)</i> – <i>Typha (angustifolia, latifolia, domingensis)</i> mu	Yes
158	<i>Schoenoplectus (acutus, californicus)</i> – Wetland herbs mu	Yes
160	<i>Distichlis spicata</i> – <i>Juncus balticus</i> – <i>Triglochin</i> spp. – <i>Glaux maritima</i> mu	Yes
161	<i>Cynodon dactylon</i> mu	No
162	<i>Schoenoplectus californicus</i> – <i>Schoenoplectus acutus</i> / <i>Rosa californica</i> Association	Yes
202	<i>Cortaderia (jubata, selloana)</i> Alliance	No
210	Medium Upland Graminoids mu	Yes
211	<i>Elytrigia pontica</i> mu	Yes
215	<i>Leymus triticoides</i> Alliance	Yes
218	<i>Festuca perennis</i> Alliance	Yes
220	<i>Festuca perennis</i> – <i>Lepidium latifolium</i> Association	Yes
222	<i>Festuca perennis</i> – <i>Rumex</i> spp. mu	Yes
223	<i>Phalaris aquatica</i> Association	Yes
225	Cultivated Annual Graminoid mu	Yes
226	Perennial Grass mu	Yes
227	Mediterranean CA Naturalized Annual And Perennial Grassland Group	Yes
228	<i>Agrostis avenacea</i> mu	Yes
230	Short Upland Graminoids mu	Yes
231	Annual Grasses mu	Yes
232	<i>Bromus (diandrus, hordeaceus)</i> – <i>Brachypodium distachyon</i> Alliance	Yes
234	<i>Hordeum marinum</i> – <i>Festuca perennis</i> mu	Yes

Mapping Code	Mapping type	Potential Habitat
235	<i>Vulpia</i> spp. – <i>Euthamia occidentalis</i> mu	Yes
238	<i>Polypogon monspeliensis</i> mu	Yes
300	Wetland Herbs mu	Yes
301	Tall Wetland Herbs mu	Yes
310	Medium Wetland Herbs mu	Yes
311	<i>Atriplex prostrata</i> Association	Yes
312	<i>Atriplex prostrata</i> – <i>Distichlis spicata</i> Association	Yes
315	<i>Atriplex prostrata</i> – <i>Bolboschoenus maritimus</i> Association	Yes
316	<i>Atriplex prostrata</i> – <i>Sesuvium verrucosum</i> Association	Yes
317	<i>Frankenia salina</i> – <i>Agrostis avenacea</i> Association	Yes
318	<i>Frankenia salina</i> – <i>Distichlis spicata</i> Association	Yes
320	<i>Frankenia salina</i> Alliance	Yes
321	<i>Grindelia (stricta)</i> Alliance	Yes
323	<i>Lepidium latifolium</i> – <i>Distichlis spicata</i> Association	Yes
324	<i>Lepidium latifolium</i> Alliance	Yes
328	<i>Persicaria lapathifolia</i> – <i>Xanthium strumarium</i> Alliance	Yes
329	<i>Persicaria</i> spp. – <i>Xanthium strumarium</i> – <i>Echinochloa crus-galli</i> mu	Yes
330	<i>Calystegia sepium</i> – <i>Euthamia occidentalis</i> mu	No
336	<i>Rumex</i> spp. mu	Yes
337	<i>Atriplex prostrata</i> – Annual Grasses Association	Yes
338	<i>Potentilla anserina</i> Alliance	Yes
339	<i>Atriplex prostrata</i> – <i>Cotula coronopifolia</i> Alliance	Yes
340	Short Wetland Herbs mu	Yes
342	<i>Cotula coronopifolia</i> Association	Yes
344	<i>Festuca perennis</i> – <i>Lotus corniculatus</i> Association	No
346	<i>Salicornia pacifica</i> Association	Yes
347	<i>Salicornia pacifica</i> – Annual Grasses Association	Yes
348	<i>Salicornia pacifica</i> – <i>Atriplex prostrata</i> Association	Yes
350	<i>Salicornia pacifica</i> – <i>Crypsis schoenoides</i> Association	Yes
356	<i>Salicornia pacifica</i> – <i>Sesuvium verrucosum</i> Association	Yes
357	<i>Sesuvium verrucosum</i> Association	Yes
358	<i>Sesuvium verrucosum</i> – <i>Distichlis spicata</i> Association	Yes
359	<i>Sesuvium verrucosum</i> – <i>Festuca perennis</i> Association	Yes
360	<i>Spergularia marina</i> – <i>Cotula coronopifolia</i> Association	No
361	<i>Salicornia pacifica</i> Alliance	Yes
364	<i>Salicornia pacifica</i> – <i>Echinochloa crus-galli</i> – <i>Polygonum</i> – <i>Xanthium strumarium</i> Association	Yes
365	<i>Salicornia pacifica</i> – <i>Cotula coronopifolia</i> Association	Yes
366	<i>Salsola soda</i> mu	No
371	<i>Stuckenia pectinata</i> Association	No
401	Tall Upland Herbs mu	Yes
402	<i>Conium maculatum</i> Association	No

Mapping Code	Mapping type	Potential Habitat
403	<i>Foeniculum vulgare</i> Association	No
405	<i>Raphanus sativus</i> Association	No
406	<i>Brassica nigra</i> Association	No
410	Medium Upland Herbs mu	Yes
413	<i>Centaurea (solstitialis, melitensis)</i> Alliance	No
421	<i>Carpobrotus edulis</i> Alliance	No
502	<i>Salix exigua</i> Association	No
514	<i>Atriplex lentiformis</i> Alliance	Yes
601	Medium Upland Shrubs mu	No
602	<i>Baccharis pilularis</i> Alliance	Yes
603	<i>Baccharis pilularis</i> / Annual Grass–Herb Association	Yes
604	<i>Rosa californica</i> Association	Yes
605	<i>Rosa californica</i> – <i>Baccharis pilularis</i> Association	Yes
606	<i>Rubus armeniacus</i> Alliance	Yes
700	Willow Trees mu	No
702	<i>Salix laevigata</i> / <i>Salix lasiolepis</i> Association	No
705	<i>Quercus agrifolia</i> / <i>Salix lasiolepis</i> Association	No
800	<i>Eucalyptus (globulus, camaldulensis)</i> Alliance	No
801	<i>Eucalyptus globulus</i> Association	No
900	Oaks mu	No
901	<i>Quercus agrifolia</i> Alliance	No
903	<i>Quercus lobata</i> Alliance	No
910	Landscape Trees mu	No
911	<i>Ailanthus altissima</i> Alliance	No
912	<i>Fraxinus latifolia</i> Planted Stands mu	No

Appendix H

Acreage and acreage change of the potential Salt Marsh Harvest Mouse habitat in Suisun Marsh within the tidal, leveed, and whole region, within the four management regions and marsh-wide in 1999, 2009, and 2012.

Table: Tidal areas

Potential SMHM Habitat	1999 Acres	2009 Acres	2012 Acres	1999-2012 Change in Acres	2009-2012 Change in Acres	1999-2012 Percent Change	2009-2012 Percent Change
Management Region 1	1767.4	1859.4	2421.6	654.2	562.2	37.0%	30.2%
Management Region 2	1732.0	1733.0	2196.8	464.8	463.9	26.8%	26.8%
Management Region 3	507.8	547.0	607.1	99.3	60.1	19.6%	11.0%
Management Region 4	2498.7	2602.5	3262.0	763.2	659.5	30.5%	25.3%
Marsh-wide	6506.0	6741.9	8487.5	1981.6	1745.7	30.5%	25.9%

Table: Leveed areas

Potential SMHM Habitat	1999 Acres	2009 Acres	2012 Acres	1999-2012 Change in Acres	2009-2012 Change in Acres	1999-2012 Percent Change	2009-2012 Percent Change
Management Region 1	12053.3	10592.3	10858.4	-1195.0	266.1	-9.9%	2.5%
Management Region 2	5452.7	4852.8	5357.6	-95.1	504.8	-1.7%	10.4%
Management Region 3	2919.9	3358.8	3099.1	179.2	-259.7	6.1%	-7.7%
Management Region 4	20586.8	19415.5	20098.4	-488.4	682.9	-2.4%	3.5%
Marsh-wide	41012.8	38219.4	39413.4	-1599.4	1194.1	-3.9%	3.1%

Table: Whole region

Potential SMHM Habitat	1999 Acres	2009 Acres	2012 Acres	1999-2012 Change in Acres	2009-2012 Change in Acres	1999-2012 Percent Change	2009-2012 Percent Change
Management Region 1	13825.9	12451.8	13280.0	-545.9	828.2	-3.9%	6.7%
Management Region 2	7184.7	6585.8	7554.4	369.7	968.7	5.1%	14.7%
Management Region 3	3427.7	3905.8	3706.2	278.4	-199.6	8.1%	-5.1%
Management Region 4	23085.5	22018.0	23360.4	274.8	1342.4	1.2%	6.1%
Marsh-wide	47523.9	44961.3	47901.0	377.1	2939.7	0.8%	6.5%

Appendix I

Acreage and acreage change of the non-native species of concern in Suisun Marsh within the tidal, leveed, and whole region, within the four management regions and marsh-wide in 1999, 2009, and 2012.

Table: Tidal area in Management Region 1

Species	1999 Acres	2009 Acres	2012 Acres	1999-2012 Change in Acres	2009-2012 Change in Acres	1999-2012 Percent Change	2009-2012 Percent Change
<i>Arundo donax</i> Alliance	0	0	0.7	0.7	0.7	N/A	N/A
<i>Carpobrotus edulis</i> Alliance	0	0	0	0	0	N/A	N/A
<i>Centaurea</i> spp. Alliance	0.8	0	0	-0.8	0.0	-100%	N/A
<i>Conium maculatum</i> Association	0	0	0	0	0	N/A	N/A
<i>Cortaderia selloana</i> Alliance	0	0	0	0	0	N/A	N/A
<i>Eucalyptus</i> spp. Alliance	0	0	0	0	0	N/A	N/A
<i>Foeniculum vulgare</i> Association	2.3	4.3	5.6	3.3	1.3	146.9%	29.9%
<i>Lepidium latifolium</i> Alliance	48.8	121.9	76.0	27.1	-46.0	55.6%	-37.7%
<i>Phragmites australis</i> Alliance	105.6	216.4	322.7	217.1	106.2	2.1	0.5
<i>Salsola soda</i> mu	0	0	0	0	0	N/A	N/A

Table: Tidal area in Management Region 2

Species	1999 Acres	2009 Acres	2012 Acres	1999-2012 Change in Acres	2009-2012 Change in Acres	1999-2012 Percent Change	2009-2012 Percent Change
<i>Arundo donax</i> Alliance	0.2	0	0	-0.2	0	-100%	N/A
<i>Carpobrotus edulis</i> Alliance	0	0	0	0	0	N/A	N/A
<i>Centaurea</i> spp. Alliance	4.2	0	0	-4.2	0	-100%	N/A
<i>Conium maculatum</i> Association	0	0	0	0	0	N/A	N/A
<i>Cortaderia selloana</i> Alliance	0.8	0.6	0	-0.8	-0.6	-100%	-100%
<i>Eucalyptus</i> spp. Alliance	3.2	6.6	3.7	0.5	-2.9	16.8%	-44.2%
<i>Foeniculum vulgare</i> Association	6.7	0	0	-6.7	0	-100%	N/A
<i>Lepidium latifolium</i> Alliance	98.7	240.6	200.4	101.7	-40.2	103.0%	-16.7%
<i>Phragmites australis</i> Alliance	19.7	73.1	95.4	75.7	22.3	384.7%	30.4%
<i>Salsola soda</i> mu	0	0	0	0	0	N/A	N/A

Table: Tidal area in Management Region 3

Species	1999 Acres	2009 Acres	2012 Acres	1999-2012 Change in Acres	2009-2012 Change in Acres	1999-2012 Percent Change	2009-2012 Percent Change
<i>Arundo donax</i> Alliance	0.6	0	0	-0.6	0.0	-100%	N/A
<i>Carpobrotus edulis</i> Alliance	0	0	0	0.0	0.0	N/A	N/A
<i>Centaurea</i> spp. Alliance	0.0	0	0	0.0	0.0	N/A	N/A
<i>Conium maculatum</i> Association	1.6	0	0	-1.6	0.0	-100%	N/A
<i>Cortaderia selloana</i> Alliance	0	0	0	0.0	0.0	N/A	N/A
<i>Eucalyptus</i> spp. Alliance	0	0	0.3	0.3	0.3	N/A	N/A
<i>Foeniculum vulgare</i> Association	0.9	0	0	-0.9	0.0	-100%	N/A
<i>Lepidium latifolium</i> Alliance	0.0	0.6	0	0.0	-0.6	N/A	-100%
<i>Phragmites australis</i> Alliance	3.6	17.4	23.0	19.4	5.6	536.8%	32.3%
<i>Salsola soda</i> mu	0	0	0	0	0	N/A	N/A

Table: Tidal area in Management Region 4

Species	1999 Acres	2009 Acres	2012 Acres	1999-2012 Change in Acres	2009-2012 Change in Acres	1999-2012 Percent Change	2009-2012 Percent Change
<i>Arundo donax</i> Alliance	1.1	0	0	-1.1	0	-100%	N/A
<i>Carpobrotus edulis</i> Alliance	1.4	0	0.2	-1.2	0.2	-82.5%	N/A
<i>Centaurea</i> spp. Alliance	0	0	0	0	0	N/A	N/A
<i>Conium maculatum</i> Association	1.7	0	0	-1.7	0	-100%	N/A
<i>Cortaderia selloana</i> Alliance	1.2	1.7	1.8	0.6	0.1	51.6%	6.6%
<i>Eucalyptus</i> spp. Alliance	9.6	3.9	3.4	-6.2	-0.4	-64.3%	-11.5%
<i>Foeniculum vulgare</i> Association	0	0	0	0	0	N/A	N/A
<i>Lepidium latifolium</i> Alliance	26.2	58.6	5.5	-20.7	-53.1	-79.0%	-90.6%
<i>Phragmites australis</i> Alliance	277.4	369.4	494.0	216.6	124.6	78.1%	33.7%
<i>Salsola soda</i> mu	0	0	0	0	0	N/A	N/A

Table: Tidal area in Management Marsh-wide

Species	1999 Acres	2009 Acres	2012 Acres	1999-2012 Change in Acres	2009-2012 Change in Acres	1999-2012 Percent Change	2009-2012 Percent Change
<i>Arundo donax</i> Alliance	1.9	0	0.7	-1.2	1	-64%	N/A

<i>Carpobrotus edulis</i> Alliance	1.4	0	0.2	-1.2	0.2	-83%	N/A
<i>Centaurea</i> spp. Alliance	5.1	0	0	-5	0	-100%	N/A
<i>Conium maculatum</i> Association	3.2	0	0	-3.2	0	-100%	N/A
<i>Cortaderia selloana</i> Alliance	2.0	2.3	1.8	-0.2	-0.4	-9%	-19.4%
<i>Eucalyptus</i> spp. Alliance	12.8	10.5	7.4	-5.3	-3.0	-42%	-28.9%
<i>Foeniculum vulgare</i> Association	9.9	4.3	5.6	-4	1	-44%	29.9%
<i>Lepidium latifolium</i> Alliance	173.7	421.7	281.8	108.1	-139.9	62%	-33.2%
<i>Phragmites australis</i> Alliance	406.3	676.3	935.0	528.7	258.7	130%	38.3%
<i>Salsola soda</i> mu	0	0	0	0	0	N/A	N/A

Table: Leveed area in Management Region 1

Species	1999 Acres	2009 Acres	2012 Acres	1999-2012 Change in Acres	2009-2012 Change in Acres	1999-2012 Percent Change	2009-2012 Percent Change
<i>Arundo donax</i> Alliance	0.6	0	1.3	0.7	1.3	103.3%	N/A
<i>Carpobrotus edulis</i> Alliance	0	0	1.7	1.7	1.7	N/A	N/A
<i>Centaurea</i> spp. Alliance	10.4	0	0	-10.4	0	-100%	N/A
<i>Conium maculatum</i> Association	49.7	14.7	16.3	-33.5	1.5	-67.3%	10.3%
<i>Cortaderia selloana</i> Alliance	7.6	3.7	3.5	-4.0	-0.1	-53.3%	-2.8%
<i>Eucalyptus</i> spp. Alliance	52.8	79.2	131.6	78.8	52.5	149.1%	66.3%
<i>Foeniculum vulgare</i> Association	42.0	23.1	37.1	-4.9	14.0	-11.6%	60.4%
<i>Lepidium latifolium</i> Alliance	224.1	237.4	202.7	-21.3	-34.7	-9.5%	-14.6%
<i>Phragmites australis</i> Alliance	84.3	209.5	277.6	193.3	68.1	2.3	0.3
<i>Salsola soda</i> mu	0	0	4.8	4.8	4.8	N/A	N/A

Table: Leveed area in Management Region 2

Species	1999 Acres	2009 Acres	2012 Acres	1999-2012 Change in Acres	2009-2012 Change in Acres	1999-2012 Percent Change	2009-2012 Percent Change
<i>Arundo donax</i> Alliance	0	0	0	0	0	N/A	N/A
<i>Carpobrotus edulis</i> Alliance	0	0	0	0	0	N/A	N/A
<i>Centaurea</i> spp. Alliance	21.9	0	0	-21.9	0	-100%	N/A
<i>Conium maculatum</i> Association	28.5	25.2	16.0	-12.5	-9.2	-43.9%	-36.4%
<i>Cortaderia selloana</i> Alliance	0	0	0	0	0	N/A	N/A

<i>Eucalyptus</i> spp. Alliance	29.9	27.2	26.3	-3.6	-1.0	-12.0%	-3.6%
<i>Foeniculum vulgare</i> Association	42.6	34.4	17.4	-25.2	-17.0	-59.1%	-49.4%
<i>Lepidium latifolium</i> Alliance	167.7	126.7	146.0	-21.7	19.3	-12.9%	15.2%
<i>Phragmites australis</i> Alliance	84.3	231.5	240.6	156.3	9.1	185.3%	3.9%
<i>Salsola soda</i> mu	0	0	0	0	0	N/A	N/A

Table: Leveed area in Management Region 3

Species	1999 Acres	2009 Acres	2012 Acres	1999-2012 Change in Acres	2009-2012 Change in Acres	1999-2012 Percent Change	2009-2012 Percent Change
<i>Arundo donax</i> Alliance	0	0	0	0	0	N/A	N/A
<i>Carpobrotus edulis</i> Alliance	0	0	0	0	0	N/A	N/A
<i>Centaurea</i> spp. Alliance	1.4	0	0	-1.4	0	-100%	N/A
<i>Conium maculatum</i> Association	8.4	2.6	1.2	-7.2	-1.4	-85.3%	-52.5%
<i>Cortaderia selloana</i> Alliance	0	0	0	0	0	N/A	N/A
<i>Eucalyptus</i> spp. Alliance	1.6	6.9	6.8	5.2	-0.1	331.4%	-0.8%
<i>Foeniculum vulgare</i> Association	5.2	13.1	13.2	7.9	0.1	151.8%	0.6%
<i>Lepidium latifolium</i> Alliance	4.1	0.0	2.2	-1.9	2.2	-45.4%	N/A
<i>Phragmites australis</i> Alliance	50.6	131.2	166.4	115.8	35.2	228.9%	26.8%
<i>Salsola soda</i> mu	0	0	0	0	0	N/A	N/A

Table: Leveed area in Management Region 4

Species	1999 Acres	2009 Acres	2012 Acres	1999-2012 Change in Acres	2009-2012 Change in Acres	1999-2012 Percent Change	2009-2012 Percent Change
<i>Arundo donax</i> Alliance	2.1	0.8	3.7	1.6	2.9	73.8%	344.3%
<i>Carpobrotus edulis</i> Alliance	5.7	0.6	6.3	0.6	5.7	10.4%	898.5%
<i>Centaurea</i> spp. Alliance	31.3	0	0	-31.3	0	-100%	N/A
<i>Conium maculatum</i> Association	222.4	195.7	16.7	-205.7	-179.0	-92.5%	-91.5%
<i>Cortaderia selloana</i> Alliance	0.2	0.2	0.2	0.1	0	33.9%	19.1%
<i>Eucalyptus</i> spp. Alliance	111.8	149.7	159.9	48.1	10.3	43.1%	6.9%
<i>Foeniculum vulgare</i> Association	37.7	4.8	2.7	-35.0	-2.1	-92.9%	-44.0%
<i>Lepidium latifolium</i> Alliance	384.8	165.2	153.9	-230.9	-11.2	-60.0%	-6.8%
<i>Phragmites australis</i> Alliance	237.1	1111.2	1111.8	874.7	0.6	368.9%	0.1%

<i>Salsola soda</i> mu	0	0	0	0	0	N/A	N/A
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Table: Leveed area in Management Marsh-wide

Species	1999 Acres	2009 Acres	2012 Acres	1999-2012 Change in Acres	2009-2012 Change in Acres	1999-2012 Percent Change	2009-2012 Percent Change
<i>Arundo donax</i> Alliance	2.8	0.8	5.0	2.2	4.2	80.7%	502.2%
<i>Carpobrotus edulis</i> Alliance	5.7	0.6	8.0	2.2	7.3	39.3%	1159.6%
<i>Centaurea</i> spp. Alliance	65.1	0	0	-65.1	0	-100%	N/A
<i>Conium maculatum</i> Association	309.1	238.2	50.2	-258.9	-188.0	-83.8%	-78.9%
<i>Cortaderia selloana</i> Alliance	7.7	3.8	3.8	-4.0	0	-51.6%	-1.9%
<i>Eucalyptus</i> spp. Alliance	196.1	262.9	324.6	128.6	61.7	65.6%	23.5%
<i>Foeniculum vulgare</i> Association	127.5	75.4	70.4	-57.1	-5.0	-44.8%	-6.7%
<i>Lepidium latifolium</i> Alliance	780.7	529.3	504.9	-275.8	-24.4	-35.3%	-4.6%
<i>Phragmites australis</i> Alliance	456.3	1683.5	1796.4	1340.1	112.9	293.7%	6.7%
<i>Salsola soda</i> mu	0	0	4.8	4.8	4.8	N/A	N/A

Table: Total area in Management Region 1

Species	1999 Acres	2009 Acres	2012 Acres	1999-2012 Change in Acres	2009-2012 Change in Acres	1999-2012 Percent Change	2009-2012 Percent Change
<i>Arundo donax</i> Alliance	0.6	0	2.0	1.3	2.0	205.5%	N/A
<i>Carpobrotus edulis</i> Alliance	0	0	1.7	1.7	1.7	N/A	N/A
<i>Centaurea</i> spp. Alliance	11.2	0	0	-11.2	0	-100%	N/A
<i>Conium maculatum</i> Association	49.7	14.7	16.3	-33.5	1.5	-67.3%	10.3%
<i>Cortaderia selloana</i> Alliance	7.6	3.7	3.5	-4.0	-0.1	-53.3%	-2.8%
<i>Eucalyptus</i> spp. Alliance	52.8	79.2	131.6	78.8	52.5	149.1%	66.3%
<i>Foeniculum vulgare</i> Association	44.2	27.4	42.7	-1.5	15.3	-3.5%	55.6%
<i>Lepidium latifolium</i> Alliance	272.9	359.4	278.7	5.8	-80.7	2.1%	-22.4%
<i>Phragmites australis</i> Alliance	189.9	425.9	600.3	410.4	174.4	2.2	0.4
<i>Salsola soda</i> mu	0	0	4.8	4.8	4.8	N/A	N/A

Table: Total area in Management Region 2

Species	1999 Acres	2009 Acres	2012 Acres	1999-2012 Change in Acres	2009-2012 Change in Acres	1999-2012 Percent Change	2009-2012 Percent Change
<i>Arundo donax</i> Alliance	0.2	0	0	-0.2	0	-100%	N/A
<i>Carpobrotus edulis</i> Alliance	0	0	0	0.0	0	N/A	N/A
<i>Centaurea</i> spp. Alliance	26.2	0	0	-26.2	0	-100%	N/A
<i>Conium maculatum</i> Association	28.5	25.2	16.0	-12.5	-9.2	-43.9%	-36.4%
<i>Cortaderia selloana</i> Alliance	0.8	0.6	0	-0.8	-0.6	-100%	-100%
<i>Eucalyptus</i> spp. Alliance	33.0	33.8	30.0	-3.1	-3.9	-9.3%	-11.5%
<i>Foeniculum vulgare</i> Association	49.3	34.4	17.4	-31.9	-17.0	-64.7%	-49.4%
<i>Lepidium latifolium</i> Alliance	266.4	367.3	346.4	80.0	-20.9	30.0%	-5.7%
<i>Phragmites australis</i> Alliance	104.0	304.6	336.0	232.0	31.3	223.0%	10.3%
<i>Salsola soda</i> mu	0	0	0	0	0	N/A	N/A

Table: Total area in Management Region 3

Species	1999 Acres	2009 Acres	2012 Acres	1999-2012 Change in Acres	2009-2012 Change in Acres	1999-2012 Percent Change	2009-2012 Percent Change
<i>Arundo donax</i> Alliance	0.6	0	0	-0.6	0	-100%	N/A
<i>Carpobrotus edulis</i> Alliance	0	0	0	0	0	N/A	N/A
<i>Centaurea</i> spp. Alliance	1.4	0	0	-1.4	0	-100%	N/A
<i>Conium maculatum</i> Association	10.0	2.6	1.2	-8.8	-1.4	-87.6%	-52.5%
<i>Cortaderia selloana</i> Alliance	0	0	0	0	0	N/A	N/A
<i>Eucalyptus</i> spp. Alliance	1.6	6.9	7.1	5.6	0.3	352.8%	4.2%
<i>Foeniculum vulgare</i> Association	6.2	13.1	13.2	7.0	0.1	114.2%	0.6%
<i>Lepidium latifolium</i> Alliance	4.1	0.6	2.2	-1.9	1.7	-45.4%	293.4%
<i>Phragmites australis</i> Alliance	54.2	148.6	189.3	135.2	40.8	249.4%	27.4%
<i>Salsola soda</i> mu	0	0	0	0	0	N/A	N/A

Table: Total area in Management Region 4

Species	1999 Acres	2009 Acres	2012 Acres	1999-2012 Change in Acres	2009-2012 Change in Acres	1999-2012 Percent Change	2009-2012 Percent Change
<i>Arundo donax</i> Alliance	3.2	0.8	3.7	0.5	2.9	14.9%	344.3%
<i>Carpobrotus edulis</i> Alliance	7.1	0.6	6.6	-0.6	5.9	-8.0%	937.6%

<i>Centaurea</i> spp. Alliance	31.3	0	0	-31.3	0	-100%	N/A
<i>Conium maculatum</i> Association	224.1	195.7	16.7	-207.4	-179.0	-92.5%	-91.5%
<i>Cortaderia selloana</i> Alliance	1.4	1.9	2.0	0.7	0.1	49.6%	7.7%
<i>Eucalyptus</i> spp. Alliance	121.4	153.5	163.4	42.0	9.8	34.6%	6.4%
<i>Foeniculum vulgare</i> Association	37.7	4.8	2.7	-35.0	-2.1	-92.9%	-44.0%
<i>Lepidium latifolium</i> Alliance	411.0	223.8	159.4	-251.6	-64.4	-61.2%	-28.8%
<i>Phragmites australis</i> Alliance	514.5	1480.6	1605.8	1091.2	125.2	212.1%	8.5%
<i>Salsola soda</i> mu	0	0	0	0	0	N/A	N/A

Table: Total area in Management Marsh-wide

Species	1999 Acres	2009 Acres	2012 Acres	1999-2012 Change in Acres	2009-2012 Change in Acres	1999-2012 Percent Change	2009-2012 Percent Change
<i>Arundo donax</i> Alliance	4.6	0.8	5.7	1.0	4.8	22.4%	581.6%
<i>Carpobrotus edulis</i> Alliance	7.1	0.6	8.2	1.1	7.6	15.2%	1198.6%
<i>Centaurea</i> spp. Alliance	70.1	0	0	-70.1	0	-100%	N/A
<i>Conium maculatum</i> Association	312.4	238.2	50.2	-262.2	-188.0	-83.9%	-78.9%
<i>Cortaderia selloana</i> Alliance	9.8	6.1	5.6	-4.2	-0.5	-42.8%	-8.4%
<i>Eucalyptus</i> spp. Alliance	208.8	273.4	332.1	123.3	58.7	59.0%	21.5%
<i>Foeniculum vulgare</i> Association	137.4	79.7	76.0	-61.4	-3.8	-44.7%	-4.7%
<i>Lepidium latifolium</i> Alliance	954.4	951.0	786.7	-167.7	-164.3	-17.6%	-17.3%
<i>Phragmites australis</i> Alliance	862.7	2359.8	2731.4	1868.8	371.6	216.6%	15.7%
<i>Salsola soda</i> mu	0	0	4.8	4.8	4.8	N/A	N/A