# 2015
# Vegetation Map Update for
# Suisun Marsh,
# Solano County, California

**A Report to the California Department of Water Resources**

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# Executive Summary

This report summarizes the methods and results of the 2015 Suisun Marsh triennial vegetation map update. This update is part of an ongoing monitoring project conducted by the Vegetation Classification and Mapping Program (VegCAMP) of the California Department of Fish and Wildlife (CDFW), in collaboration with the Department of Water Resources (DWR) and the CDFW Bay Delta Region. The project tracks changes in the Suisun Marsh vegetation over time to fulfill specific permit requirements of the Suisun Marsh Plan of Protection of 1984 and the Suisun Marsh Preservation Agreement of 1986. This is the sixth update using the current mapping standards originally implemented in 1999. All of the vegetation maps (starting with the 1999 map and including the 2015 map on which this report is based), can be viewed and downloaded using the online CDFW Biogeographic Information and Observation System (BIOS); the links to the associated reports are included in the map metadata. The reports are also available from the VegCAMP report website. For detailed information regarding the history and evolution of this project, see Appendix A in the 2012 update report (Boul and Keeler-Wolf 2016).

The final map contains vegetation and land use polygons ranging from 0.002 acre to 1,737 acres and averaging 2.39 acres. The tidally influenced acreage is covered by 4,388 vegetation polygons; 24,641 vegetation polygons cover the leveed acreage. The total mapped acreage of vegetation changes slightly with each map update due to variations in channel erosion or accretion and the tide level at the time of imagery acquisition.

An Accuracy Assessment was conducted on the 2015 map based on 260 field samples collected in the summer of 2016. The users' accuracy was 79.4% and the producers' accuracy was 83.7% for types with at least three samples. Because the state standard for map accuracy is 80%, we explored using higher levels of the classification hierarchy while still maintaining important information. After consulting with the Environmental Coordination Advisory Team (ECAT), we have reduced the number of map classes. Reassigning map classes per the revised map classification improved producers' accuracy to 85.9% and users' accuracy to 84.3%

The primary and secondary Salt Marsh Harvest Mouse (SMHM) habitat types listed in the Bay Delta Conservation Plan (DWR 2013) were crosswalked by Bay Delta Region staff to the revised map classification and used to calculate potential habitat for SMHM. The 2015 triennial vegetation update suggests that there are 43,682.5 acres of potential habitat in Suisun Marsh, with approximately 82% of this habitat in leveed areas. The leveed areas have seen a 4.3% decrease in potential habitat since 2012 and a 13.1% decrease since 1999. The tidal areas of the Marsh have seen a 1.9% decrease since 2012, but a 35.4% increase in potential SMHM habitat since 1999. Over the entire marsh, potential habitat is down 3.9% since 2012 and 7.3% since 1999.

This update included an evaluation of the ability to use Worldview-3 satellite imagery as a potential cost savings over the high-resolution imagery acquired by DWR for this project. Comparison of delineations in a pilot area using sample satellite imagery from May 13, 2015 and the 2015 DWR imagery revealed that the lower resolution of the satellite imagery did not allow interpretation of fine-scale patterns. Additionally, the satellite imagery cannot be acquired for a specified time of year or tidal stage and may have up to 15% cloud cover, making it unsuitable for the purposes of the triennial map update.

The most current version of this report can be found in the CDFW Document Library.

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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. Since 1999, the Marsh has experienced significant variations in salinity conditions, including prolonged droughts. Plant communities can be expected change over time due to these natural environmental factors, but also from direct management activities such as flooding regime changes, weed control, and plantings, as well as from accidental introductions of invasive weeds and levee breaches.


**Figure 1:** Location of the Suisun Marsh study area.

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. A brief history of this survey is provided by Barthman-Thompson (2018).

The current methodology for this survey was adopted in 1999 (Keeler-Wolf and Vaghti 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 methodology documents changes in

preferred habitat for the SMHM and gathers vegetation information 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 followed the National Vegetation Classification (NVC) standards and resulted in a vegetation classification based on quantitative vegetation sampling (Appendix A). The vegetation classification was used to create vegetation type descriptions (Appendix B) and a mapping classification (Appendix C). 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, there have been updates in 2000, 2003, 2006, 2009, and 2012. This report documents changes based on the 2015 vegetation map update.

As requested by DWR and with Bay Delta Region agreement, for each map update, vegetation change has been analyzed for tidal wetlands, leveed wetlands, and marsh-wide. 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. The leveed wetlands are those areas that are completely enclosed and have no natural tidal influence.

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 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.

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 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 the 2006 update were of note: 1) a 174% increase in flooded wetlands (due to severe storms resulting in levee breaches), 2) a net loss of 945 acres of *Salicornia pacifica* vegetation types since 1999, 3) a net gain of 780 acres of *Phragmites australis* since 1999, 580 acres of which established since 2003, and 4) acreage decrease or stabilization of several of the non-native species of concern. Several issues with the

remapping process and change detection protocol emerged and VegCAMP suggested changes to the protocol. These were implemented in the 2009 vegetation remap.

The 2009 remap study (VegCAMP 2012) used an updated protocol developed to accommodate advances in available technology and mitigate for past inconsistencies; we discontinued modification of polygons, but instead mapped *de novo*. The protocol update is discussed in detail in Appendix A in Boul and Keeler-Wolf (2016). 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 there had been open water in 2006.

The 2012 remap study (Boul and Keeler-Wolf 2016) showed a marsh-wide 7% increase in potential habitat for SMHM since 2009 and 1% increase since 1999. By 2012, *Phragmites australis* had increase threefold in acreage since the first map in 1999. The increase has been in the non-native genotype. Stands dominated by *Lepidium latifolium* showed a marsh-wide decrease in total acreage since 1999, but showed a 63% increase in the tidal habitats of the Marsh.

# Methods

## 2015 Field Data Collection

This mapping cycle included the collection of 340 reconnaissance points that captured data for 406 vegetation polygons using the Reconnaissance Field Form and Protocol presented in Appendix D. These were collected in June and July of 2015, except for two collected in May of 2016.

## Spatial Accuracy in the 2015 Aerial Images

In 2009, staff from 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 within ±5 meters. Fifty-one control points were measured and used to process the 2009 imagery, resulting in an orthomosaic that closely agreed with National Agricultural Imagery Program (NAIP) digital orthorectified quarter quadrangle (DOQQ) aerial photography. The same method and control points were used to process the 2012 and 2015 imagery, producing spatially comparable vegetation maps. Refer to the 2009 update report (VegCAMP 2012) for a complete description of the methods used for improving the spatial accuracy of the imagery.

## 2015 Aerial Photograph Interpretation, Heads-up Digitizing and Attributing

To create the 2015 Suisun Marsh vegetation map, vegetation was interpreted from a mosaic of the true color imagery that was flown at a scale of 1:9600 on June 15, 2015 and delivered to VegCAMP in October 2015. Polygons were delineated using heads-up digitizing (i.e., a photo interpreter manually drew polygons around each stand of vegetation) in Esri's ArcMAP 10.3 and polygon attributes were recorded within a personal geodatabase.

All attributes were interpreted using the Suisun Marsh 2015 imagery as the base imagery. The photo interpreters used 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 2015 NAIP, 2015 NAIP Color Infrared, all imagery available through Google Earth (including street view), Bing, and Digital Globe, and the 1999, 2003, 2006, 2009, and 2012 Suisun Marsh imagery.

The mapping area was divided between two photo interpreters. Each photo interpreter then checked a portion of the other's delineations and attributions, and a senior ecologist then checked the work of both interpreters. With both field checks and office review, 1,629 polygons were quality-checked.

## 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 stand below 0.25 acre should be separately delineated. For example, a smaller polygon would be appropriate for any new occurrence of a non-native species of concern, such as *Phragmites australis*, *Arundo donax*, *Carpobrotus edulis*, *Eucalyptus*

spp., and *Lepidium latifolium*. The minimum mapping unit was 0.009 acre (400 square feet) for the Blacklock restoration project area.

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 stand fell below the minimum width, the polygon was not split.

**Map Attributes**

The vegetation mapping classification used for this project is based on the vegetation classification created in 1999 (Keeler-Wolf and Vaghti 2000). The names of the mapping units have been updated over the years to reflect current nomenclature and/or current understanding of vegetation classification. We used the same map classes for the 2015 map as were used as for the 2012 map for the original mapping. However, as discussed in detail under Accuracy Assessment below, we combined some classes that we could not consistently distinguish on the imagery to create a revised classification. The 2015 map has both the 2012 attributes and the crosswalked, revised 2015 type attributes. See Appendix C for a list of all the mapping types and a crosswalk of the map classes since 1999.

In addition to the mapping unit, several other attributes are assigned to each polygon: percent vegetation cover, average vegetation height, degree of human disturbance, method of interpretation, habitat, and management region. For this update, we have added an attribute denoting the presence of *Lepidium latifolium* in the polygon, as discussed further below. For more information about each attribute, see Appendix E.

**Method for Accuracy Assessment**

To validate the vegetation map, VegCAMP conducted an Accuracy Assessment this mapping cycle. An accuracy assessment analysis helps the map users determine how much confidence can be assigned to each of the map units, and provides an understanding of the map's appropriateness for various applications. Federal Geographic Data Committee standards (FGDC 2008) require 80% accuracy for vegetation maps.

Accuracy Assessment (AA) sample allocation employed an analysis that balanced three goals: achieving target levels of samples based on budgeted staff time for conducting the AA, distributing the samples amongst the vegetated mapping classes, and facilitating access to vegetation polygons based on land ownership and access efficiency.

Fieldwork for the AA was done in the summer of 2016, before the 2015 vegetation map was complete. This restricted the allocation to approximately 65% of the project area. Additionally, over 80% of Suisun Marsh is privately owned, also limiting access for AA. It was crucial that access to private properties be acquired in order to conduct a valid Accuracy assessment. The Suisun Resource Conservation District (SRCD) was invaluable in getting VegCAMP permission to access private properties.

The first step in the allocation process was to select polygons that were on publicly accessible properties or on private properties that we were likely to receive permission to access. Within the resulting subset, polygons that had been previously field visited in 2015 were excluded. Then polygons were selected that were within 500 meters of the roads layer or the digitized road polygons from the vegetation map. Polygons from Ryer Island, which has no roads but is accessible by boat, were also included.

The accessible polygons were then used as geographic input to the Generalized Random Tesselation Stratified (GRTS) function (Kincaid and Olsen, 2011) of the R statistical package. A set of spatially balanced, stratified sample points was generated based on the Suisun Marsh mapping classification. The polygons that contained the GRTS points were selected as the initial accuracy assessment allocation.

In order to determine if a vegetation type had achieved the required 80% accuracy, at least five polygons should be assessed. Vegetation types with fewer than five polygons were either eliminated from the allocation or consolidated into a higher level of the classification hierarchy.

After the allocation process was complete, a priority level was assigned to each polygon based on its vegetation type. Vegetation types where five polygons had been allocated were assigned the highest priority. Types with six to nine allocated polygons were given intermediate priority. All types with more than nine allocated polygons were considered low priority. Priority levels were incorporated into field maps to help staff manage the time they would spend accessing particular polygons. In total, 359 polygons were allocated.

To prevent bias, paper and digital maps prepared for AA field crews did not include the vegetation type or other map attributes. Additionally, only the polygons to be assessed were shown on the maps so that the shape of surrounding polygons would not influence the field crews. Field data were collected on Apple iPads using the Esri Collector application. See Appendix D for the form and protocol used for collecting accuracy assessment data.

The AA surveys evaluated both the type and the extent of the polygon when possible. When a mapped polygon could be divided due to the presence of multiple types within the given MMU standards, an assessment was done for each type. Total vegetation cover and height were recorded as well.

VegCAMP and Bay Delta Branch staff collected 290 accuracy assessment points (Figure 2) from May to September 2016 using the Accuracy Assessment form and protocol in Appendix D.

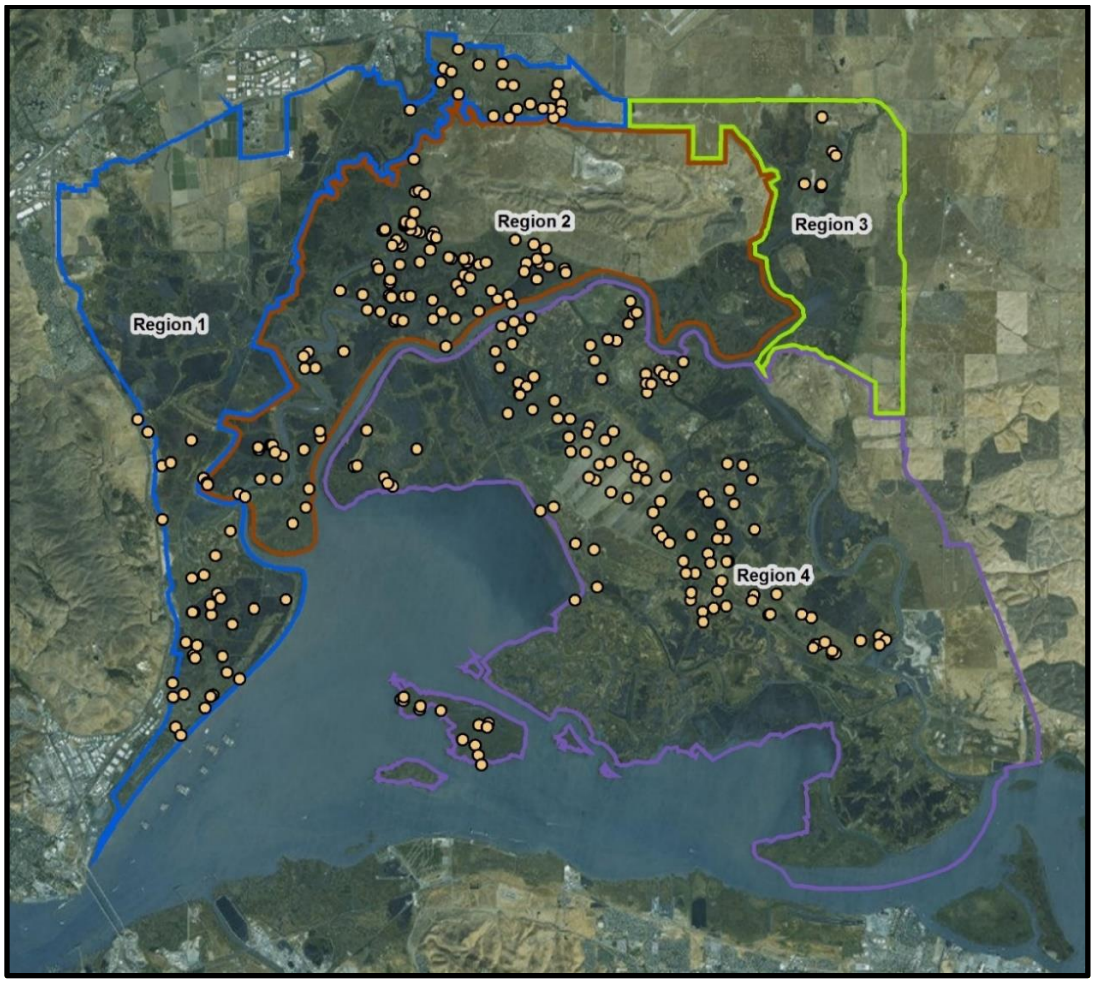



**Figure 2**: Location of Accuracy Assessment samples within the four management regions in Suisun Marsh.

In the office, data from the field AA forms were entered into an Access database that allowed the vegetation type recorded by the photo interpreter (PI) to be scored using the field surveys. The photo interpreters did not score their own mapped polygons. Cover and height attributes were not scored, but were provided as feedback to the PIs. If the field crews could not identify the vegetation type based on the field key, then staff assigned the correct type in the office when possible, based on the species' covers recorded, any additional notes taken by the field crews, and field photos. All field calls were reviewed and a "Final call" was recorded in the database when possible.

A fuzzy logic method was used to score each AA point, rather than simply denoting whether a sample was correct or incorrect (Gopal and Woodcock 1994; Congalton and Green 1999; Foody 2002; Hagen 2003; Metzler and Sader 2005). Each field-verified polygon was scored according to the set of decision rules listed in Table 1, with a total of 5 points possible for each. Scores were summed for each vegetation type, then divided by the total possible score and multiplied by 100 for a percent accuracy. The scores were provided back to the mapper so that specific and systematic errors could be corrected.

**Table 1:** Scoring rules and points

| Code | Reason For Score | Score |
|---|---|---|
| A | PI completely correct. | 5 |
| B | The PI chose the correct Group OR the next level up in the hierarchy. | 4 |
| C | Threshold/transition between PI call and Final call. This was used when cover values of the dominant or indicator species were close to the values that would key to the PI's type. | 4 |
| D | Correct Macrogroup OR next level up in hierarchy. | 3 |
| E | Based on close ecological similarity. Ecological similarity addresses assessed and mapped calls that contained vegetation with overlapping diagnostic species but not technically closely related in the NVC hierarchy. | 3 |
| F | Correct Division. | 2 |
| G | Some floristic/hydrologic similarity. This addresses cases in which the mapped and the assessed vegetation type had different diagnostic species, but bore some similarity in ecological traits. | 2 |
| H | Correct only at Lifeform. | 1 |
| I | No similarity above Formation and incorrect life form. | 0 |
| J | Survey removed because there was a significant change in the polygon (e.g., the stand was burned, developed, or cleared since the date of the base imagery). | no score |
| K | Survey removed because an inadequate portion (<10%) of the polygon was viewed by the field crew. | no score |
| L | Survey removed because field/PI data are incomplete, inadequate or confusing (e.g., cover values were not provided for key species in the stand). | no score |
| M | Supplementary record not scored (for multiple point assessments within a polygon where the AA call was the same). | no score |

During analysis, 30 of the points were removed for one of the reasons J through M given in Table 1. Of the 108 types mapped, 69 were assessed (Table 2). Ideally, every mapped type would be thoroughly assessed, but this was not possible given the limited access to private land and the fact that the vegetation map was not complete at the time the AA field work was conducted. Not all types were found in the mapped area at the time of AA; some types were found in numbers that were too low to analyze and some were inaccessible.

**Table 2:** Vegetation types mapped in 2015, with the assessed types identified. These same types were used for the 2012 map update. The list is ordered alphabetically by mapping type; non-vegetation types are located at the end of the list.

| **Mapping Type** | **Assessed** |
|---|---|
| *Alisma triviale* Mapping Unit | No |
| *Arundo donax* Association | No |
| *Atriplex lentiformis* Alliance | Yes |
| *Atriplex prostrata* Alliance | No |
| *Atriplex prostrata* Association | No |
| *Atriplex prostrata* – Annual Grasses Association | No |

| Mapping Type | Assessed |
|---|---|
| *Atriplex prostrata – Bolboschoenus maritimus* Association | Yes |
| *Atriplex prostrata – Distichlis spicata* Association | Yes |
| *Atriplex prostrata – Sesuvium verrucosum* Association | No |
| *Baccharis pilularis* / Annual Grasses Association | Yes |
| *Baccharis pilularis* Alliance | Yes |
| *Baccharis salicifolia* Alliance | No |
| *Bolboschoenus maritimus* Alliance | Yes |
| *Bolboschoenus maritimus* Association | Yes |
| *Bolboschoenus maritimus – Salicornia pacifica* Association | Yes |
| *Bolboschoenus maritimus – Sesuvium verrucosum* Association | Yes |
| *Brassica nigra* Association | Yes |
| *Carpobrotus edulis* Association | No |
| *Conium maculatum* Association | Yes |
| *Cortaderia selloana* Association | No |
| *Cotula coronopifolia* Association | Yes |
| *Crypsis schoenoides* Association | Yes |
| Cultivated Annual Graminoid Mapping Unit | No |
| *Distichlis spicata* Alliance | Yes |
| *Distichlis spicata* Association | Yes |
| *Distichlis spicata* – Annual Grasses Association | Yes |
| *Distichlis spicata – Bolboschoenus maritimus* Association | Yes |
| *Distichlis spicata – Cotula coronopifolia* Association | Yes |
| *Distichlis spicata – Juncus balticus* Association | Yes |
| *Distichlis spicata – Juncus balticus – Triglochin* sp. *– Glaux maritima* Association | Yes |
| *Distichlis spicata – Lotus corniculatus* Association | Yes |
| *Distichlis spicata – Salicornia pacifica* Association | Yes |
| *Distichlis spicata – Schoenoplectus americanus* Association | Yes |
| *Elytrigia pontica* Association | Yes |
| *Eucalyptus globulus* Association | Yes |
| *Festuca perennis* Alliance | Yes |
| *Festuca perennis – Lotus corniculatus* Semi-Natural Association | No |
| *Foeniculum vulgare* Association | No |
| *Frankenia salina* Alliance | Yes |
| *Frankenia salina – Distichlis spicata* Association | Yes |
| *Grindelia stricta* Association | No |
| *Juncus arcticus (*var. *balticus, mexicanus)* Alliance | Yes |
| *Juncus balticus* Association | Yes |
| *Juncus balticus – Conium maculatum* Association | Yes |
| *Juncus balticus – Lepidium latifolium* Association | Yes |
| Landscape Trees Mapping Unit | Yes |

| Mapping Type | Assessed |
|---|---|
| *Lepidium latifolium* Alliance | Yes |
| *Lepidium latifolium – Distichlis spicata* Association | Yes |
| *Leymus triticoides* Alliance | Yes |
| Mediterranean California Naturalized Annual and Perennial Grassland Group | Yes |
| Medium Upland Shrubs Mapping Unit | No |
| *Persicaria lapathifolia – Xanthium strumarium* Alliance | Yes |
| *Phalaris aquatica* Association | No |
| *Phragmites australis* Association | Yes |
| *Phragmites australis* Alliance | No |
| *Phragmites australis – Schoenoplectus (acutus, californicus)* Association | Yes |
| *Phragmites australis – Xanthium strumarium* Association | No |
| *Polygonum* spp. *– Xanthium strumarium – Echinochloa crus-galli* Association | Yes |
| *Quercus agrifolia* Association | No |
| *Raphanus sativus* Association | Yes |
| *Rosa californica* Association | No |
| *Rosa californica – Baccharis pilularis* Association | Yes |
| *Rubus discolor* Association | Yes |
| *Salicornia pacifica (Salicornia depressa)* Alliance | Yes |
| *Salicornia pacifica* Association | Yes |
| *Salicornia pacifica* – Annual Grasses Association | Yes |
| *Salicornia pacifica – Atriplex prostrata* Association | Yes |
| *Salicornia pacifica – Cotula coronopifolia* Association | Yes |
| *Salicornia pacifica – Crypsis schoenoides* Association | No |
| *Salicornia pacifica – Polygonum* spp. *– Xanthium strumarium – Echinochloa crus-galli* Association | Yes |
| *Salicornia pacifica – Sesuvium verrucosum* Association | Yes |
| *Salix exigua* Association | No |
| *Salix laevigata / Salix lasiolepis* Association | No |
| *Salsola Soda* Provisional Alliance | Yes |
| *Schoenoplectus (acutus, californicus)* Mapping Unit | Yes |
| *Schoenoplectus (acutus, californicus) – Rosa californica* Association | Yes |
| *Schoenoplectus (acutus, californicus) – Typha (angustifolia, latifolia, domingensis)* Association | Yes |
| *Schoenoplectus (acutus, californicus)* – Wetland Herbs Association | Yes |
| *Schoenoplectus americanus* Alliance | Yes |
| *Schoenoplectus americanus* Association | Yes |
| *Schoenoplectus americanus – Lepidium latifolium* Association | Yes |
| *Schoenoplectus americanus – Potentilla anserina* Association | Yes |
| *Schoenoplectus americanus – Schoenoplectus (acutus, californicus)* Association | No |
| *Sesuvium verrucosum* Association | Yes |
| *Sesuvium verrucosum – Distichlis spicata* Association | No |

| Mapping Type | Assessed |
|---|---|
| *Spergularia – Cotula coronopifolia* Association | Yes |
| *Stuckenia pectinata* Association | No |
| *Tamarix* spp. Semi-Natural Alliance | No |
| Temperate Pacific Intertidal Flat Group | No |
| *Typha (angustifolia, latifolia, domingensis)* (dead stalks) Mapping Unit | No |
| *Typha (angustifolia, latifolia, domingensis)* Alliance | Yes |
| *Typha (angustifolia, latifolia, domingensis)* Association | Yes |
| *Typha (angustifolia, latifolia, domingensis) – Distichlis spicata* Association | Yes |
| *Typha (angustifolia, latifolia, domingensis) – Phragmites australis* Association | Yes |
| *Typha (angustifolia, latifolia, domingensis) – Polygonum* sp. *– Xanthium strumarium – Echinochloa crus-galli* Association | No |
| *Typha (angustifolia, latifolia, domingensis) – Schoenoplectus americanus* Association | Yes |
| Wetland Herbs Mapping Unit | Yes |
| Bare Ground Mapping Unit | Yes |
| Ditch Mapping Unit | No |
| Open Water Mapping Unit | No |
| Parking Lot Mapping Unit | No |
| Railroad Track Mapping Unit | No |
| Road Mapping Unit | No |
| Slough Mapping Unit | No |
| Structure Mapping Unit | No |
| Tidal Mudflat Mapping Unit | No |
| Trail Mapping Unit | No |
| Urban Area Mapping Unit | No |

**Methods for Analysis**

As previously mentioned, DWR and Bay Delta Region have requested that change analysis be done for tidal wetlands, leveed wetlands, and marsh-wide. 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), created by CDFW in 2008, was used as a reference. The basis for the habitat shapefile was the Bay Area Aquatic Resources Inventory (BAARI) Basemap (SFEI 2011) from the San Francisco Estuary Institute (SFEI). The habitat shapefile is updated each mapping year with input from CDFW and SRCD staff familiar with Suisun Marsh to keep it as current as possible. However, due to its coarse scale and poor spatial accuracy, a simple spatial analysis 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 2015, the polygons that were contained completely within the "tidal" habitat polygons from the 2008 CDFW Suisun_Regions_habitats_ver2 shapefile were given the habitat attribute "tidal." Those polygons that intersected the outline of the "tidal" habitat polygons from the 2008 CDFW 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 2012 vegetation maps in order to compare them to the 2015 map.

In addition to the separation between leveed and tidal wetlands, Suisun Marsh is geographically divided into four management regions (Figure 2). These regions are described in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan (USDI Bureau of Reclamation et al. 2013) 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 management region in which it resides.

As discussed under Results below, the Accuracy Assessment led us to make changes to the mapping classification, mostly through lumping categories that were not reliably distinguished by their photo signatures. Before we conducted change analysis, we crosswalked the 1999 and 2012 maps to the revised 2015 classification.

The vegetation map was checked for changes in stand-forming non-native species of concern between 1999 and 2015 and between 2012 and 2015. The analysis was performed marsh-wide (total area, leveed habitats, and tidal habitats) and within the four management regions (total area, leveed habitats, and tidal habitats). The non-native species of concern are as follows: *Arundo donax, Carpobrotus edulis, Cortaderia selloana, Eucalyptus* species, *Lepidium latifolium, Phragmites australis* (predominantly the non-native strain), and *Salsola soda*. These species are represented by the following mapping units:

*Arundo donax* Semi-Natural Association
*Carpobrotus edulis* or Other Ice Plants Herbaceous Semi-Natural Alliance
*Cortaderia (jubata, selloana)* Herbaceous Semi-Natural Alliance
*Eucalyptus (globulus, camaldulensis)* Woodland Semi-Natural Alliance
*Lepidium latifolium* Herbaceous Semi-Natural Alliance
*Phragmites australis* Herbaceous Alliance
*Salsola soda* Mapping Unit

As discussed in the 2012 map update report, the photo interpretability of *Lepidium latifolium* relies on the distinctive white flowers being present at the time that the aerial imagery is acquired. 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 the same time. This means that not all of the vegetation supporting *L. latifolium* is being reported. For the 2015 map update, we have further tried to mitigate this by including an attribute that allows the mapper to indicate if *Lepidium latifolium* is evident in the polygon at any level. This means that not only *Lepidium* types are calculated in the acreage, but also stands of vegetation that support *Lepidium* at any visible level are included. We then added this attribute to the 1999 and 2012 maps and gave it a value of "present" if *Lepidium* was in the name of the map type.

Additionally, the Accuracy Assessment revealed that we could not reliably identify *Conium maculatum* or *Foeniculum vulgare* on the imagery, two species we had previously analyzed. We combined these types into the Mediterranean Grasses Group, and selected polygons of this type that were over 1 meter tall, which would exclude most of the other species that would fall into this group.

We did not map any *Centaurea solstitialis* in the 2015 map update; either it was not present or was not distinguishable.

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 (*Reithrodontomys raviventris halicoetes*) in Suisun Marsh. Ten *Salicornia pacifica* (or "pickleweed") vegetation types or mapping units were collectively considered important habitat for the Salt Marsh Harvest Mouse (SMHM) in 2003 (Vaghti and Keeler-Wolf 2004). Since then, biologists have gained a better understanding of the habitat requirements of the SMHM and have considerably broadened the definition of what is considered SMHM habitat. For this analysis, Bay Delta staff specified the 2015 revised mapping classes that should be considered potential habitat. See Appendix F for the full list of mapping units that are considered potential SMHM 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:

$$\frac{\text{(Current Year Acreage – Previous Acreage)}}{\text{Previous Acreage}} * 100$$

As stated earlier, before we conducted change analysis, we crosswalked the 1999 and 2012 maps to the revised 2015 classification, so all comparisons use the same classification. See Appendices G and H for vegetation change in the SMHM habitat and non-native species of concern.

**Comparing Aerial Imagery with Satellite Imagery**

We evaluated the use of Worldview-3 satellite imagery instead of DWR's custom-flown, high-resolution imagery for potential cost savings for the project. We obtained a sample of the satellite imagery from May 13, 2015 (the closest available date to the DWR imagery) with a 0.3-meter panchromatic band resolution and 1.24-meter multi-spectral resolution. We mapped the same 106-acre area of the Marsh using the satellite imagery and the DWR imagery, and then compared the maps.

# Results

## Mapping

The mapped project area in 2015 was 91,495 acres. The Suisun Bay made up 24.2% of this area, tidal sloughs made up 3.2%, and areas mapped as vegetation or land use (such as roads or development) made up 72.6% (Table 3). Of the vegetation and land use area, 15.1% was tidally influenced and the rest was leveed. The vegetation and land use polygons range from 0.002 acre to 1,737 acres and average 2.39 acres in size.

The 2012 map update report (Boul and Keeler-Wolf 2016) described and explained the discrepancies in the total acreage mapped in the previous years. These differences were corrected this year by filling in gaps between the mapped area and project boundary in each of the 1999 through 2006 maps. The total mapped acreage of vegetation still changes slightly with each map update due to the tide level at the time the imagery was acquired and channel erosion or accretion since the area was last mapped.

**Table 3:** Total acreage and polygons mapped in the 2015 Suisun Map Update. This table is based on the values in the "habitat" attribute.

| Area mapped as: | Acres | Polygons |
|---|---|---|
| Suisun Bay | 22,141 | 1 |
| Sloughs | 2,886 | 4 |
| Tidal vegetation/land use | 10,061 | 4,388 |
| Leveed vegetation/land use | 56,407 | 24,641 |
| **Total project area** | **91,495** | **29,034** |

## Accuracy Assessment

Two forms of accuracy (users' and producers') can be estimated from the data (Story and Congalton 1986). Users' accuracy provides an estimate of commission error, or how well spatial mapping data actually represent what is found on the ground, i.e., if the user goes to a location mapped as a certain class, what is the probability it is in fact that class? Producers' accuracy, on the other hand, measures omission error, or the probability that vegetation of a given class in the field is mapped as that class. Producers' accuracy may inform the mappers if a mapping class may even be detected (Story and Congalton 1986, Lea and Curtis 2010).

A contingency table for this accuracy assessment is provided in Appendix I. Each row in the table represents a type as mapped by the PIs (producers); by reading across the row, one can see what the field surveyors (users) assessed the mapped polygon types to be on the ground. Numbers on the diagonal are correct calls by the PIs. The table displays the numbers of assessed polygons by type, and does not incorporate fuzzy scores.

General guidelines for mapping projects in California were used for this map accuracy assessment. However, with an uneven probability of accessibility and uneven mapped frequency distribution for the

types, it was not possible to obtain the desired minimum number of samples for each of the map units, so we report all types with three or more producers' or users' samples in Table 4. The average producers' accuracy was 83.7% and the average users' accuracy was 79.4%.

**Table 4:** Producers' and users' polygon count and average closeness-of-fit (fuzzy) scores per map class. Polygon counts may be found in the contingency table in Appendix I. The vegetation types are those on the original 2015 map, which correspond to the hierarchy used in 2012. The table is ordered alphabetically.

| Vegetation Type (Original 2012 hierarchy) | Producers' Count | Producers' Accuracy | Users' Count | Users' Accuracy |
|---|---|---|---|---|
| *Atriplex lentiformis* Alliance | 4 | 100.0 | 4 | 100.0 |
| *Atriplex prostrata – Cotula coronopifolia* Alliance | 2 | 60.0 | 5 | 60.0 |
| *Baccharis pilularis* / Annual Grass–Herb Association | 11 | 92.6 | 8 | 100.0 |
| *Baccharis pilularis* Alliance | 2 | 100.0 | 4 | 90.0 |
| *Bolboschoenus maritimus – Salicornia pacifica* Association | 8 | 67.4 | 0 | n/a |
| *Bolboschoenus maritimus – Sesuvium verrucosum* Association | 3 | 60.0 | 0 | n/a |
| *Bolboschoenus maritimus* Alliance | 1 | 100.0 | 7 | 82.8 |
| *Cotula coronopifolia* Association | 1 | 100.0 | 7 | 71.4 |
| *Distichlis spicata* – Annual Grasses Association | 5 | 100.0 | 9 | 86.6 |
| *Distichlis spicata – Cotula coronopifolia* Association | 2 | 90.0 | 7 | 68.4 |
| *Distichlis spicata – Juncus balticus – Triglochin* spp. *– Glaux maritima* Mapping Unit | 13 | 81.4 | 7 | 94.2 |
| *Distichlis spicata – Lotus corniculatus* Mapping Unit | 3 | 66.6 | 0 | n/a |
| *Distichlis spicata – Salicornia pacifica* Association | 5 | 72.0 | 4 | 80.0 |
| *Distichlis spicata – Schoenoplectus americanus* Mapping Unit | 6 | 73.2 | 7 | 80.0 |
| *Distichlis spicata* Alliance | 4 | 70.0 | 3 | 73.2 |
| *Distichlis spicata* Association | 5 | 80.0 | 8 | 82.4 |
| *Elytrigia pontica* Mapping Unit | 3 | 60.0 | 0 | n/a |
| *Eucalyptus globulus* Association | 4 | 100.0 | 5 | 92.0 |
| *Frankenia salina – Distichlis spicata* Association | 3 | 86.6 | 6 | 76.6 |
| *Frankenia salina* Alliance | 7 | 85.6 | 3 | 100.0 |
| *Juncus arcticus* var. *balticus* Alliance | 4 | 40.0 | 0 | n/a |
| *Juncus arcticus* var. *balticus* Association | 0 | n/a | 6 | 53.2 |
| *Lepidium latifolium* Alliance | 3 | 93.2 | 5 | 68.0 |
| *Leymus triticoides* Alliance | 4 | 80.0 | 3 | 100.0 |
| *Lolium multiflorum* Alliance | 5 | 76.0 | 0 | n/a |
| Mediterranean California Naturalized Annual and Perennial Grassland Group | 1 | 100.0 | 10 | 76.0 |
| *Phragmites australis – Schoenoplectus* spp. Association | 0 | n/a | 5 | 80.0 |
| *Phragmites australis* Association | 14 | 84.2 | 6 | 100.0 |
| *Rosa californica – Baccharis pilularis* Association | 4 | 100.0 | 4 | 100.0 |
| *Rubus discolor* Association | 2 | 100.0 | 4 | 65.0 |
| *Salicornia pacifica* – Annual Grasses Association | 2 | 100.0 | 6 | 90.0 |

| Vegetation Type (Original 2012 hierarchy) | Producers' Count | Producers' Accuracy | Users' Count | Users' Accuracy |
|---|---|---|---|---|
| *Salicornia pacifica – Atriplex prostrata* Association | 7 | 85.6 | 8 | 75.0 |
| *Salicornia pacifica – Polygonum* spp. *– Xanthium strumarium – Echinochloa crus-galli* Association | 0 | n/a | 4 | 65.0 |
| *Salicornia pacifica – Sesuvium verrucosum* Association | 11 | 83.6 | 8 | 92.4 |
| *Salicornia pacifica* Alliance | 3 | 66.6 | 9 | 75.4 |
| *Salicornia pacifica* Association | 20 | 85.0 | 10 | 94.0 |
| *Salicornia pacifica – Cotula coronopifolia* Association | 11 | 85.4 | 6 | 83.2 |
| *Schoenoplectus (acutus, californicus) – Rosa californica* Association | 2 | 100.0 | 4 | 90.0 |
| *Schoenoplectus (acutus, californicus) – Typha (angustifolia, latifolia, domingensis)* Mapping Unit | 12 | 70.0 | 7 | 77.0 |
| *Schoenoplectus (acutus, californicus)* Asspcoatopm | 1 | 100.0 | 4 | 85.0 |
| *Schoenoplectus americanus – Lepidium latifolium* Association | 4 | 100.0 | 10 | 82.0 |
| *Schoenoplectus americanus – Potentilla anserina* Association | 1 | 80.0 | 7 | 57.0 |
| *Schoenoplectus americanus* Alliance | 9 | 68.8 | 0 | n/a |
| *Schoenoplectus americanus* Association | 4 | 90.0 | 7 | 74.2 |
| *Sesuvium verrucosum* Association | 3 | 73.2 | 4 | 70.0 |
| *Typha (angustifolia, latifolia, domingensis) – Distichlis spicata* Association | 0 | n/a | 4 | 55.0 |
| *Typha (angustifolia, latifolia, domingensis) – Phragmites australis* Association | 1 | 100.0 | 4 | 65.0 |
| *Typha (angustifolia, latifolia, domingensis) – Schoenoplectus americanus* Association | 6 | 73.2 | 5 | 76.0 |
| *Typha (angustifolia, latifolia, domingensis)* Association | 8 | 85.0 | 7 | 82.8 |
| Wetland Herbs Mapping Unit | 0 | n/a | 3 | 46.6 |
| **Average Accuracy** | **-** | **83.7** | **-** | **79.4** |

Note that the accuracy scores reported refer to the "pre-AA" polygons that were mapped of each type. Once the scoring was completed, VegCAMP made corrections to types and to delineations based on notes from the field.

Types with the highest scores in both users' and producers' accuracy include the tree and shrub types *Eucalyptus globulus* Association, *Atriplex lentiformis* Alliance, *Baccharis pilularis* Alliance, *Baccharis pilularis* / Annual Grasses Association, and *Rosa californica – Baccharis pilularis* Association. This is not surprising because there are few woody types in Suisun Marsh and most have unique signatures. However, two herbaceous types also scored very high, including the *Schoenoplectus (acutus, californicus) – Rosa californica* Association and *Salicornia pacifica* – Annual Grasses Association. In

fact, all associations of *Salicornia pacifica* scored high, except the *Salicornia pacifica – Polygonum* spp. *– Xanthium strumarium – Echinochloa crus-galli* Association. This last type was confused with two types of *Bolboschoenus maritimus* or was attributed to *Salicornia pacifica* Alliance. Interestingly, the *Salicornia pacifica* Alliance did not score particularly high. The Alliance was chosen when the mapper wasn't sure of association, indicating it was a difficult or mixed polygon that might even be hard to key on the ground. Similarly, the associations of *Distichlis spicata* scored high in either the users', producers', or both categories, but the *Distichlis spicata* Alliance type did not score well. Other herbaceous types that scored well include *Frankenia salina* Alliance, *Leymus triticoides* Alliance, and *Bolboschoenus maritimus* Alliance.

Producers' accuracy for *Juncus arcticus* var. *balticus* Alliance was very low; the mappers missed this type 60% of the time. This Alliance is used when *Juncus arcticus* mixes with other plants, in which case it is not dense enough to appear on the imagery. This likely explains the low score. However, the users' accuracy for the pure *Juncus balticus* Association was also low, with the mappers correctly calling a polygon this type only 53% of the time. There was no pattern in the types with which the *Juncus balticus* Association was confused. Wetland Herbs is a mapping type used when the mappers are unsure of the species mix, so it is not surprising that the users' accuracy was only 46.6%. When these samples were visited on the ground, the biologists could identify the types and would not use the generic "Wetland Herbs."

Because the state standard for map accuracy is 80%, VegCAMP explored the use of higher levels of the classification hierarchy while still maintaining important information. Some hard-to-distinguish vegetation types were consolidated to higher levels of the hierarchy. After consulting with the Environmental Coordination Advisory Team (ECAT), the number of map classes was reduced from 139 to 88. Reassigning map classes per the revised map classification improved producers' accuracy to 85.9% and users' accuracy to 84.3% (Table 5). The reduction in map classes does not result in a loss of important information, but more realistically reflects how well the types can be discerned. A crosswalk from the 2012 classification to the revised 2015 classification is presented in Appendix C.

**Table 5:** Producers' and users' polygon count and average closeness-of-fit (fuzzy) scores per map class. The vegetation types correspond to the revised 2015 hierarchy.

| Vegetation Type (Revised 2015 hierarchy) | Producers' Count | Producers' Accuracy | Users' Count | Users' Accuracy |
|---|---|---|---|---|
| *Atriplex lentiformis* Alliance | 4 | 100.0 | 4 | 100.0 |
| *Atriplex prostrata – Cotula coronopifolia* Herbaceous Semi-Natural Alliance | 6 | 53.3 | 12 | 66.7 |
| *Baccharis pilularis* / Annual Grasses Association | 11 | 92.7 | 8 | 100.0 |
| *Baccharis pilularis* Alliance | 2 | 100.0 | 4 | 90.0 |
| *Bolboschoenus maritimus* Alliance | 13 | 81.5 | 7 | 100.0 |
| *Distichlis spicata* Alliance | 8 | 70.0 | 3 | 80.0 |
| *Distichlis spicata* Association | 5 | 80.0 | 8 | 82.5 |
| *Distichlis spicata* – Annual Grasses Association | 5 | 100.0 | 9 | 86.7 |
| *Distichlis spicata – Cotula coronopifolia* Association | 2 | 90.0 | 7 | 68.6 |

| Vegetation Type (Revised 2015 hierarchy) | Producers' Count | Producers' Accuracy | Users' Count | Users' Accuracy |
|---|---|---|---|---|
| *Distichlis spicata – Juncus balticus – Triglochin* spp. *– Glaux maritima* Association | 13 | 81.5 | 7 | 94.3 |
| *Distichlis spicata – Salicornia pacifica* Association | 5 | 72.0 | 4 | 80.0 |
| *Distichlis spicata – Schoenoplectus americanus* Association | 6 | 73.3 | 7 | 80.0 |
| *Eucalyptus (globulus, camaldulensis)* Semi-Natural Alliance | 4 | 100.0 | 5 | 92.0 |
| *Frankenia salina* Alliance | 7 | 85.7 | 3 | 100.0 |
| *Frankenia salina – Distichlis spicata* Association | 3 | 86.7 | 6 | 76.7 |
| *Juncus arcticus* (var. *balticus, mexicanus*) Herbaceous Alliance | 6 | 53.3 | 6 | 56.7 |
| *Lepidium latifolium* Alliance | 3 | 100.0 | 6 | 73.3 |
| *Leymus triticoides* Alliance | 4 | 80.0 | 3 | 100.0 |
| Mediterranean California Naturalized Annual and Perennial Grassland Group | 14 | 85.7 | 10 | 100.0 |
| *Phragmites australis* Alliance | 14 | 94.3 | 11 | 100.0 |
| *Rosa californica – Baccharis pilularis* Association | 4 | 100.0 | 4 | 100.0 |
| *Rubus discolor* Association | 2 | 100.0 | 4 | 65.0 |
| *Salicornia pacifica (Salicornia depressa)* Herbaceous Alliance | 10 | 84.0 | 21 | 78.1 |
| *Salicornia pacifica* Association | 20 | 85.0 | 10 | 94.0 |
| *Salicornia pacifica* – Annual Grasses Association | 2 | 100.0 | 6 | 90.0 |
| *Salicornia pacifica – Sesuvium verrucosum* Association | 11 | 83.6 | 8 | 92.5 |
| *Salicornia virginica – Cotula coronopifolia* Association | 11 | 87.3 | 6 | 86.7 |
| *Schoenoplectus (acutus, californicus)* Mapping Unit | 1 | 100.0 | 4 | 85.0 |
| *Schoenoplectus (acutus, californicus) – Rosa californica* | 2 | 100.0 | 4 | 90.0 |
| *Schoenoplectus (acutus, californicus) – Typha (angustifolia, latifolia, domingensis)* Association | 12 | 70.0 | 7 | 88.6 |
| *Schoenoplectus americanus* Alliance | 18 | 86.7 | 24 | 76.7 |
| *Sesuvium verrucosum* Provisional Association | 3 | 73.3 | 4 | 70.0 |
| Temperate and Boreal Salt Marsh Formation | 0 | n/a | 3 | 46.7 |
| *Typha (angustifolia, latifolia, domingensis)* Alliance | 17 | 85.9 | 21 | 74.3 |
| **Average Accuracy** | - | **85.9** | - | **84.3** |

## Vegetation Change Analysis

As discussed in the Methods section, we analyzed vegetation change by crosswalking the 1999 and 2012 vegetation maps to the revised 2015 classes and then comparing changes in acreage. Thus, the original numbers of acres for a given type in 1999 or 2012 in this report will not match numbers in previous reports for map classes that were merged.

## Salt Marsh Harvest Mouse Habitat

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*). Ten *Salicornia pacifica* (or "pickleweed") vegetation types or

mapping units were collectively considered important habitat for the SMHM in 2003. 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 (Sustaita et al. 2011). Refer to Appendix F for the full list of vegetation mapping units that are considered Salt Marsh Harvest Mouse (SMHM) habitat for this report.

**Marsh-wide**: Figure 3, Appendix G

Of the 66,468 acres of vegetation/land use mapped in the Marsh in 2015, 66% (43,683 acres) is considered potential SMHM habitat, a decrease of 3% since 2012 (there was previously less than 1% change from 1999 to 2012). There has been a 13.1% decrease in potential SMHM habitat in the leveed areas and a 35.4% increase in potential SMHM habitat in the tidal areas of the Marsh since 1999. Since 2012, SMHM habitat has decreased 1.9% in the tidal areas and 4.3% in the leveed areas. SMHM habitat now comprises 76% of the tidal vegetation/land use and 64% of the non-tidal vegetation/land use.

**By management region**: Figure 3, Figure 4, Appendix G

Region 1:

Management Region 1 contains approximately 10,874.6 acres (25%) of SMHM habitat in the Marsh. The majority of the SMHM habitat of this region is in the leveed area (8,545.0 acres), where it has decreased by 27.3% since 1999. However, in the tidal areas, the SMHM habitat has increased by 52.3% (800.3 acres) since 1999.

Region 2:

Management Region 2 contains 7,410.5 acres (17%) of the 2015 potential SMHM habitat in the Marsh, which is up by 7.1% since 1999. Over 71% (5,321.9 acres) of the potential SMHM habitat of this region is in the leveed areas, where it has decreased by 4.3% since 1999 (236.5 acres). The potential SMHM habitat in the tidal areas of this region has increased by 53.5% (727.8 acres) since 1999.

Region 3:

Management Region 3 has 2,972.9 acres (7%) of the SMHM habitat of the Marsh, with a decrease of 16.6% (590.0 acres) since 1999. There are 2,375.6 acres of potential habitat in the leveed areas, down 738.5 acres (23.7%) since 1999 and down 688.9 acres (22.5%) since 2012. There are 597.3 acres in the tidal areas of this region, up 148.5 acres (33.1%) since 1999 but down 8.0 acres (1.3%) since 2012.

Region 4:

Management Region 4 has 22,424.5 acres (51%) of the potential SMHM habitat in the Marsh. Over 88% (19,780.7 acres) of the potential habitat in this region is located in the leveed areas, where it has decreased since 1999 by 5.9% (1,238.2 acres) and increased by 1.3% (255.5 acres) since 2012. The potential SMHM habitat in the tidal areas of this region has increased by 14.1% (327.3 acres) since 1999, but decreased 17.9% (574.8 acres) since 2012.

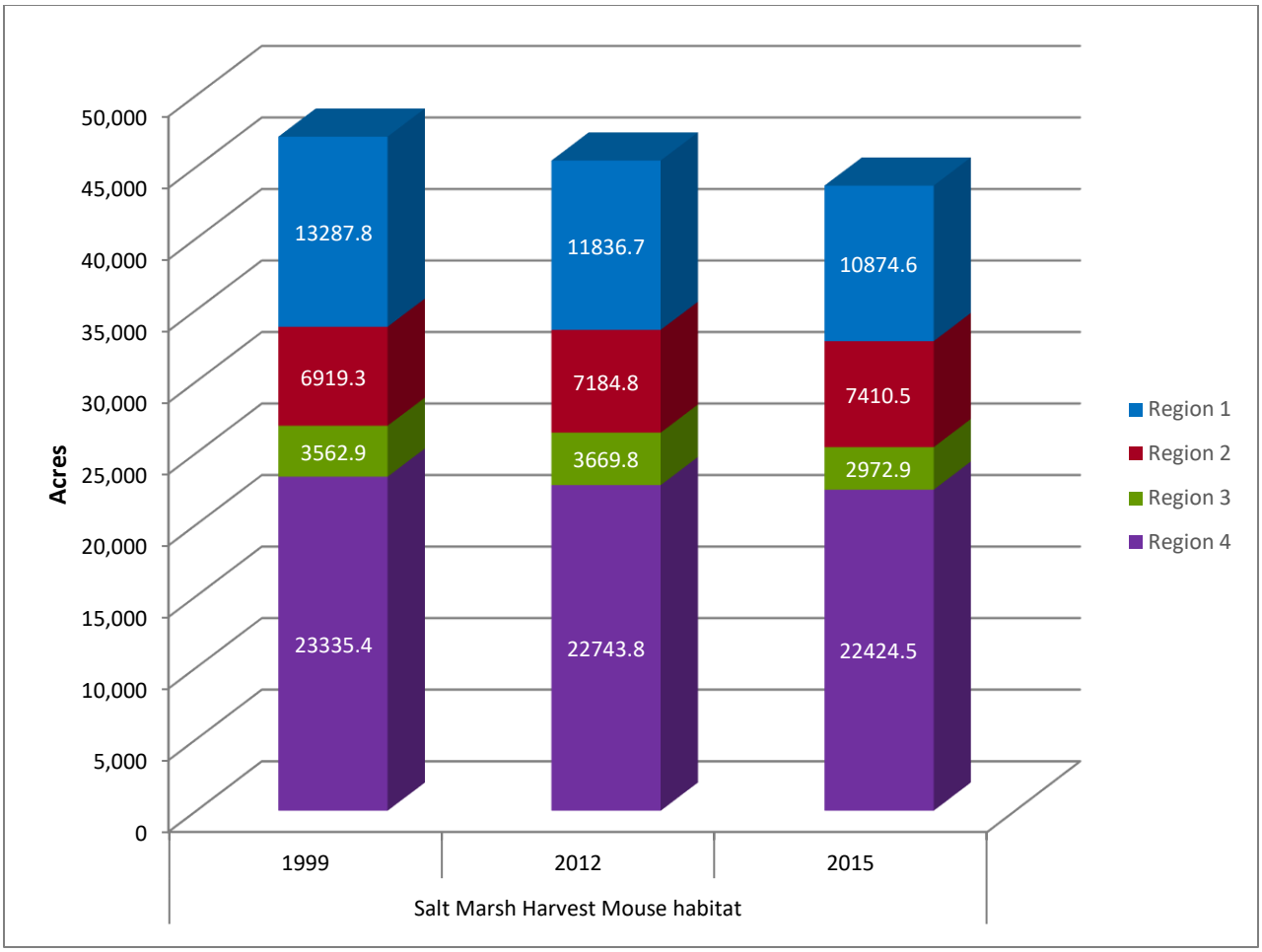



**Figure 3:** The acreage and distribution across the four management regions for the potential Salt Marsh Harvest Mouse habitat mapped within the Suisun Marsh triennial vegetation maps in 1999, 2012, and 2015.

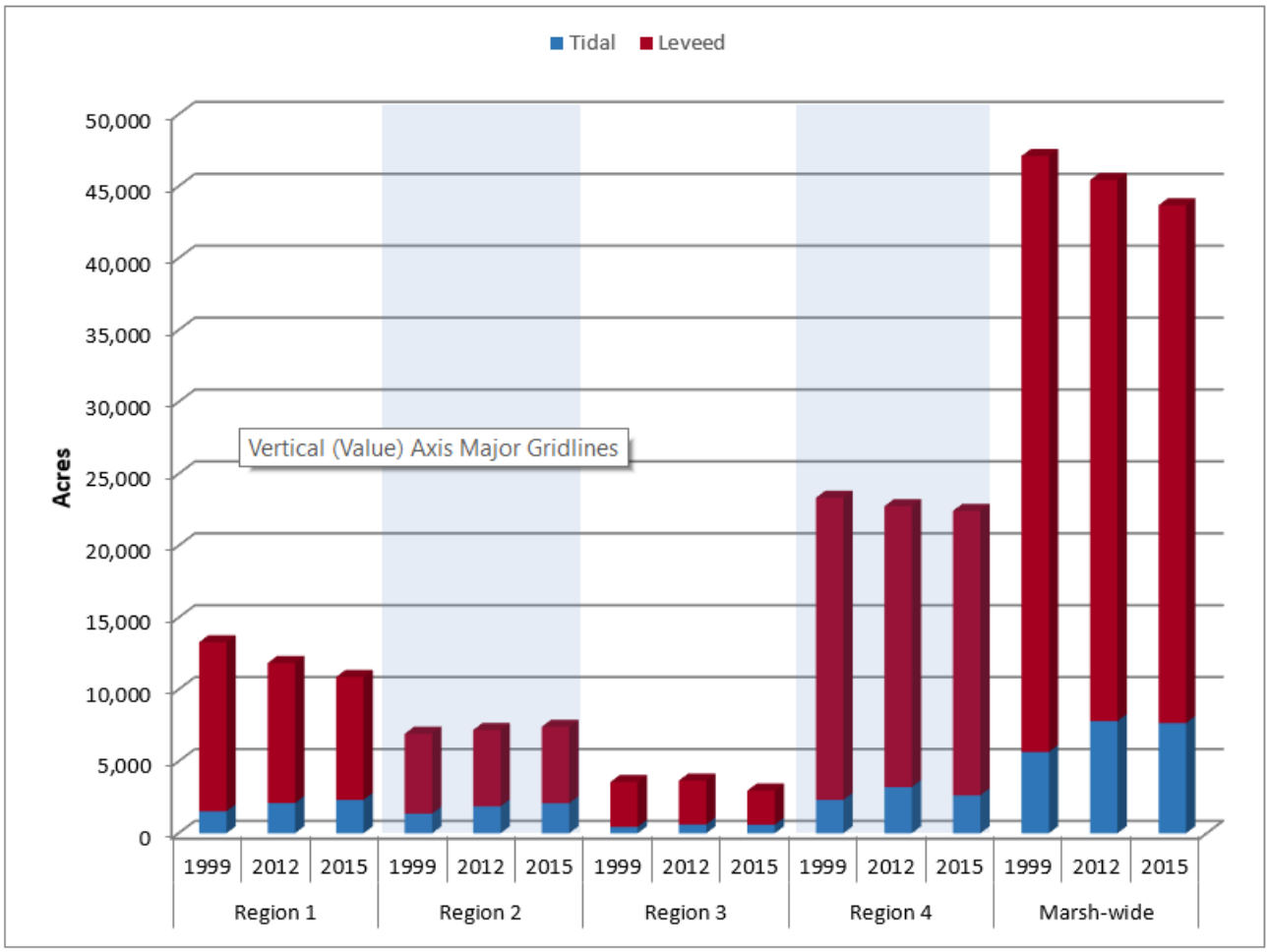



**Figure 4**: The acreage for the potential Salt Marsh Harvest Mouse habitat mapped within the Suisun Marsh triennial vegetation maps in 1999, 2012, and 2015 for the four management regions and marsh-wide, showing the proportion of tidal and leveed habitats for each.

**Non-Native Species of Concern**

All of the results of change detection for non-native species of concern are presented in Appendix H and are summarized or highlighted in the discussion below.

**Marsh-wide**: Figure 5, Appendix H

*Arundo donax* has increased from 4.7 acres to 6.1 acres since 1999 marsh-wide. Some of this increase is an artifact of better image interpretation or better imagery. Also, some areas that were considered below minimum mapping unit in the 1999 map, which was based on hand delineation on overlays, are now being delineated even though they are below MMU.

*Carpobrotus edulis* increased from 7.0 acres in 1999 to 8.2 acres in 2012 and then to 33.1 acres in 2015, a 370.9% increase since mapping began. However, like *Arundo donax*, the increase in acres is partially

due to better photo interpretation and the lack of an MMU for invasive species in the later maps; little appears to be due to *Carpobrotus* actually spreading.

*Cortaderia selloana* has decreased in the Marsh from 9.8 acres to 6.3 acres since 1999, although it increased 0.7 acre from 2012 to 2015. The decrease from 1999 seems to be from two specific areas: one was converted/graded, and the other seems to have had very low cover of *Cortaderia* in 1999 and may have been incorrectly mapped. The increase from 2012 to 2015 seems to be due to refinement of interpreted polygons, not an actual increase.

Mapped stands of *Eucalyptus* spp. have increased from 208.1 acres in 1999 to 288.8 acres in 2015 for an increase of 38.8%, although there was a 43.1 acre (13%) loss from 2012 to 2015. In the leveed areas of the Marsh, where most of the coverage occurs, *Eucalyptus* spp. has decreased by 13.4% since the 2012 remap. The total area covered by *Eucalyptus* spp. in the tidal areas, as expected, has remained low, starting with 12.7 acres in 1999 and decreasing to 7.7 acres in 2015.

As discussed in the Methods section, for the 2015 mapping we added an attribute to each polygon denoting whether *Lepidium latifolium* was present, so this change analysis considers more than just the polygons mapped as *Lepidium latifolium* Semi-Natural Alliance. Since 1999, there has been a 19.5% increase (from 956.2 to 1,142.3 acres) of this species, with a 45.7% increase over the past three years, though the acreage had previously been decreasing. There was a much larger increase in tidal acreage (75.4%) than leveed acreage (29.1%) since 2012.

As discussed previously, *Conium maculatum* and *Foeniculum vulgare* are now represented by the portion of the Mediterranean Grasses Group that is over 1 meter in height. This map unit and height combination also includes *Brassica nigra*. Since 1999, this type (hereinafter referred to as tall weeds) has decreased from 1,266.3 acres to 426.5 acres, a 66.3% difference, though it increased 91.3 acres (27.2%) since 2012. Some of this decrease can be explained by a difference in photo interpretation between 1999 and 2015. Much of what was mapped as tall weeds in 1999 has since been mapped as (or converted to) agriculture, roads, bare ground and *Distichlis spicata* – Annual Grasses Association.

No *Centaurea solstitialis* was mapped in 2015.

The non-native genotype of *Phragmites australis* is the most widespread non-native species of concern in the Marsh (Figure 5). This mapping effort does not distinguish between the native and non-native forms, however, what is mapped as the *Phragmites australis* mapping unit is the non-native form, which forms dense, monotypic stands. Since 1999, *P. australis* has increased by 325.2% over the entire marsh, from 693.1 acres in 1999 to 2,947.0 acres in 2015. As of 2015, *P. australis* covers 1,764.2 acres (3.1%) of the leveed marsh and 1,182.8 acres (11.8%) of the tidal marsh. It has more than doubled in the tidal marsh since 1999, up by 227% (821.2 acres), and has expanded 432.1% (1,432.6 acres) in the leveed areas. This is despite control efforts in some leveed areas such as spraying, disking and burning.

*Salsola soda* has spread very rapidly as a dominant and co-dominant in the Marsh, from 4.8 acres in 2012 to 67.0 acres in 2015. As mapped, stands are concentrated in six separate areas in Regions 1, 2, and 4.

**By management region**: Figure 6, Figure 7, Figure 8, Appendix H

Region 1:

Thirty-seven percent of the *Arundo donax*, 6% of the *Carpobrotus edulis*, 62% of the *Cortaderia selloana*, 32% of the *Eucalyptus* spp., 28% of the *Lepidium latifolium*, 19% of the tall weeds, 21% of the *Phragmites australis*, and 45% of the *Salsola soda* occur within this management region.

*Arundo donax* has more than doubled in this region since 1999, from 0.7 to 2.2 acres, at least in part due to better imagery or interpretation.

*Cortaderia* has decreased by 48.6% since 1999 in this region. Two acres in Parcel 110 along Chadbourne Road that were mapped as *Cortaderia* in 1999 appear to have been bladed, eliminating the *Cortaderia*.

All but 0.9 acre of 91.8 acres of *Eucalyptus* spp. in this region are found in the leveed habitats, where the type has increased by 73.0% (38.4 acres) since 1999, but decreased 30.9% (40.7 acres) since 2012. Much of the decrease occurred SSE of the intersection of Chadbourne Road and Jacksnipe Road, and in Parcels 120 and 130.

Vegetation dominated by *Lepidium latifolium* has increased 14.5% in this region since 2012 and 15.8% since 1999. It has increased by 170.4% in the tidal areas since 1999 but decreased in the leveed areas.

Tall-weed-dominated vegetation is not generally an issue in tidal areas, given that the plants are upland species, and so acreage remains low. In the leveed areas of the region, tall weeds decreased by 87.9% since 1999.

*Phragmites australis* has increased in this region by 431.9 acres since 1999 and 116.4 acres since 2012, for a total of 617.1 acres of *P. australis* in this region in 2015.

This region contained the first known mappable stands of *Salsola soda* within the Marsh, in 2012. The stands in Management Region 1 grew from 4.8 acres to 29.9 acres by 2015, a 520.8% increase, all in the leveed areas.

Region 2:

One percent of the *Carpobrotus edulis*, 10% of the *Eucalyptus* spp., 45% of the *Lepidium latifolium*, 9% of the tall weeds, 12% of the *Phragmites australis*, and 12% of the *Salsola soda* in the entire marsh were in this management region. There were no mapped stands of *Arundo donax* or *Cortaderia selloana* in this region.

Vegetation dominated by *Lepidium latifolium* increased 92.1% since 1999 and 48.5% since 2012. The greatest increase since 1999 was in the tidal areas (151.9%). *Lepidium* is the most widespread of the non-native species of concern in this region.

Tall weeds have decreased 64.3% in leveed areas since 1999.

*Phragmites australis* has increased more rapidly since 2012 in the tidal areas (32.6%, from 94.8 to 125.8 acres) than the leveed areas (0.9%) in Region 2. Over the entire region, it has increased almost 400% since 1999.

*Salsola soda* was mapped in this region for the first time in 2015, with 8.2 acres in leveed areas.

Region 3:

Three percent of the *Eucalyptus* spp. in the entire marsh was found in Management Region 3, as was less than 1% of the *Lepidium latifolium,* 8% of the tall weeds, and 6% of the *Phragmites australis*. There were no mapped stands of *Arundo donax, Carpobrotus edulis*, *Cortaderia selloana* or *Salsola soda* in this region.

Tall weeds have increased 100.8% (to 35.5 acres) in leveed areas since 1999.

*Phragmites australis* is the most abundant species of concern in this region, and although it has decreased in leveed areas by 11.0% since 2012, it has increased by 47.7% in the tidal areas of the region since 2012 and from 1.2 acres 31.6 acres (2,531%) since 1999.

Region 4:

Sixty-three percent of the *Arundo donax,* 93% of the *Carpobrotus edulis*, 38% of the *Cortaderia selloana*, 56% of the *Eucalyptus* spp., 27% of the *Lepidium latifolium,* 64% of the tall weeds, 61% of the *Phragmites australis,* and 43% of the *Salsola soda* occur within this management region.

*Arundo donax* decreased 91.4% in tidal areas in this region since 1999 (from 1.1 to 0.1 acre), but increased 73.3% in leveed areas (from 2.1 to 3.7 acres), though it has remained the same since 2012.

*Carpobrotus edulis* decreased 93.1% (from 1.6 to 0.1 acre) since 1999 in the tidal areas, but increased 460.8% (from 5.5 to 30.7 acres) since 1999 in the leveed areas. Most of the increase in the leveed areas occurred since 2012 (385.0%). A review of specific areas of "change" point to easier interpretation of *Carpobrotus* with the 2015 imagery and not to a real increase in the type.

*Cortaderia selloana* acreage is small (under 2.5 acres overall in this region), and review of historical imagery suggests the percent changes may reflect increased mapping accuracy or better imagery.

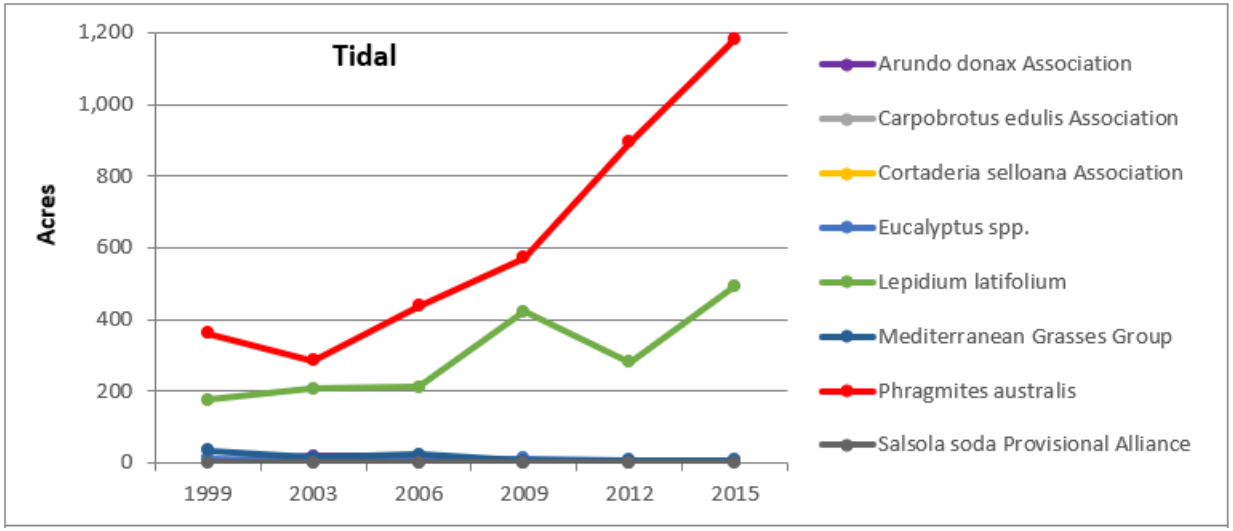
*Eucalyptus* spp. has decreased 53.2% in the tidal areas and increased 39.8% in leveed areas since 1999, though it has shown a decrease of 2.4% in leveed areas since 2012.

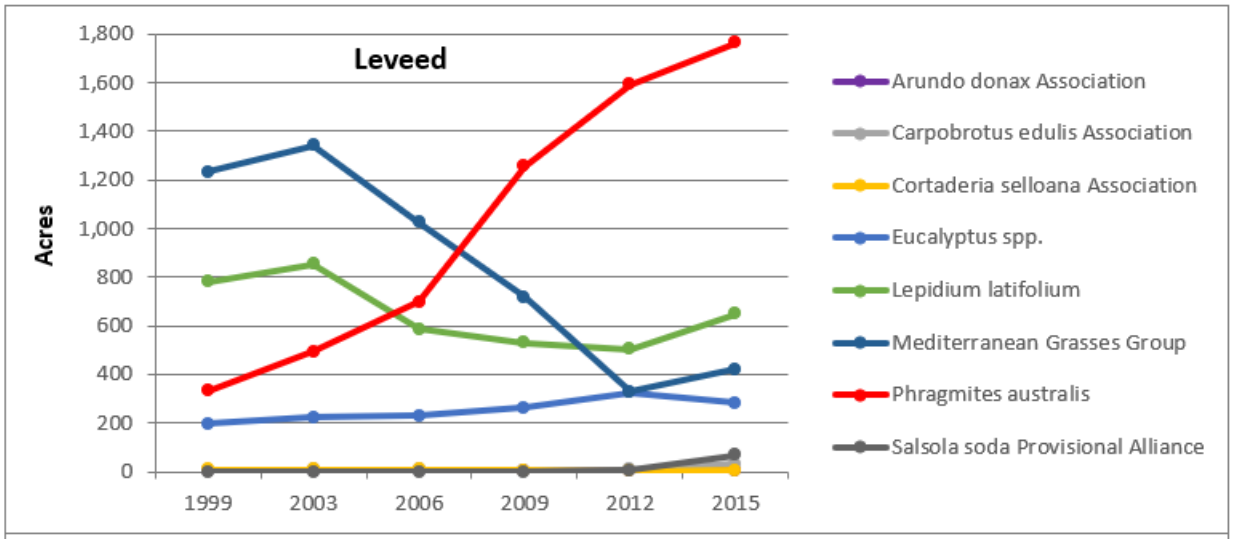
*Lepidium latifolium* has increased from 26.4 acres in 1999 to 107.6 acres in 2015 in the tidal portion of this region, though it had previously decreased to 5.5 acres in 2012. It has decreased in leveed areas by 47.5% (from 384.7 to 202.0 acres) since 1999, but increased by 48.1 acres since 2012.

Tall weeds have decreased in the leveed areas of this region by 39.4% since 1999, but increased 1,499.7% since 2012. Most of the increase was in areas that were mapped in 2012 as a shorter version of the same type, with lesser amounts having been mapped as roads or the *Distichlis spicata* – Annual Grasses Association.

*Phragmites australis* is the most abundant species of concern in this region, increasing in tidal areas by 15.8% since 2012 and 137.4% since 1999. It has increased by 24.0% in the leveed areas of the region since 2012 and 626.7% since 1999 (from 170.4 to 1,238.6 acres), despite control efforts.

*Salsola soda* was mapped in Management Region 4 for the first time, with 28.9 acres in 2015, all in the leveed areas.


Tidal
Acres
1,200
1,000
800
600
400
200
0
1999
2003
2006
2009
2012
2015
Arundo donax Association
Carpobrotus edulis Association
Cortaderia selloana Association
Eucalyptus spp.
Lepidium latifolium
Mediterranean Grasses Group
Phragmites australis
Salsola soda Provisional Alliance


Leveed
Acres
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
1999
2003
2006
2009
2012
2015
Arundo donax Association
Carpobrotus edulis Association
Cortaderia selloana Association
Eucalyptus spp.
Lepidium latifolium
Mediterranean Grasses Group
Phragmites australis
Salsola soda Provisional Alliance

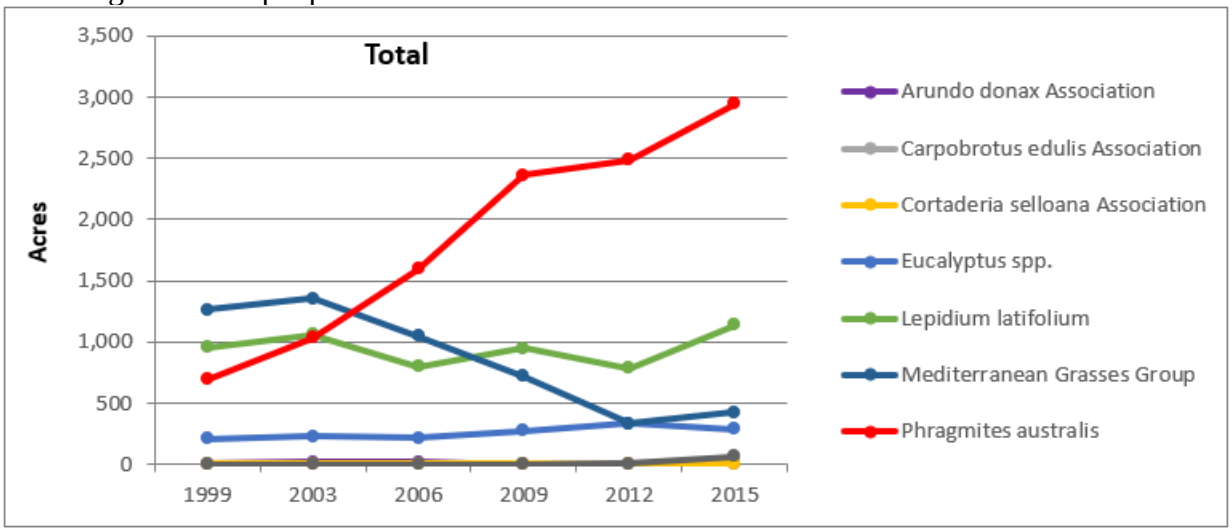



**Figure 5**: The acreage trend from 1999 to 2015 of the non-native species of concern in Suisun Marsh. Note the different scales in each graph.

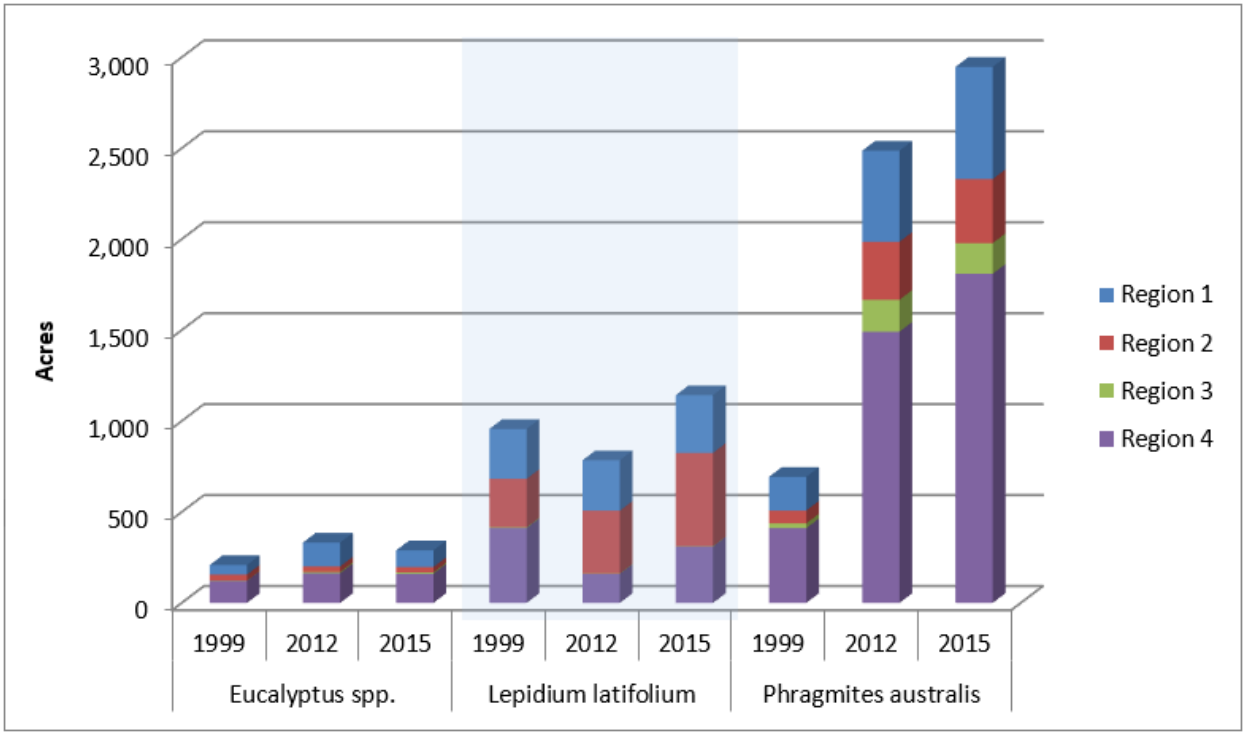



**Figure 6**: The acreage distribution of the most abundant non-native species of concern in Suisun Marsh in 1999, 2012, and 2015 across each of the four management regions.

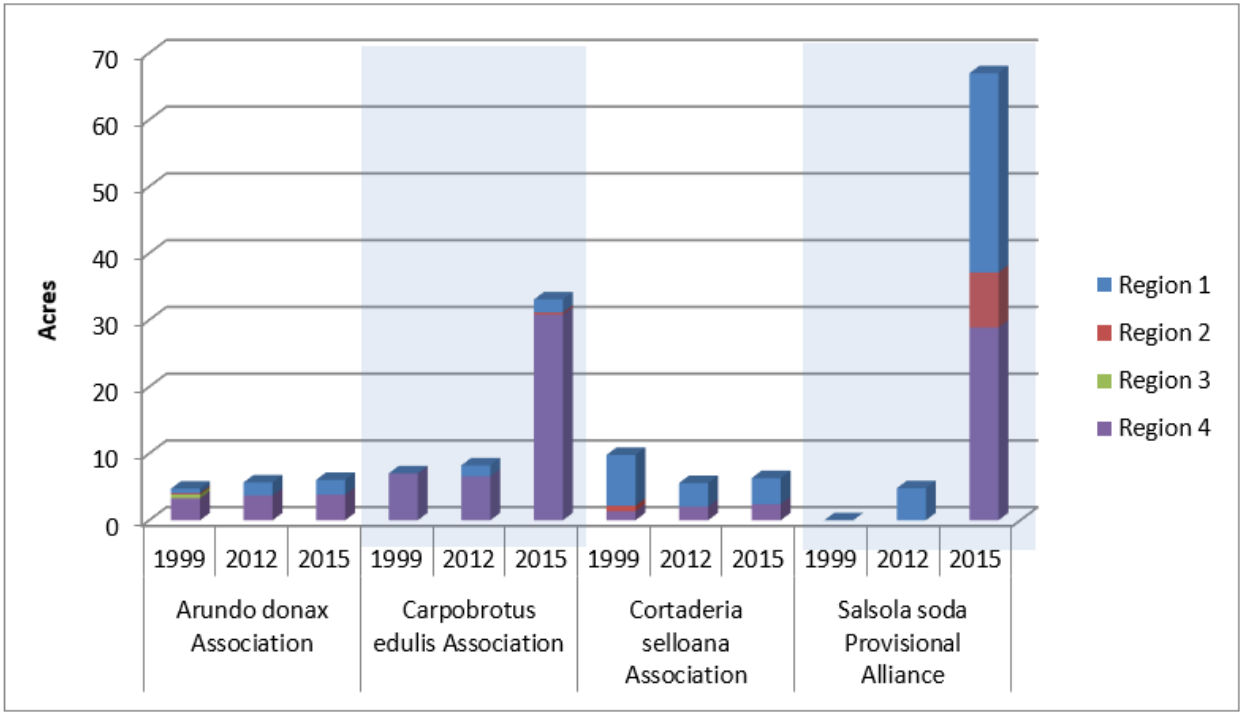



**Figure 7**: The acreage distribution of the less abundant non-native species of concern in Suisun Marsh in 1999, 2012, and 2015 across each of the four management regions. Note the difference in scale between Figure 6 and Figure 7. The apparent increase in *Carpobrotus edulis* is due to elimination of the MMU for this type.

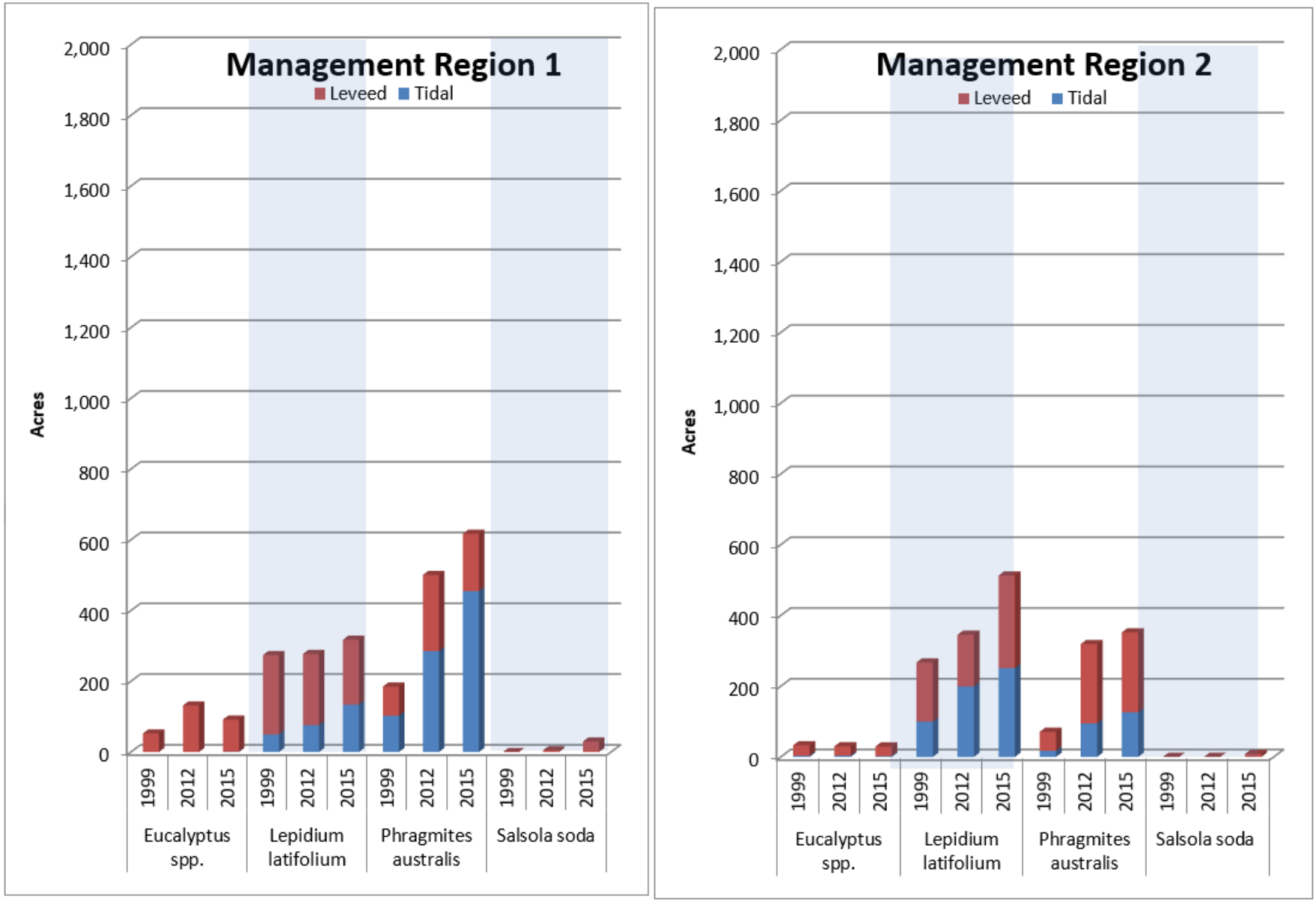
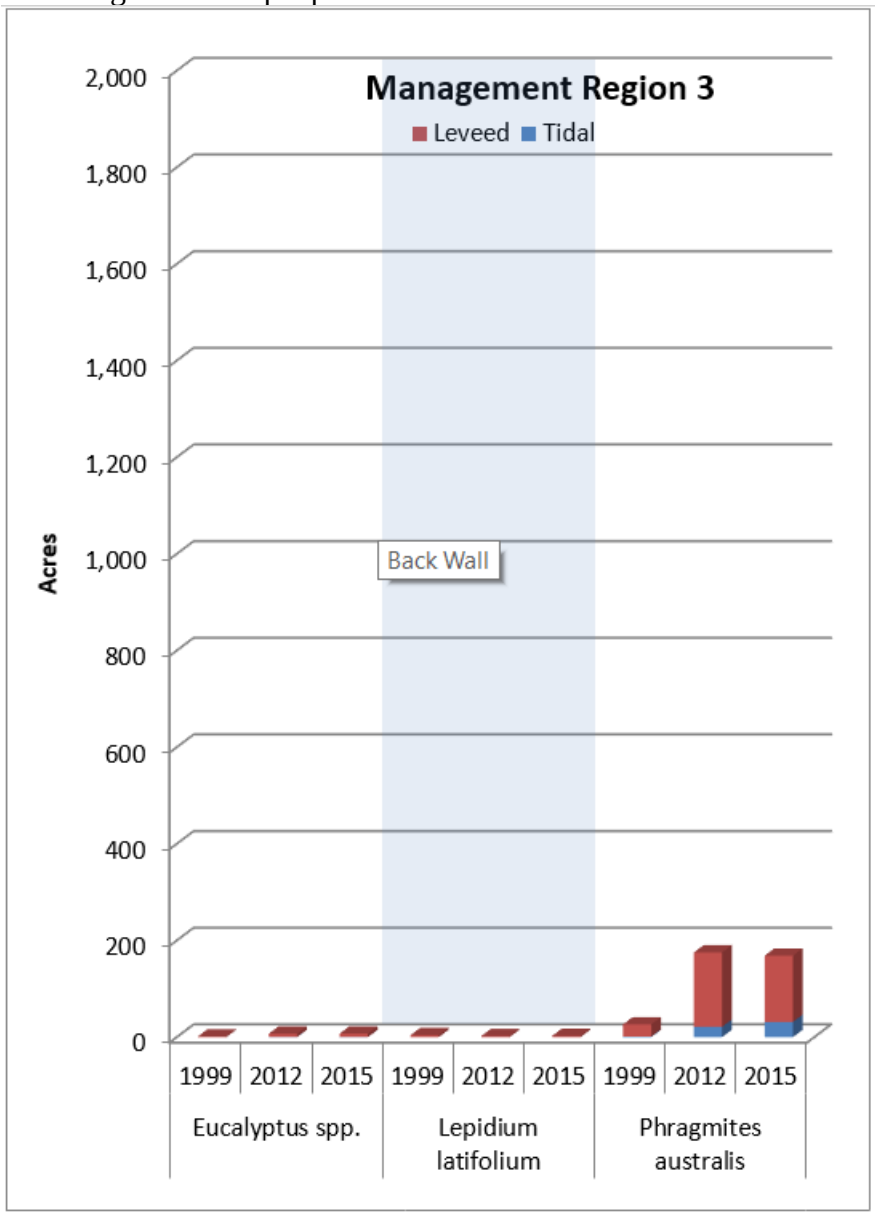



**Figure 8**: The acreages of noteworthy non-native species of concern in Suisun Marsh in 1999, 2012, and 2015 for each of the four management regions showing the proportion of each type that occurs in the tidal habitats and leveed habitats.



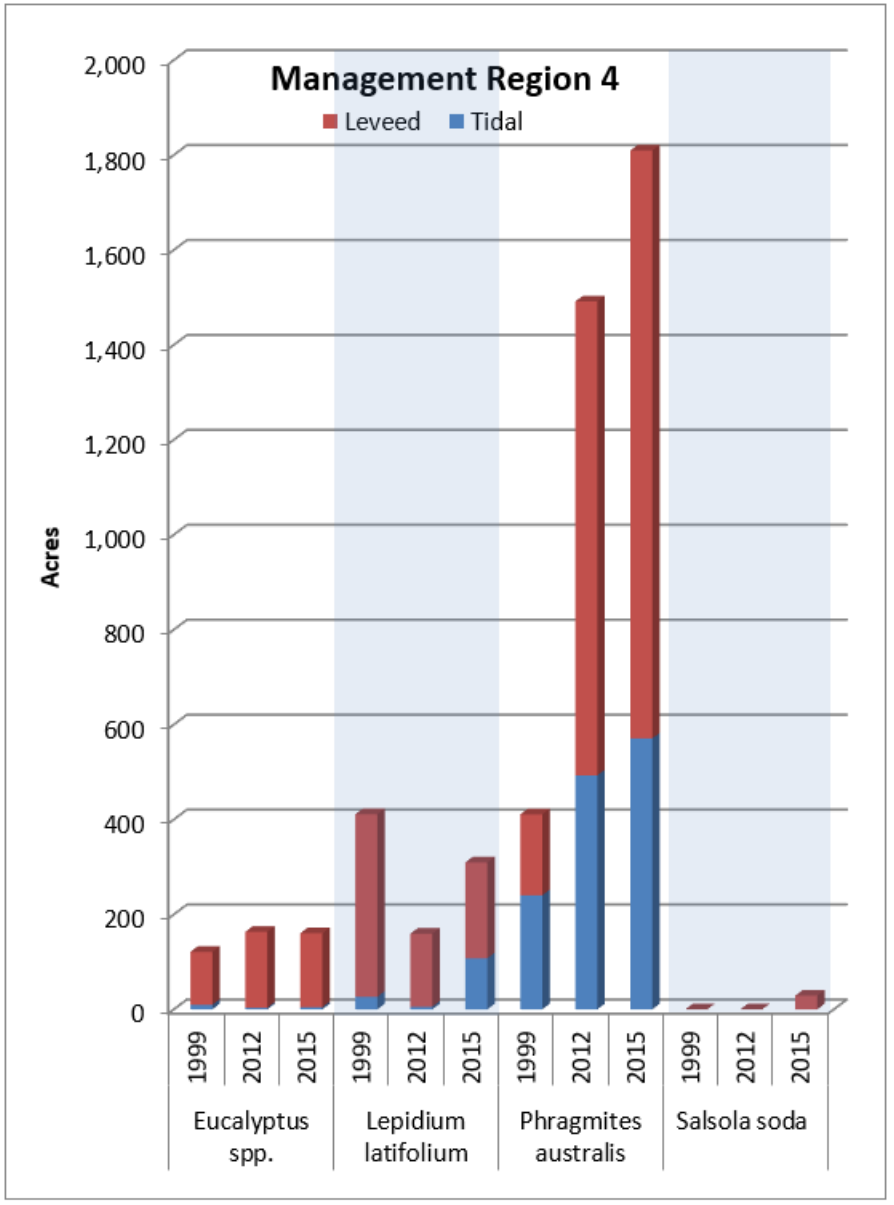




**Figure 8 (continued):** The acreages of noteworthy non-native species of concern in Suisun Marsh in 1999, 2012, and 2015 for each of the four management regions showing the proportion of each type that occurs in the tidal habitats and leveed habitats of the region.

**Comparison of Aerial Imagery with Satellite Imagery**

Comparison of independent mapping in a pilot area using sample satellite imagery from May 13, 2015 and the 2015 DWR imagery revealed the lower resolution of the satellite imagery (Figure 9), which reduced the number of polygons that could be delineated (Table 6). Further reducing the value of the satellite imagery is the inability to acquire imagery at a specified date and tidal stage. Imagery taken at the same time of the year (and phenology) and tidal stage allows map comparisons between years. Additionally, industry standard for a new collection on WorldView-3 or WorldView-2 is up to 15% cloud coverage (C. Sheil, personal communication, December 8, 2015). This means that up to 15% of the project area might not be visible on the imagery.

**Figure 9:** Satellite imagery and mapped polygons (left) vs. aerial photograph and mapped polygons (right) for the same location.

**Table 6:** Comparison of mapping of pilot area using satellite vs. aerial photo imagery.

| Metric | Satellite | Photo |
|---|---|---|
| Total number of polygons | 80 | 101 |
| Number of types mapped | 24 | 24 |
| Number of polys mapped as non-vegetation | 16 | 19 |
| Number of polys mapped as vegetation MU | 0 | 2 |
| Number of polys mapped at NVC Group level | 2 | 1 |
| Number of polys mapped at NVC Alliance level | 6 | 7 |
| Number of polys mapped at NVC Association level | 56 | 78 |

# Discussion, Conclusions, and Recommendations

For this analysis, we have used the same interpretation of what constitutes potential Salt Marsh Harvest Mouse habitat (Appendix F) as in the report for the 2012 map update, with some changes due to the combining of several classes based on the Accuracy Assessment. Using these map classes, 66% of vegetation/land use mapped in the Marsh is considered potential habitat for SMHM, down 3% since 1999 and 2012.

*Phragmites australis* is still increasing, as in previous years, with an 18.7% increase since 2012 (Figure 10). There was again evidence of land managers working to control this species in the leveed areas through mowing and the application of herbicides.

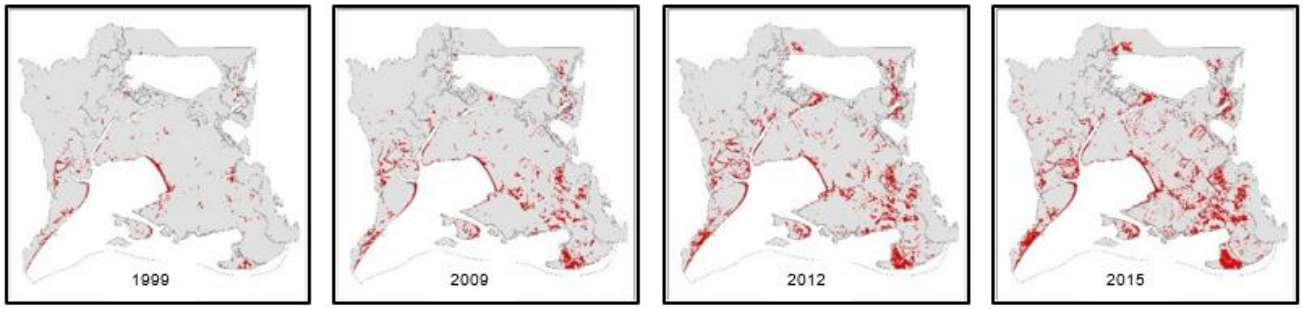



**Figure 10:** Progression of *Phragmites australis* cover in Suisun Marsh from 1999 through 2015.

As seen by the dominance of *Phragmites* in the Blacklock restoration site (Figure 11), the plant will be a particular concern for marsh restoration projects, including the Tule Red site, given its proximity to one of the largest stands of *Phragmites* in the Marsh.

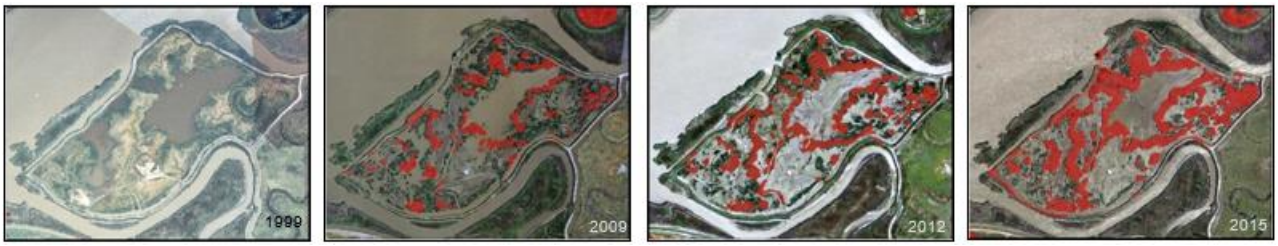



**Figure 11:** The Blacklock site was essentially free of *Phragmites* in 1999, before the levees were breached to allow tidal influences to prevail. By 2015, *Phragmites* was well established throughout the site.

As in previous years, the types that are dominated by *Arundo donax* and *Carpobrotus edulis* have shown very little change since 1999. These species tend to spread rapidly in other habitats in the United States, but in the Marsh they seem to be limited due to their preference for levee-edge, upland settings. *Cortaderia selloana*, which we believe is the pampas grass in Suisun, is not as invasive as *Cortaderia jubata*, with which it is often confused, and in the Marsh most of the stands are near buildings and developments, suggesting they were planted. The marsh-wide area mapped as *Cortaderia* has actually decreased since 1999. We recommend that *Arundo*, *Cortaderia*, and *Carpobrotus* not be analyzed in future reports because they are not spreading

and could actually be eradicated if desired. *Carpobrotus*, in particular, seems to be a landscaping plant around some of the developed areas.

*Salsola soda* continued to increase at the site it was originally mapped in Management Region 1 and it appeared for the first time in Management Regions 2 and 4. It is possible that this species has been in the Marsh since mapping began, but was misidentified as *Salsola tragus*; we don't have voucher specimens for this plant from past sampling and mapping efforts so cannot rule this out.

Dean Podolsky of Suisun Resource Conservation District alerted VegCAMP staff about an annual or biennial *Symphyotrichum* (formerly *Aster*) that has recently invaded some of the managed wetlands, forming tall, dense stands. He and VegCAMP staff visited some of the stands on 7/8/2015 (Figure 12) and made collections, which will be deposited at the Herbarium (CDA) at the Plant Pest Diagnostics Center of the California Department of Food and Agriculture. These specimens were keyed to two, or possibly three, varieties of *Symphyotrichum subulatum*: var. *squamatum,* var. *elongatum,* and, potentially, var. *ligulatum.* The California Consortium of Herbaria has only 12 collections in California of the first variety, *squamatum,* the closest to Suisun Marsh being from the Cosumnes River Preserve in Sacramento County. The Consortium has 21 collections in the state of variety *elongatum,* most from southern California but two from an unknown location in Solano County and one from West Sacramento in Yolo County. Fred Hrusa of CDA identified an earlier collection made by VegCAMP as potentially *S. subulatum* var. *ligulatum.* The plant was not mature enough for positive identification, but was not var. *elongatum* (F. Hrusa, personal communication). All are invading areas that are seasonally flooded. We recommend further investigation of this species to identify how many and which varieties are in the Marsh, their life histories, management factors that influence their spread, and control methods.

The invasive annual, *Dittrichia graveolens* (common name: stinkwort), was observed for the first time by VegCAMP staff in the Marsh in 2015 at two locations in Management Region 4 (Figure 12), both along levee roadsides. The first collection of this plant in Solano County was in 1998 at the Benicia Industrial Park along Bayshore Road. Sarah Estrella of DFW (pers. comm.) observed this plant in Management Region 1 prior to 2007. The California Invasive Plant Council (Cal-IPC) classifies the potential impact of this plant on ecosystems as moderate (see the Cal-IPC website for information on this plant). VegCAMP staff observed *Dittrichia graveolens* forming large, monotypic stands in the managed ponds in the Sonoma marshes, so this plant may cover larger areas in Suisun Marsh ponds that we did not see or could not map, given we had no representative photo signature for the 2015 mapping. Land managers may want to investigate control of this species, in addition to the *Symphyotrichum* species described above.

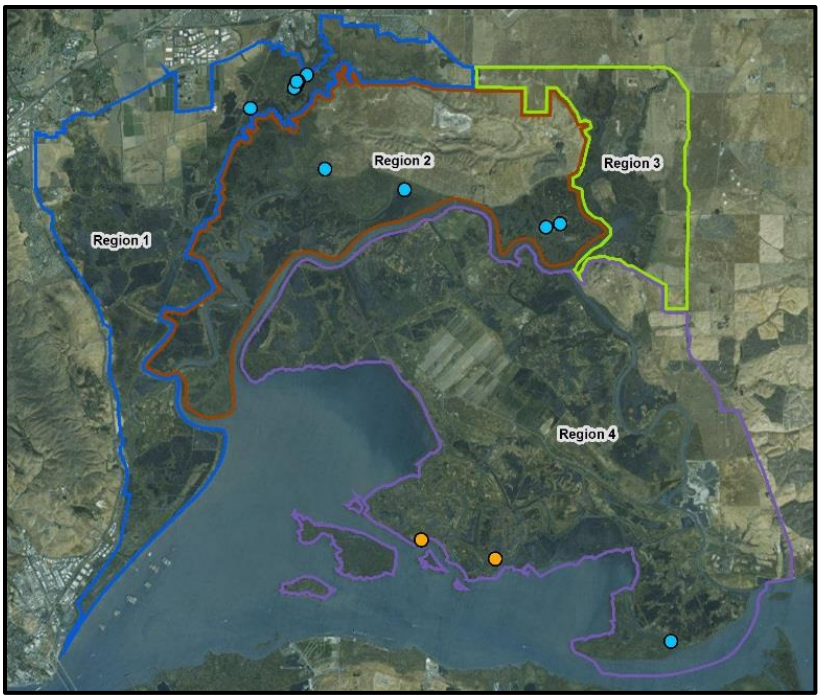



**Figure 12:** Location of apparently non-native *Symphyotrichum* (blue points) and *Dittrichia* (orange points) in Suisun Marsh.

### Comparison of Aerial Imagery with Satellite Imagery

The cost of the satellite imagery for the project area from Harris MapMart would be $22,000 to $26,000 before rectification using existing control points (C. Sheil, personal communication, December 8, 2015). We did not have access to the costs of aerial imagery as currently acquired. However, limitations on the date, tidal stage, and cloud cover of the satellite imagery acquisition, as well as its coarser scale, indicate that the satellite imagery is not appropriate for this project.

### Future Mapping Efforts

The Suisun map requires fine-scale vegetation classification and spatial delineation, which involves intensive effort on the part of ecologists. Consequently, the final map may be completed up to a year after the base imagery is flown, a time lag that may not be acceptable to decision makers. Vegetation mapping methods have changed with technology over the history of this project, becoming more efficient and accurate (see Barthman-Thompson 2018). However, we do not believe that fully automated mapping can achieve the same thematic accuracy as an experienced ecologist-mapper at this time. The time lag may be reduced by a combination of automated mapping techniques and manual attribution. Accuracy may be enhanced by use of a drone to acquire reconnaissance samples since access for field surveys is often hampered by flooded ditches or channels. VegCAMP recommends a reevaluation of the required mapping resolution as well as periodic assessment of alternative mapping techniques, imagery acquisition, and field methods.

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# Appendix A

## 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). 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. Following the 2015 remap and accuracy assessment, the Suisun Marsh vegetation types were reviewed and modified to match the most current USNVC hierarchy more closely. Some types that were difficult to distinguish on the imagery were aggregated to higher levels of the hierarchy (group or macrogroup level). Some types that were equivalent to current USNVC types were renamed to conform to the current hierarchy. New mapping codes have been assigned to all vegetation types as of the 2015 map; the new codes are listed in parentheses following each type.

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 Mediterranean California Naturalized Annual and Perennial Grassland Group. These broadly defined mapping units are listed with their corresponding USNVC vegetation types under "Legacy Mapping Units" at the end of the hierarchy.

In the future, when the Suisun Marsh vegetation field data are reanalyzed with a larger data set, the 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 | *Quercus agrifolia* |
| Level 8 - Association | *Quercus agrifolia / Salix lasiolepis* |

Descriptions of vegetation types in the 2015 map can be found in Appendix B.

**1. Forest and Woodland Class**

**a. Temperate Forest Subclass**

**i. Warm Temperate Forest Formation (1000000)**

**1. Madrean Forest and Woodland Division (1100000)**

**a. California Forest and Woodland Macrogroup (1110000)**

i. Californian Broadleaf Forest and Woodland Group[1] (1111000)

1. *Quercus agrifolia* Woodland Alliance (1111100)

a. *Quercus agrifolia* Association (1111101)

b. *Quercus agrifolia / Salix lasiolepis* Association (1111102)

2. *Quercus lobata* Woodland Alliance (1111200)

**ii. Cool Temperate Forest Formation (2000000)**

**1. North American Introduced Evergreen Broadleaf and Conifer Forest Division (2100000)**

**a. Introduced North American Mediterranean Woodland and Forest Macrogroup (2110000)**

i. no subdivision at group level

1. *Eucalyptus (globulus, camaldulensis)* Woodland Semi-Natural Alliance (2110100)

a. *Eucalyptus globulus* Semi-Natural Association (2110101)

2. *Ailanthus altissima* Woodland Semi-Natural Alliance (2110200)

**b. Southwestern North American Riparian, Flooded and Swamp Forest Macrogroup (2120000)**

i. Southwestern North American Riparian Evergreen and Deciduous Woodland Group[2] (2121000)

1. *Salix laevigata* Woodland Alliance (2121100)

a. *Salix laevigata / Salix lasiolepis* Association (2121101)

ii. Southwestern North American Riparian/Wash Scrub Group (2122000)

1. *Salix exigua* Shrubland Alliance (2122100)

a. *Salix exigua* Association (2122101)

2. *Rosa californica* Shrubland Alliance (2122200)

a. *Rosa californica* Association (2122201)

b. *Rosa californica – Baccharis pilularis* Association (2122202)

3. *Baccharis salicifolia* Shrubland Alliance (2122300)

iii. Southwestern North American Introduced Riparian Scrub Group (2123000)

1. *Arundo donax* Herbaceous Semi-Natural Alliance (2123100)

a. *Arundo donax* Semi-Natural Association (2123101)

2. *Tamarix* spp. Shrubland Semi-Natural Alliance (2123200)

iii. **Temperate Flooded and Swamp Forest Formation (3000000)**

**1. Western North America Flooded and Swamp Forest Division (3100000)**

**a. Western Cordilleran Montane–Boreal Riparian Scrub Macrogroup (3110000)**

i. Vancouverian Riparian Deciduous Forest Group (3111000)

1. *Fraxinus latifolia* Woodland Alliance (3111100)

a. *Fraxinus latifolia* Planted Stands Mapping Unit (3111101)

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[1] Formerly named Oaks Mapping Unit

[2] Formerly named Willow Trees Mapping Unit

**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 (4000000)**
**1. California Grassland and Meadow Division (4100000)**
**a. California Annual and Perennial Grassland Macrogroup (4110000)**
i. Mediterranean California Naturalized Annual and Perennial Grassland Group[3] (4111000)
1. *Brassica nigra* and Other Mustards Herbaceous Semi-Natural Alliance (4111100)
a. *Brassica nigra* Semi-Natural Association (4111101)
b. *Raphanus sativus* Semi-Natural Association (4111102)
2. *Bromus (diandrus, hordeaceus) – Brachypodium distachyon* Herbaceous Semi-Natural Alliance (4111200)
3. *Centaurea (solstitialis, melitensis)* Herbaceous Semi-Natural Alliance (4111300)
4. *Conium maculatum – Foeniculum vulgare* Herbaceous Semi-Natural Alliance (4111400)
a. *Conium maculatum* Semi-Natural Association (4111401)
b. *Foeniculum vulgare* Semi-Natural Association (4111402)
5. *Cortaderia (jubata, selloana)* Herbaceous Semi-Natural Alliance (4111500)
6. *Festuca perennis* Herbaceous Semi-Natural Alliance (4111600)
a. *Festuca perennis – Lepidium latifolium* Semi-Natural Association (4111601)
b. *Festuca perennis – Lotus corniculatus* Semi-Natural Association (4111602)
c. *Festuca perennis – Rumex* spp. Mapping Unit (4111603)
d. *Hordeum marinum – Festuca perennis* Mapping Unit (4111604)
7. *Elytrigia pontica* Mapping Unit (4111700)
8. *Agrostis avenacea* Mapping Unit (4111800)
9. *Vulpia* spp. *– Euthamia occidentalis* Mapping Unit (4111900)

**3. Mesomorphic Shrub and Herb Vegetation Class**
**a. Temperate and Boreal Shrubland and Grassland Subclass**
**i. Temperate Grassland, Meadow, and Shrubland Formation (5000000)**
1. **Vancouverian and Rocky Mountain Grassland and Shrubland Division (5100000)**
**a. Western North American Temperate Grassland and Meadow Macrogroup (5110000)**
i. Vancouverian and Rocky Mountain Naturalized Perennial Grassland Group (5111000)
1. *Phalaris aquatica* Herbaceous Semi-Natural Alliance (5111100)
a. *Phalaris aquatica* Semi-Natural Association (5111101)
**b. Vancouverian Lowland Grassland and Shrubland Macrogroup (5120000)**
i. Naturalized Non-Native Deciduous Scrub Group (5121000)
1. *Rubus armeniacus* Shrubland Semi-Natural Alliance (5121100)
**ii. Temperate and Boreal Scrub and Herb Coastal Vegetation Formation (6000000)**
**1. Pacific Coast Scrub and Herb Littoral Vegetation Division (6100000)**
**a. Vancouverian Coastal Dune and Bluff Macrogroup (6110000)**
i. California Coastal Evergreen Bluff and Dune Scrub Group[4] (6111000)
1. *Baccharis pilularis* Shrubland Alliance (6111100)
a. *Baccharis pilularis* / Annual Grass–Herb Association (6111101)
ii. California–Vancouverian Semi-Natural Littoral Scrub and Herb Vegetation Group (6112000)
1. *Carpobrotus edulis* or Other Ice Plants Herbaceous Semi-Natural Alliance (6112100)

[3] Formerly named Annual Grasses/Weeds Mapping Unit
[4] Formerly named Medium Upland Shrubs Mapping Unit

**iii. Temperate and Boreal Freshwater Marsh Formation (7000000)**

**1. Western North American Freshwater Marsh Division (7100000)**

**a. Western North American Freshwater Marsh Macrogroup (7110000)**

i. Arid West Freshwater Emergent Marsh Group[5] (7111000)

1. *Typha (angustifolia, latifolia, domingensis*) Herbaceous Alliance (7111100)
   a. *Typha (angustifolia, latifolia, domingensis)* Association (7111101)
   b. *Typha (angustifolia, latifolia, domingensis)* (dead stalks) Mapping Unit (7111102)
   c. *Typha (angustifolia, latifolia, domingensis) – Echinochloa crus-galli* Association (7111103)
   d. *Typha (angustifolia, latifolia, domingensis) – Distichlis spicata* Association (7111104)
   e. *Typha (angustifolia, latifolia, domingensis) – Phragmites australis* Association (7111105)
   f. *Typha (angustifolia, latifolia, domingensis) – Schoenoplectus americanus* Association (7111106)
2. *Schoenoplectus (acutus, californicus)* Herbaceous Alliance (7111200)
   a. *Schoenoplectus californicus – Schoenoplectus acutus* Association (7111201)
   b. *Schoenoplectus (acutus, californicus)* Mapping Unit (7111202)
   c. *Schoenoplectus (acutus, californicus) – Rosa californica* Association (7111203)
   d. *Schoenoplectus (acutus, californicus)* – Wetland Herbs Mapping Unit (7111204)
3. *Schoenoplectus (acutus, californicus) – Typha (angustifolia, latifolia, domingensis)* Mapping Unit (7111300)
4. *Phragmites australis* Herbaceous Alliance (7111400)
   a. *Phragmites australis* Association (7111401)
   b. *Phragmites australis – Schoenoplectus* spp. Association (7111402)
   c. *Phragmites australis – Xanthium strumarium* Mapping Unit (7111403)
5. *Alisma triviale* Mapping Unit (7111500)

ii. Vancouverian Coastal/Tidal Marsh and Meadow Group (7112000)

1. *Potentilla anserina* Herbaceous Alliance (7112100)

**b. Western North America Vernal Pool Macrogroup (7120000)**

i. Californian Mixed Annual/Perennial Freshwater Vernal Pool/Swale Bottomland Group (7121000)

1. *Grindelia (stricta)* Provisional Herbaceous Alliance (7121100)

**c. Western North America Wet Meadow and Low Shrub Carr Macrogroup[6] (7130000)**

i. Californian Warm Temperate Marsh/Seep Group (7131000)

1. *Juncus arcticus (*var. *balticus, mexicanus)* Herbaceous Alliance (7131100)
   a. *Juncus arcticus* var. *balticus* Association (7131101)
   b. *Juncus arcticus* var. *balticus – Conium maculatum* Association (7131102)
   c. *Juncus arcticus* var. *balticus – Lepidium latifolium* Association (7131103)
   d. *Juncus arcticus* var. *balticus – Potentilla anserina* Association (7131104)
2. *Leymus triticoides* Herbaceous Alliance (7131200)

ii. Naturalized Warm-Temperate Riparian And Wetland Group (7132000)

1. *Lepidium latifolium* Herbaceous Semi-Natural Alliance (7132100)

[5] Formerly named Tall Wetland Graminoids Mapping Unit
[6] Formerly named Medium Wetland Graminoids Mapping Unit

2. *Persicaria lapathifolia – Xanthium strumarium* Herbaceous Alliance (7132200)
   a. *Persicaria* spp. – *Xanthium strumarium – Echinochloa crus-galli* Mapping Unit (7132201)
3. *Cynodon dactylon – Crypsis* spp. – *Paspalum* spp. Moist Herbaceous Semi-Natural Alliance (7132300)
   a. *Crypsis schoenoides* Mapping Unit (7132301)
   b. *Cynodon dactylon* Mapping Unit (7132302)
4. *Polypogon monspeliensis* Mapping Unit (7132400)
5. *Rumex* spp. Mapping Unit (7132500)
6. *Salsola soda* Mapping Unit (7132600)

**iv. Temperate and Boreal Salt Marsh Formation (8000000)**

**1. Temperate and Boreal Pacific Coastal Salt Marsh Division (8100000)**

**a. North American Pacific Coastal Salt Marsh Macrogroup[7] (8110000)**

i. Temperate Pacific Tidal Salt and Brackish Meadow Group (8111000)

1. *Bolboschoenus maritimus* Herbaceous Alliance (8111100)
   a. *Bolboschoenus maritimus* Association (8111101)
   b. *Bolboschoenus maritimus – Salicornia pacifica* Association (8111102)
   c. *Bolboschoenus maritimus – Sesuvium verrucosum* Association (8111103)
2. *Distichlis spicata* Herbaceous Alliance (8111200)
   a. *Distichlis spicata* Association (8111201)
   b. *Distichlis spicata* – Annual Grasses Association (8111202)
   c. *Distichlis spicata – Juncus arcticus* var. *balticus (J. arcticus* var. *mexicanus*) Association (8111203)
   d. *Distichlis spicata – Lotus corniculatus* Mapping Unit (8111204)
   e. *Distichlis spicata – Salicornia pacifica* Association (8111205)
   f. *Distichlis spicata – Schoenoplectus americanus* Provisional Association (8111206)
   g. *Distichlis spicata – Cotula coronopifolia* Association (8111207)
   h. *Distichlis spicata – Bolboschoenus maritimus* Mapping Unit (8111208)
   i. *Distichlis spicata – Juncus balticus – Triglochin* spp. *– Glaux maritima* Mapping Unit (8111209)
   j. *Lepidium latifolium – Distichlis spicata* Semi-Natural Association (8111210)
3. *Salicornia pacifica (Salicornia depressa)* Herbaceous Alliance (8111300)
   a. *Salicornia pacifica* Association (8111301)
   b. *Salicornia pacifica* – Annual Grasses Association (8111302)
   c. *Salicornia pacifica – Atriplex prostrata* Association (8111303)
   d. *Salicornia pacifica – Crypsis schoenoides* Association (8111304)
   e. *Salicornia pacifica – Sesuvium verrucosum* Association (8111305)
   *f. Salicornia pacifica – Echinochloa crus-galli – Polygonum – Xanthium strumarium* Association (8111306)
   g. *Salicornia pacifica – Cotula coronopifolia* Association (8111307)
4. *Spartina foliosa* Herbaceous Alliance (8111400)

ii. Western North American Disturbed Alkaline Marsh and Meadow Group (8112000)

1. *Atriplex prostrata – Cotula coronopifolia* Herbaceous Semi-Natural Alliance (8112100)
   a. *Cotula coronopifolia* Semi-Natural Association (8112101)

[7] Formerly named Short Wetland Graminoids Mapping Unit

b. *Atriplex prostrata* Semi-Natural Association (8112102)
c. *Atriplex prostrata – Distichlis spicata* Semi-Natural Association (8112103)
d. *Atriplex prostrata – Bolboschoenus maritimus* Semi-Natural Association (8112104)
e. *Atriplex prostrata – Sesuvium verrucosum* Semi-Natural Association (8112105)
f. *Atriplex prostrata* – Annual Grasses Semi-Natural Association (8112106)

2. *Sesuvium verrucosum* Herbaceous Alliance (8112200)
a. *Sesuvium verrucosum* Association (8112201)
b. *Sesuvium verrucosum – Distichlis spicata* Association (8112202)
c. *Sesuvium verrucosum – Festuca perennis* Association (8112203)
d. *Sesuvium verrucosum – Cotula coronopifolia* Association (8112204)

3. *Spergularia marina* Provisional Herbaceous Alliance (8112300)
a. *Spergularia marina – Cotula coronopifolia* Mapping Unit (8112301)

**2. Western North American Interior Alkali–Saline Wetland Division (8200000)**
**a. Warm Semi-Desert/Mediterranean Alkali–Saline Wetland Macrogroup (8210000)**
i. Southwestern North American Alkali Marsh/Seep Vegetation Group (8211000)
1. *Schoenoplectus americanus* Herbaceous Alliance (8211100)
a. *Schoenoplectus americanus* Association (8211101)
b. *Schoenoplectus americanus – Potentilla anserina* Association (8211102)
c. *Schoenoplectus americanus* – S*choenoplectus californicus – Schoenoplectus acutus* Association (8211103)
d. *Schoenoplectus americanus – Lepidium latifolium* Association (8211104)

ii. Southwestern North American Salt Basin and High Marsh Group (8212000)
1. *Atriplex lentiformis* Shrubland Alliance (8212100)
2. *Frankenia salina* Herbaceous Alliance (8212200)
a. *Frankenia salina* – Annual grasses Mapping Unit *(*8212201)
b. *Frankenia salina – Distichlis spicata* Association (8212202)

**4. Hydromorphic Vegetation (Aquatic Vegetation) Class (9000000)**
**a. Saltwater Aquatic Vegetation Subclass**
**i. Marine and Estuarine Saltwater Aquatic Vegetation Formation (9100000)**
**1. Temperate Pacific Saltwater Aquatic Vegetation Division (9110000)**
**a. Temperate Pacific Intertidal Shore Macrogroup (9111000)**
i. Temperate Pacific Intertidal Flat Group (9111100)
1. *Stuckenia (pectinata) – Potamogeton* spp. Herbaceous Alliance (9111200)
a. *Stuckenia pectinata* Association (9111201)
2. *Ruppia (cirrhosa, maritima)* Herbaceous Alliance (9111300)

**b. Freshwater Aquatic Vegetation Subclass**
**i. Freshwater Aquatic Vegetation Formation**
**1. North American Freshwater Aquatic Vegetation Division (9200000)**
**a. Western North American Freshwater Aquatic Vegetation Macrogroup (9210000)**
i. Naturalized Temperate Pacific Freshwater Vegetation Group (9211000)
1. *Ludwigia (hexapetala, peploides)* Provisional Herbaceous Semi-Natural Alliance (9211100)

**5. Agriculture & Developed Vegetation Class**
- **a. Herbaceous Agricultural Vegetation Subclass (9310000)**
  - **i. Row & Close Grain Crop Formation[8] (9311000)**
  - **ii. Fallow Field and Weed Vegetation Formation (9312000)**
    - **1. Cropland Fallow Field Division (9312100)**
      - **a. Fallow Field Macrogroup (9312110)**
- **b. Herbaceous & Woody Developed Vegetation Subclass (9410000)**
  - **i. Other Developed Vegetation Formation (9411000)**
    - **1. Other Developed Vegetation Division (9411100)**
      - **a. Tree Developed Vegetation Macrogroup (9411110)**
        - i. Temperate Tree Developed Vegetation Group[9] (9411111)

**Non-Vegetation Mapping Units**

Bare Ground Mapping Unit (1)
Agriculture (2)
Road / Trails Mapping Unit (4)
Slough Mapping Unit (6)
Tidal Mudflat Mapping Unit (7)
Railroad Track Mapping Unit (8)
Ditch Mapping Unit (9)
Open Water Mapping Unit (11)
Developed Mapping Unit (15)

**Legacy Mapping Units**

**Californian Broadleaf Forest and Woodland Group (1111000)**
Oaks Mapping Unit (1111001)
**Southwestern North American Riparian Evergreen and Deciduous Woodland Group (2121000)**
Willow Trees Mapping Unit (2121001)
**Southwestern North American Riparian/Wash Scrub Group (2122000)**
Tall Wetland Shrubs Mapping Unit (2122001)
Medium Wetland Shrubs Mapping Unit (2122002)
**California Annual and Perennial Grassland Macrogroup (4110000)**
Annual Grasses Mapping Unit (4110001)
**Mediterranean California Naturalized Annual and Perennial Grassland Group (4111000)**
Tall Upland Graminoids Mapping Unit (4111001)
Medium Upland Graminoids Mapping Unit (4111002)
Perennial Grass Mapping Unit (4111003)
Short Upland Graminoids Mapping Unit (4111004)
Tall Upland Herbs Mapping Unit (4111005)
Medium Upland Herbs Mapping Unit (4111006)
Short Upland Herbs Mapping Unit (4111007)
Annual Grasses/Weeds Mapping Unit (4111008)

[8] Formerly named Cultivated Annual Graminoid Mapping Unit
[9] Formerly named Landscape Trees Mapping Unit

**California Coastal Evergreen Bluff and Dune Scrub Group (6111000)**
Medium Upland Shrubs Mapping Unit (6111001)
**Arid West Freshwater Emergent Marsh Group (7111000)**
Tall Wetland Graminoids Mapping Unit (7111001)
*Calystegia sepium – Euthamia occidentalis* Mapping Unit (7111002)
**Western North America Wet Meadow and Low Shrub Carr Macrogroup (7130000)**
Medium Wetland Graminoids Mapping Unit (7130001)
**Temperate and Boreal Salt Marsh Formation (8000000)**
Wetland Herbs Mapping Unit (8000001)
Tall Wetland Herbs Mapping Unit (8000002)
Medium Wetland Herbs Mapping Unit (8000003)
**North American Pacific Coastal Salt Marsh Macrogroup (8110000)**
Short Wetland Graminoids Mapping Unit (8110001)
Short Wetland Herbs Mapping Unit (8110002)
**Hydromorphic Vegetation (Aquatic Vegetation) Class (9000000)**
Floating-leaved Wetland Herbs Mapping Unit (9000001)
**Row & Close Grain Crop Formation (9311000)**
Cultivated Annual Graminoid Mapping Unit (9311001)
**Temperate Tree Developed Vegetation Group (9411111)**
Landscape Trees Mapping Unit (9411112)
**Developed (15)**
Parking Lot Mapping Unit (3)
Structure Mapping Unit (5)
Water Treatment Pond Mapping Unit (13)
Urban Area Mapping Unit (14)
**Road / Trails Mapping Unit (4)**
Trail Mapping Unit (10)

# Appendix B

## Suisun Marsh Vegetation Type Descriptions

These descriptions were created for vegetation types mapped in Suisun Marsh in 2015.

These descriptions are 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 listed with its current mapping code. An example of the type as it is represented on imagery is included with each description. Terms used in the descriptions are defined as follows:

*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.

*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* (Baldwin et al. 2012), but not PLANTS Database, we default to the Jepson name.

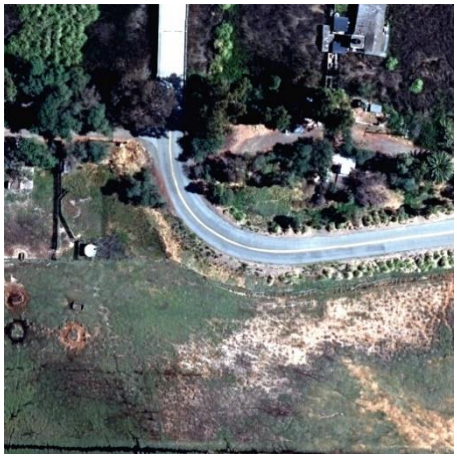
**1 Bare Ground Mapping Unit**

Ground generally has <10% cover of vegetation. Does not include unvegetated tidal flats, but does include unvegetated leveed ground such as scraped areas or formerly inundated areas with no vegetation.

**2 Agriculture Mapping Unit**

Includes fallow, disked fields. Does not include Row and Close Grain Crop (9311000).

**4 Road / Trails Mapping Unit**



Includes roads and trails that are wider than the minimum mapping width of 10 feet. May have mown vegetation.

**6 Slough Mapping Unit**

Wide, fully tidal waterways.

**7 Tidal Mudflat Mapping Unit**

Tidally exposed mud deposits, generally unvegetated or with low cover of herbs or algae.

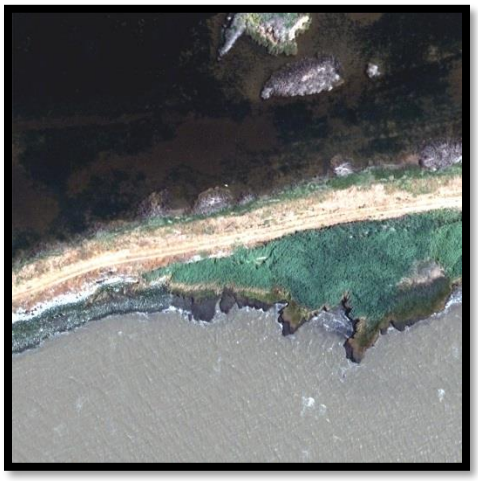
**8 Railroad Track Mapping Unit**

Railroad track, ballast and roadbed.

**9 Ditch Mapping Unit**

Non-tidal, smaller waterways and graded or maintained permanent or temporary ditches that may or may not contain water at the time of the imagery.

**11 Open Water Mapping Unit**



Unchannelized tidal or non-tidal areas of standing water, including Suisun Bay.

**15 Developed Mapping Unit**

Includes parking lots, structures, water treatment ponds and urban areas.

**1111100 *Quercus agrifolia* Woodland Alliance**

*Quercus agrifolia* (coast live oak) is dominant or co-dominant in the tree canopy. Typically bordering freshwater creeks at upper reaches of marsh only, making this a fairly uncommon vegetation type in Suisun Marsh.

**2110100 *Eucalyptus (globulus, camaldulensis)* Woodland Semi-Natural Alliance**

*Eucalyptus camaldulensis, Eucalyptus globulus* or other gum tree is dominant in the tree canopy. Planted as trees, groves, and windbreaks; naturalized on uplands and stream courses.

Understories are usually depauperate, though sometimes other non-natives, such as *Hedera helix*, clamber extensively in stands. Seeds of *Eucalyptus* germinate when tree crowns and built-up debris are removed by fire or in other ways.

**2121101 *Salix laevigata / Salix lasiolepis* Association**

*Salix laevigata* (red willow) is dominant or co-dominant in the tree or shrub canopy with *S. lasiolepis* (Arroyo willow). Generally found at the edges of the marsh along freshwater creeks.

**2122101 *Salix exigua* Association**

*Salix exigua* (narrow-leaf willow) is dominant or co-dominant in the shrub canopy with >20% absolute cover.

**2122201 *Rosa californica* Association**

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

**2122202 *Rosa californica – Baccharis pilularis* Association**

*Rosa californica* (California rose) and *Baccharis pilularis* (coyote brush) co-occur in stand; either species may be dominant, but each has over 5% absolute cover. Often occurs along levees and roads.

**2122300 *Baccharis salicifolia* Shrubland Alliance**

One stand strongly dominated by *Baccharis salicifolia* (mule-fat) occurs in the marsh; it was planted at the Blacklock restoration site along the southeastern levee.

**2123101 *Arundo donax* Semi-Natural Association**

Clonal dense stands of *Arundo donax* (giant reed), generally small and locally distributed near settlements and roads in marsh. The signature on the true-color imagery is slightly more gray than *Phragmites australis*, with which it might be confused. *Arundo* is also found in linear stands along roads or ditches more often than *Phragmites*, and the stand edges appear more ragged.

**2123200 *Tamarix* spp. Shrubland Semi-Natural Alliance**

Stands are dominated by tamarisk, a large, non-native shrub with diffuse habit.

**4111000 Mediterranean Californian Naturalized Annual and Perennial Grassland Group**

Upland grasslands generally not associated with saturated soil or tidal influence throughout the growing season. Shrubs are generally less than 10% cover or, if more, sub-shrubs are overtopped by the dominant grass or herb species. Dominant species include the grasses *Hordeum murinum, Bromus* spp., *Festuca perennis, Elytrigia pontica* and *Avena* spp. Also included in this group are stands dominated by weeds such as *Conium maculatum* (poison hemlock), *Foeniculum vulgare* (wild fennel), *Raphanus sativus* (wild radish), and *Brassica nigra* (black mustard).

**4111500 *Cortaderia (jubata, selloana)* Semi-Natural Herbaceous Alliance**

Stands dominated by the large, non-native, mound-like *Cortaderia selloana* (pampas grass). Stands are generally small but conspicuous, and occur in moist areas in the ecotone between wetlands and uplands. Some stands occur on the outboard sides of levees, however all stands appear to be near buildings.

**5111101 *Phalaris aquatica* Semi-Natural Association**

Stands are dominated by the tall bunch grass *Phalaris aquatica* (canary grass). These are usually small stands along levees, but may occur in larger upland stands adjacent to the marsh.

**5121100 *Rubus armeniacus* Shrubland Semi-Natural Alliance**

Vegetation dominated by the introduced *Rubus armeniacus* (Himalayan berry), often in narrow briar patches along levees and roads in the Marsh. When co-dominant with *Rosa californica* or *Baccharis pilularis*, assign to those alliances.

**6111000 California Coastal Evergreen Bluff and Dune Scrub Group**

One stand of *Acmispon glaber* (deerweed), which fits into this group, was observed onsite in the Marsh in an area that had apparently received some sandy fill or dredge material. The signature is somewhat unique, but was identified in the field.

**6111100 *Baccharis pilularis* Shrubland Alliance**

*Baccharis pilularis* (coyote brush) is dominant to co-dominant with other shrubs such as *Atriplex lentiformis* (big saltbrush). *Rosa californica* (California rose) is typically absent or <<5% absolute cover.

**6111101 *Baccharis pilularis* / Annual Grass – Herb Association**

*Baccharis pilularis* (coyote brush) dominates, with an understory that is typically dominated by annual grasses (*Hordeum* spp., *Festuca perennis, Bromus* spp.) and/or annual herbs.

**6112100 *Carpobrotus edulis* or Other Ice Plants Herbaceous Semi-Natural Alliance**

Vegetation dominated (>50% relative cover) by perennial non-native *Carpobrotus edulis* (iceplant), generally on levees and areas adjacent to buildings. Most stands are uniform and dense and have a distinct signature, particularly in the CIR imagery, where they are bright pink.

**7111100 *Typha (angustifolia, latifolia, domingensis)* Herbaceous Alliance**

Stands dominated by cattail species including *Typha angustifolia*, *T. latifolia,* and *T. domingensis* (Cattail (narrowleaf, broadleaf, and southern). 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/domingensis*) predominate. Often, stands appear to be mostly dead standing cattails from the previous season, but CIR imagery reveals that they are regenerating.

**7111202 *Schoenoplectus (acutus, californicus)* Mapping Unit**

Vegetation dominated by *Schoenoplectus californicus* (California bulrush) and/or the ecologically and morphologically similar *Schoenoplectus acutus* (hardstem bulrush). Occasionally *Typha* spp. may occur in equal or higher cover than the *Schoenoplectus* spp., but *Schoenoplectus californicus* or *Schoenoplectus acutus* has at least 10% relative cover**.**

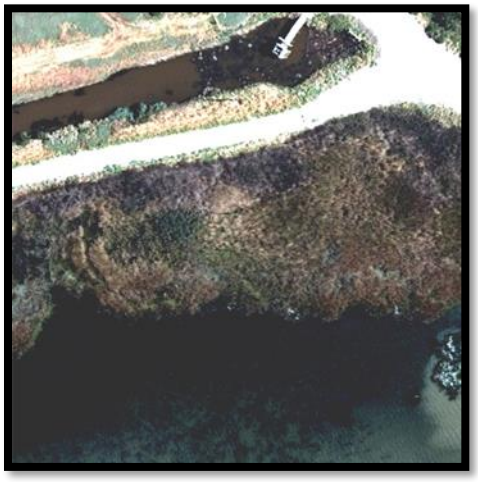
**7111203 *Schoenoplectus (acutus, californicus) / Rosa californica* Association**

*Rosa californica* (California rose) is present with *Schoenoplectus californicus* (California bulrush), and/or *Schoenoplectus acutus* (hardstem bulrush). Usually found along levees bordering sloughs and channels, including the intertidal zone.

**7111204 *Schoenoplectus (acutus, californicus)* – Wetland Herbs Mapping Unit**

Stands dominated by *Schoenoplectus californicus* (California bulrush) and/or *S. acutus* (hardstem bulrush) 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 glutinosa, Achillea millefolium*, and *Stachys ajugoides*. May also include *Lepidium latifolium*.

**7111300 *Schoenoplectus (acutus, californicus) – Typha (angustifolia, latifolia, domingensis)* Mapping Unit**



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

**7111400 *Phragmites australis* Herbaceous Alliance**

Most of the *Phragmites australis* (common reed) in the marsh is the very densely growing, invasive, non-native form. When *Phragmites* dominates, even when it is mixed with other plants such as *Schoenoplectus*, it is mapped as this type. The signature is very distinct, especially in the CIR imagery, in which it appears hot pink. There is no minimum mapping area for this type.

**7111500 *Alisma triviale* Mapping Unit**

Vegetation dominated by *Alisma triviale* (water plantain). Mapping is limited to a pond that receives freshwater drainage along Highway 680.

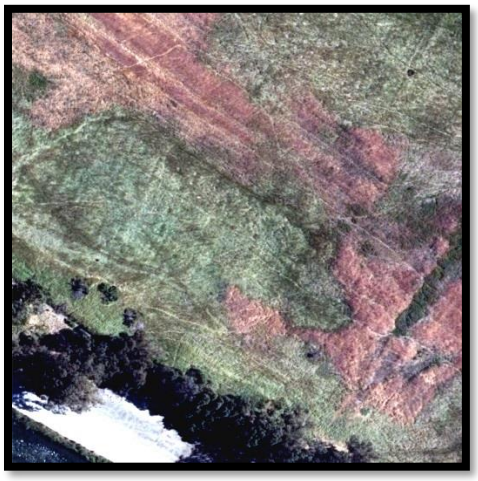
**7121100 *Grindelia (stricta)* Provisional Herbaceous Alliance**

Stands dominated by the diffuse perennial herb *Grindelia* spp. (*Grindelia* ×*paludosa* may be more common in the marsh than previously thought and *Grindelia stricta* less so). May contain a variety of subordinate species, some weedy and 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.

**7131100 *Juncus arcticus (*var. *balticus, mexicanus)* Herbaceous Alliance**

Vegetation dominated or co-dominated (>30% relative cover) by the stoloniferous (clonal) rush *Juncus arcticus* var. *balticus* (Baltic rush) or *Juncus arcticus* var. *mexicanus* (Mexican rush), often associated with other taller or shorter herbaceous species. Usually in temporarily saturated wetlands not inundated for extensive periods. The signature on true color imagery is often very dark brown or black and its clonal habit is usually obvious.

**7131200 *Leymus triticoides* Herbaceous Alliance**



Stands dominated (>50% relative cover) by the native *Leymus triticoides* (creeping wild rye). Stands are generally narrow bands of wetland-upland borders including natural ecotones between the *Distichlis spicata* (salt grass) Alliance and naturalized annual grass stands. Also occurs along levee tops and margins of marsh adjacent to vegetation of intermittent flooding zone. Non-natives, such as *Lepidium latifolium* and *Lotus corniculatus*, often invade these stands. Some very large stands, such as on Grizzly Island, may have been planted. The signature is bluer green in comparison to other perennial grasses.

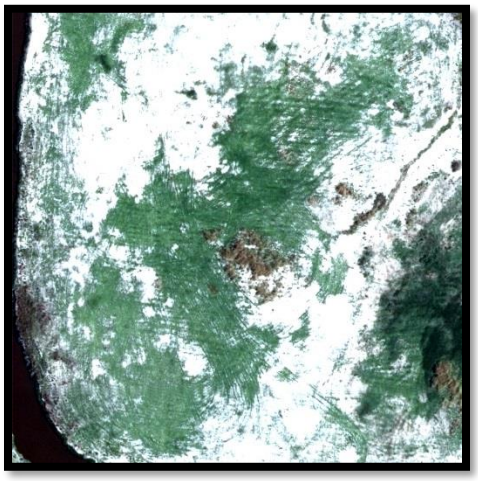
**7132100 *Lepidium latifolium* Herbaceous Semi-Natural Alliance**

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* (three-square), *Juncus arcticus* var. *balticus* (Baltic rush), and *Distichlis spicata* (saltgrass) Alliance stands (as at Rush Ranch). Often stands are at peak flower at the time of the imagery acquisition and so appear mounded and white. CIR imagery shows a very light pink signature.

**7132200 *Persicaria lapathifolia – Xanthium strumarium* Herbaceous Alliance**

Vegetation of regularly disturbed, winter and vernally wet ponds and fields, usually on fine-grained clay-rich soils. *Xanthium strumarium* (cocklebur), *Persicaria lapathifolia* (common knotweed or willow weed), or other knotweed species are dominant or co-dominant in the herbaceous layer.

**7132301 *Crypsis schoenoides* Mapping Unit**



Stands dominated by the low annual *Crypsis schoenoides* (swamp timothy). Found in winter and vernally flooded flats and pools. Vegetation is generally scattered, with intervening small to large openings of dry, cracked mud during summer.

**7132600 *Salsola soda* Mapping Unit**

Stands dominated or co-dominated by *Salsola soda* (opposite-leaf Russian thistle). Large stands originated on the Hill Slough Unit.

**8000000 Temperate and Boreal Salt Marsh Formation**

This type includes the former wetland herbs mapping unit and is applied when the vegetation is dominated by herbs in a wetland setting that do not have a recognizable signature or are too mixed in species composition to fit into a more specific vegetation type.

**8111100 *Bolboschoenus maritimus* Herbaceous Alliance**

Vegetation of seasonally wet flats and pond bottoms, dominated or co-dominated (>30% relative cover) by *Bolboschoenus maritimus* (alkali bulrush) in the taller herb/graminoid layer. Co-dominant species may include *Distichlis spicata, Salicornia pacifica, Sesuvium verrucosum, Spergularia salina, Typha latifolia,* and/or short herbs or grasses. Some stands also include the similar species *Bolboschoenus robustus* (sturdy bulrush) or hybrids between the two.

**8111200 *Distichlis spicata* Herbaceous Alliance**

Stands usually dominated (>50% relative cover) by *Distichlis spicata* (salt grass), or if not dominant, salt grass has higher cover than any other single species. *Distichlis spicata* has a grey-green or yellow-green signature in comparison to *Frankenia salina,* which is more blue-green and occurs in similar settings.

**8111201 *Distichlis spicata* Association**

Stands strongly dominated by salt grass, *Distichlis spicata,* with no other species greater than 5% cover.

**8111202 *Distichlis spicata* – Annual Grasses Association**

Stands composed of a mixture of *Distichlis spicata* (salt grass) and non-native annual grasses. *Distichlis* may be dominant or share dominance (as low as 30% relative cover) with annual grass species, primarily *Polypogon monspeliensis* (rabbit's foot grass), *Festuca perennis* (perennial ryegrass), and/or *Hordeum* spp. (barley). Annuals generally cover at least 10%. Found at the higher marsh margins.

**8111203 *Distichlis spicata – Juncus arcticus* var. *balticus (J. arcticus* var. *mexicanus*) Association**

Stands of *Distichlis spicata* (salt grass), with *Juncus arcticus* var. *balticus or Juncus arcticus* var. *mexicanus* as principal subordinate species (>5% relative cover). *Juncus* should be consistently present throughout the stand but does not need to be the most abundant subordinate species.

**8111205 *Distichlis spicata – Salicornia pacifica* Association**

Stands are co-dominated by *Distichlis spicata* (salt grass) and *Salicornia pacifica* (pickleweed), both with 30% to 60% relative cover.

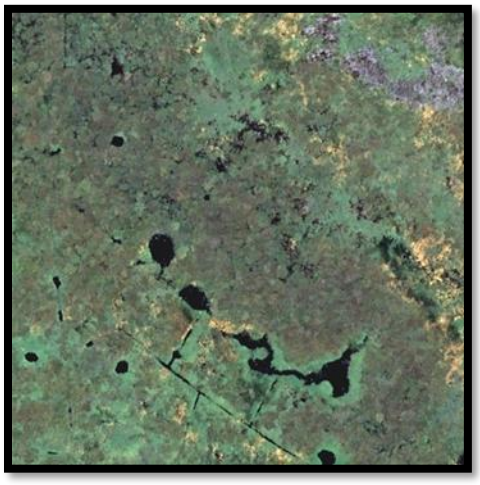
**8111206 *Distichlis spicata – Schoenoplectus americanus* Provisional Association**

*Distichlis spicata* (salt grass) is the characteristic grass species with emergent *Schoenoplectus americanus* (three square bulrush) conspicuous, but less than 40% cover. Found in tidal and muted tidal settings with little disturbance.

**8111207 *Distichlis spicata – Cotula coronopifolia* Association**

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

**8111209 *Distichlis spicata – Juncus balticus – Triglochin* spp. – *Glaux maritima* Mapping Unit**



*Distichlis spicata* (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/or *Limonium californicum.* This type characterizes the most pristine native short tidal marsh habitats.

**8111300 *Salicornia pacifica (Salicornia depressa)* Herbaceous Alliance**

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 *Salicornia pacifica* (pickleweed).

**8111301 *Salicornia pacifica* Association**

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

**8111302 *Salicornia pacifica* – Annual Grasses Association**

Stand is dominated by *Salicornia pacifica* (pickleweed) with a sparse to dense mixture of annual grasses (*Polypogon, Hordeum, Festuca perennis, Bromus* spp.).

**8111304 *Salicornia pacifica – Crypsis schoenoides* Association**

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

**8111305 *Salicornia pacifica – Sesuvium verrucosum* Association**

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

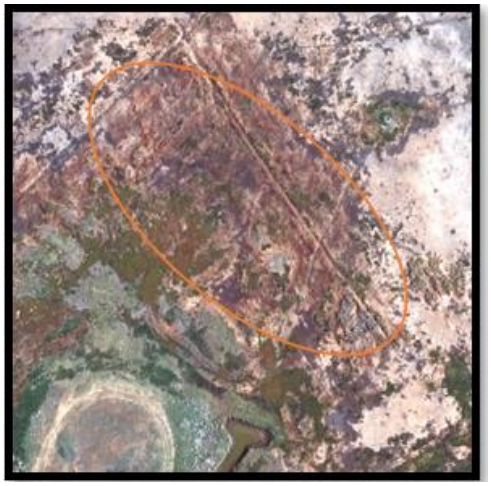
**8111307 *Salicornia pacifica – Cotula coronopifolia* Association**

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.

**8112100 *Atriplex prostrata – Cotula coronopifolia* Herbaceous Semi-Natural Alliance**

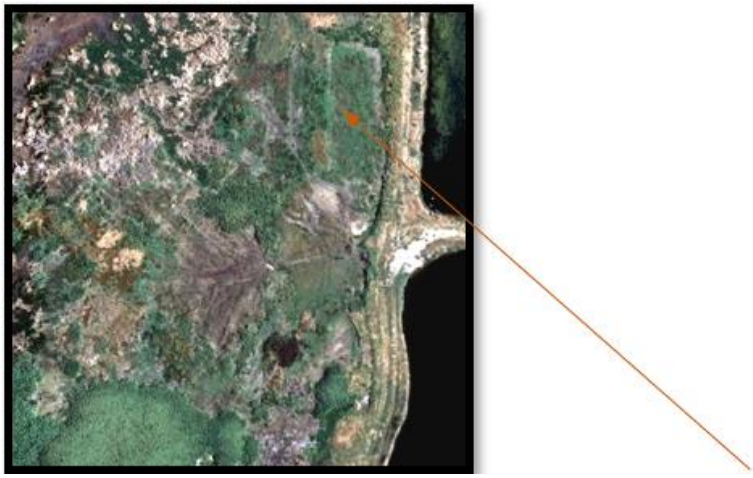
Stands dominated or characterized by *Atriplex prostrata* (fat hen) and/or *Cotula coronopifolia* (brass buttons). Both species are indicative of disturbed conditions in alkaline or saline wetlands. Both are early seral plants; they may be abundant to sparse from year to year depending on disturbance regime and salinity.

**8112101 *Cotula coronopifolia* Semi-Natural Association**



Stands strongly dominated by *Cotula coronopifolia* (brass buttons) with little or no significant cover from other species. Found on recently inundated, exposed mudflats. When still growing, the CIR imagery signature is a salmon color.

**8112200 *Sesuvium verrucosum* Herbaceous Alliance**

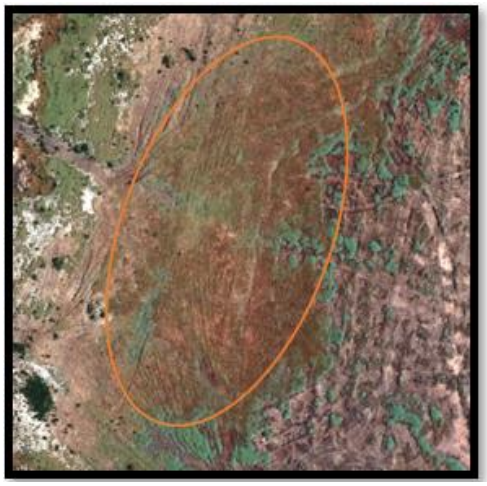


*Sesuvium verrucosum* (sea purslane) > 50% relative cover in the herbaceous layer, dominant or co-dominant with *Chenopodium chenopodioides, Cotula coronopifolia, Distichlis spicata, Lolium perenne, Rumex crispus, Rumex pulcher, Salicornia pacifica* and/or *Spergularia marina.*

**8112201 *Sesuvium verrucosum* Association**

*Sesuvium verrucosum* (sea purslane) is strongly dominant.

**8112300 *Spergularia marina* Provisional Herbaceous Alliance**



Stands dominated by *Spergularia marina* (sand spurrey). Found in moist or seasonally flooded alkaline/saline areas, and newly scraped areas exposing mudflats of high salinity.

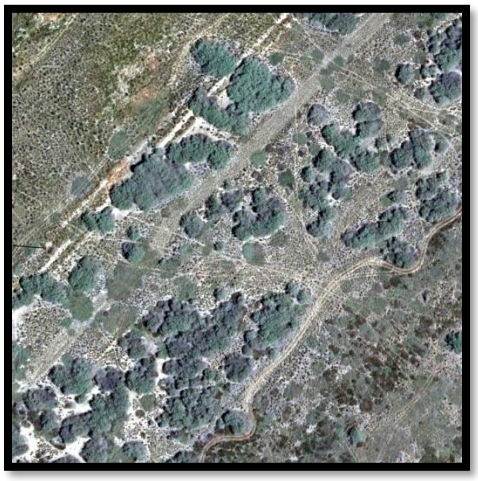
**8211100 *Schoenoplectus americanus* Herbaceous Alliance**

*Schoenoplectus americanus* (three-square bulrush) dominates (>50% relative cover) stand. Co-dominants may include *Distichlis spicata, Juncus arcticus, Schoenoplectus acutus,* and *Schoenoplectus californicus. 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.

**8211104 *Schoenoplectus americanus – Lepidium latifolium* Association**

*Schoenoplectus americanus* (three-square bulrush) is dominant to co-dominant with *Lepidium latifolium* (perennial pepperweed), which may approach *S. americanus* in total cover. Tends to replace native associations of *S. americanus* along small tidal creeks and channels.

**8212100 *Atriplex lentiformis* Shrubland Alliance**



Scrub dominated by the medium-to-large-sized shrub (up to 4 m in height) *Atriplex lentiformis* (big saltbrush). Generally occurs in small, linear stands at borders of managed fields and intermittently flooded wetlands, usually associated with annual grasses and non-native herbs. In true color imagery, its signature is very gray in comparison to other shrubs of the same size.

**8212200 *Frankenia salina* Herbaceous Alliance**

*Frankenia salina* (alkali heath) is dominant or co-dominant, and may have equal or somewhat higher cover of *Distichlis.spicata* (salt grass) or annual grasses. Generally found in seasonally moist or intermittently flooded clayey saline soils. *Frankenia* generally has a bluer green color relative to *Distichlis spicata*, which is more yellow-green but often has the same texture in appearance and occurs in similar settings.

**8212202 *Frankenia salina – Distichlis spicata* Association**

*Frankenia salina* (alkali heath) and *Distichlis spicata* (saltgrass) co-dominate.

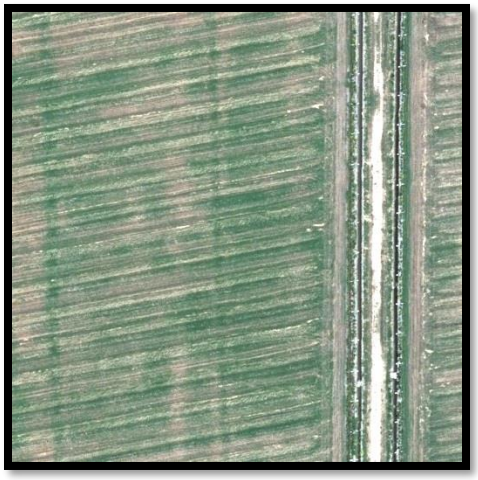
**9111100 Temperate Pacific Intertidal Flat Group**

This group-level mapping unit is used for floating aquatic vegetation that was not identifiable to species on the imagery and which had no field samples to verify its identification.

**9111201 *Stuckenia pectinata* Association**

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.

**9311000 Row & Close Grain Crop Formation**



Upland stands dominated by annual grasses and distinguished by heavily managed site history. Species are various, but are planted, mowed and/or cultivated regularly.

**9411111 Temperate Tree Developed Vegetation Group**

Stands dominated by non-native or planted trees, except *Eucalyptus*, which are mapped as *Eucalyptus (globulus, camaldulensis)* Woodland Semi-Natural Alliance.

# Appendix C

## 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 NVCS classification unit). The 2012 (2015 Original) column shows the mapping units that were used in 2012 and for the first version of the 2015 map. For the revised 2015 map, some mapping units were aggregated to a higher level. In those cases, the Common Name is identified with a filled light green cell and the 2015 Revised column will reflect the current name. In other cases, the mapping unit name has changed to reflect the current vegetation hierarchy, although the composition of the mapping unit has not changed. In those cases, the Common Name column will reflect the new name.

The table is ordered by the revised 2015 Mapping Code.

The *Jepson Manual: Vascular Plants of California, Second Edition* (Baldwin et al. 2012) is the source for the species nomenclature for this project.

| Mapping Code | Vegetation Name 1999-2006 | Vegetation Name 2009 | Vegetation Name 2012 (2015 Original) | Vegetation Name 2015 Revised | 2015 Mapping Code | Common Name |
|---|---|---|---|---|---|---|
| 1 | Bare Ground | Bare Ground mu | Bare Ground mu | Bare Ground mu | 1 | Bare Ground |
| 2 | Fallow Disced Field | Fallow Disced Field mu | Fallow Disced Field mu | Agriculture mu | 2 | Agriculture |
| 3 | Parking Lot | Parking Lot mu | Parking Lot mu | Developed mu | 3 | Parking Lot |
| 4 | Road | Road mu | Road mu | Road / Trails mu | 4 | Roads and trails |
| 5 | Structure | Structure mu | Structure mu | Developed mu | 5 | Structure |
| 6 | Slough | Slough mu | Slough mu | Slough mu | 6 | Slough |
| 7 | Tidal Mudflat | Tidal Mudflat mu | Tidal Mudflat mu | Tidal Mudflat mu | 7 | Tidal Mudflat |
| 8 | Railroad Track | Railroad Track mu | Railroad Track mu | Railroad Track mu | 8 | Railroad Track |
| 9 | Ditch | Ditch mu | Ditch mu | Ditch mu | 9 | Ditch |
| 10 | Trail | Trail mu | Trail mu | Road / Trails mu | 10 | Trail |
| 11 | Flooded Managed Wetland | Open Water mu | Open Water mu | Open Water mu | 11 | Open Water |
| 12 | Freshwater Drainage | Freshwater Drainage mu | Freshwater Drainage mu | Deleted, never used - | 12 | Freshwater Drainage |
| 13 | Water Treatment Pond | Water Treatment Pond mu | Water Treatment Pond mu | Developed mu | 13 | Water Treatment Pond |
| 14 | Urban Area | Urban Area mu | Urban Area mu | Developed mu | 14 | Urban Area mu |
| 15 | | | | Developed mu | 15 | Developed mu |
| 900 | Oaks | Oaks mu | Oaks mu | Californian Broadleaf Forest and Woodland Group | 1111000 | Californian Broadleaf Forest and Woodland Group |

| Mapping Code | Vegetation Name 1999-2006 | Vegetation Name 2009 | Vegetation Name 2012 (2015 Original) | Vegetation Name 2015 Revised | 2015 Mapping Code | Common Name |
|---|---|---|---|---|---|---|
| 901 | *Quercus agrifolia* | *Quercus agrifolia* | *Quercus agrifolia* Alliance | *Quercus agrifolia* Woodland Alliance | 1111100 | Coast Live Oak |
| 705 | *Salix lasiolepis/Quercus agrifolia* | *Salix lasiolepis/Quercus agrifolia* | *Quercus agrifolia / Salix lasiolepis* Association | *Quercus agrifolia / Salix lasiolepis* Association | 1111102 | Arroyo Willow/Coast Live Oak |
| 903 | *Quercus lobata* | *Quercus lobata* | *Quercus lobata* Alliance | *Quercus lobata* Woodland Alliance | 1111200 | Valley Oak |
| 800 | *Eucalyptus* | *Eucalyptus* mu | *Eucalyptus (globulus, camaldulensis)* Alliance | *Eucalyptus (globulus, camaldulensis)* Woodland Semi-Natural Alliance | 2110100 | Gum Tree |
| 801 | *Eucalyptus globulus* | *Eucalyptus globulus* | *Eucalyptus globulus* Association | *Eucalyptus (globulus, camaldulensis)* Woodland Semi-Natural Alliance | 2110101 | Blue Gum |
| 911 | *Ailanthus altissima* | *Ailanthus altissima* | *Ailanthus altissima* Alliance | *Ailanthus altissima* Woodland Semi-Natural Alliance | 2110200 | Tree of Heaven |
| 700 | Willow Trees | Willow Trees | Willow Trees mu | Southwestern North American Riparian Evergreen and Deciduous Woodland Group | 2121000 | Southwestern North American Riparian Evergreen and Deciduous Woodland Group |
| 702 | *Salix laevigata/S. lasiolepis* | *Salix laevigata/Salix lasiolepis* | *Salix laevigata / Salix lasiolepis* Association | *Salix laevigata / Salix lasiolepis* Association | 2121101 | Red Willow/Arroyo Willow |
| 500 | | | | Southwestern North American Riparian/Wash Scrub Group | 2122000 | Southwestern North American Riparian/Wash Scrub Group |
| 502 | *Salix exigua* | *Salix exigua* | *Salix exigua* Association | *Salix exigua* Association | 2122101 | Narrowleaf Willow |
| 604 | *Rosa californica* | *Rosa californica* | *Rosa californica* Association | *Rosa californica* Association | 2122201 | California Rose |
| 605 | *Rosa/Baccharis* | *Rosa californica-Baccharis pilularis* | *Rosa californica – Baccharis pilularis* Association | *Rosa californica – Baccharis pilularis* Association | 2122202 | California Rose-Coyote Brush |
| 607 | | | | *Baccharis salicifolia* Shrubland Alliance | 2122300 | Mule-fat |
| 102 | *Arundo donax* | *Arundo donax* | *Arundo donax* Association | *Arundo donax* Semi-Natural Association | 2123101 | Giant Reed |

| Mapping Code | Vegetation Name 1999-2006 | Vegetation Name 2009 | Vegetation Name 2012 (2015 Original) | Vegetation Name 2015 Revised | 2015 Mapping Code | Common Name |
|---|---|---|---|---|---|---|
| 107 | | | | *Tamarix* spp. Shrubland Semi-Natural Alliance | 2123200 | Tamarisk |
| 912 | *Fraxinus latifolia* | *Fraxinus latifolia* | *Fraxinus latifolia* Planted Stands mu | *Fraxinus latifolia* Planted Stands mu | 3111101 | Oregon Ash |
| 231 | Annual Grasses generic | Annual Grasses generic | Annual Grasses mu | California Annual and Perennial Grassland Macrogroup | 4110000 | Annual Grasses generic |
| 231 | Annual Grasses generic | Annual Grasses generic | Annual Grasses mu | California Annual and Perennial Grassland Macrogroup | 4110001 | Annual Grasses generic |
| 227 | Annual Grasses/Weeds | Annual Grasses/Weeds | Mediterranean California Naturalized Annual and Perennial Grassland Group | Mediterranean California Naturalized Annual and Perennial Grassland Group | 4111000 | Mediterranean California Naturalized Annual and Perennial Grassland Group |
| 210 | Medium Upland Graminoids | Medium Upland Graminoids mu | Medium Upland Graminoids mu | Mediterranean California Naturalized Annual and Perennial Grassland Group | 4111002 | Mediterranean California Naturalized Annual and Perennial Grassland Group |
| 226 | Perennial Grass | Perennial Grass | Perennial Grass mu | Mediterranean California Naturalized Annual and Perennial Grassland Group | 4111003 | Perennial Grass |
| 230 | Short Upland Graminoids | Short Upland Graminoids mu | Short Upland Graminoids mu | Mediterranean California Naturalized Annual and Perennial Grassland Group | 4111004 | Short Upland Graminoids |
| 401 | Upland Herbs | Upland Herbs mu | Tall Upland Herbs mu | Mediterranean California Naturalized Annual and Perennial Grassland Group | 4111005 | Upland Herbs |
| 410 | Medium Upland Herbs | Medium Upland Herbs mu | Medium Upland Herbs mu | Mediterranean California Naturalized Annual and Perennial Grassland Group | 4111006 | Medium Upland Herbs |
| 406 | *Brassica nigra* (generic) | *Brassica nigra* | *Brassica nigra* Association | Mediterranean California Naturalized Annual and Perennial Grassland Group | 4111101 | Black Mustard |
| 405 | *Raphanus sativus* (generic) | *Raphanus sativus* | *Raphanus sativus* Association | Mediterranean California Naturalized Annual and Perennial Grassland Group | 4111102 | Radish |

| Mapping Code | Vegetation Name 1999-2006 | Vegetation Name 2009 | Vegetation Name 2012 (2015 Original) | Vegetation Name 2015 Revised | 2015 Mapping Code | Common Name |
|---|---|---|---|---|---|---|
| 232 | *Bromus* spp./*Hordeum* | *Bromus* spp.-*Hordeum* spp. | *Bromus (diandrus, hordeaceus) – Brachypodium distachyon* Alliance | Mediterranean California Naturalized Annual and Perennial Grassland Group | 4111200 | Brome-Barley |
| 413 | *Centaurea* (generic) | *Centaurea* spp. | *Centaurea (solstitialis, melitensis)* Alliance | Mediterranean California Naturalized Annual and Perennial Grassland Group | 4111300 | Knapweed, Star Thistle |
| 402 | *Conium maculatum* | *Conium maculatum* | *Conium maculatum* Association | Mediterranean California Naturalized Annual and Perennial Grassland Group | 4111401 | Poison Hemlock |
| 403 | *Foeniculum vulgare* | *Foeniculum vulgare* | *Foeniculum vulgare* Association | Mediterranean California Naturalized Annual and Perennial Grassland Group | 4111402 | Sweet Fennel |
| 202 | *Cortaderia selloana* | *Cortaderia selloana* | *Cortaderia (jubata, selloana)* Alliance | *Cortaderia (jubata, selloana)* Semi-Natural Herbaceous Alliance | 4111500 | Pampas Grass |
| 218 | *Lolium* (generic) | *Lolium multiflorum* | *Festuca perennis* Alliance | Mediterranean California Naturalized Annual and Perennial Grassland Group | 4111600 | Rye Grass |
| 220 | *Lolium/Lepidium* | *Lolium multiflorum-Lepidium latifolium* | *Festuca perennis – Lepidium latifolium* Association | Mediterranean California Naturalized Annual and Perennial Grassland Group | 4111601 | Rye Grass-Perennial Pepperweed |
| 344 | *Lotus corniculatus* | *Lotus corniculatus* | *Festuca perennis – Lotus corniculatus* Association | Mediterranean California Naturalized Annual and Perennial Grassland Group | 4111602 | Bird's-foot Trefoil |
| 222 | *Lolium/Rumex* | *Lolium multiflorum-Rumex* spp. | *Festuca perennis – Rumex* spp. mu | Mediterranean California Naturalized Annual and Perennial Grassland Group | 4111603 | Rye Grass-Dock |
| 234 | *Hordeum/Lolium* | *Hordeum* spp.-*Lolium multiflorum* | *Hordeum marinum – Festuca perennis* mu | Mediterranean California Naturalized Annual and Perennial Grassland Group | 4111604 | Barley-Rye Grass |

| Mapping Code | Vegetation Name 1999-2006 | Vegetation Name 2009 | Vegetation Name 2012 (2015 Original) | Vegetation Name 2015 Revised | 2015 Mapping Code | Common Name |
|---|---|---|---|---|---|---|
| 211 | *Elytrigia pontica* | *Elytrigia pontica* | *Elytrigia pontica* mu | Mediterranean California Naturalized Annual and Perennial Grassland Group | 4111700 | Tall Wheat Grass |
| 228 | *Agrostis avenacea* | *Agrostis avenacea* | *Agrostis avenacea* mu | Mediterranean California Naturalized Annual and Perennial Grassland Group | 4111800 | Pacific Bent Grass |
| 235 | *Vulpia/Euthamia* | *Vulpia/Euthamia* | *Vulpia* spp. – *Euthamia occidentalis* mu | Mediterranean California Naturalized Annual and Perennial Grassland Group | 4111900 | Rattail Fescue-Western Goldenrod |
| 223 | *Phalaris aquatica* | *Phalaris aquatica* | *Phalaris aquatica* Association | *Phalaris aquatica* Semi-Natural Association | 5111101 | Harding Grass |
| 606 | *Rubus discolor* | *Rubus discolor* | *Rubus armeniacus* Alliance | *Rubus armeniacus* Shrubland Semi-Natural Alliance | 5121100 | Himalayan Blackberry |
| 601 | Medium Upland Shrubs | Medium Upland Shrubs mu | Medium Upland Shrubs mu | California Coastal Evergreen Bluff and Dune Scrub Group | 6111000 | California Coastal Evergreen Bluff and Dune Scrub Group |
| 602 | | | *Baccharis pilularis* Alliance | *Baccharis pilularis* Shrubland Alliance | 6111100 | Coyote Brush |
| 603 | *Baccharis*/Annual Grasses | *Baccharis pilularis* /Annual Grasses | *Baccharis pilularis* / Annual Grass–Herb Association | *Baccharis pilularis* / Annual Grass –Herb Association | 6111101 | Coyote Brush/Annual Grasses Association |
| 421 | *Carpobrotus edulis* | *Carpobrotus edulis* | *Carpobrotus edulis* Alliance | *Carpobrotus edulis* or Other Ice Plants Herbaceous Semi-Natural Alliance | 6112100 | Ice plant |
| 101 | Tall Wetland Graminoids | Tall Wetland Graminoids mu | Tall Wetland Graminoids mu | Arid West Freshwater Emergent Marsh Group | 7111000 | Arid West Freshwater Emergent Marsh Group |
| 330 | *Calystegia/Euthamia* | *Calystegia sepium-Euthamia occidentalis* | *Calystegia sepium – Euthamia occidentalis* mu | *Schoenoplectus (acutus, californicus)* – Wetland herbs mu | 7111002 | Hedge Bindweed-Western Goldenrod |
| 122 | | | *Typha (angustifolia, domingensis, latifolia)* Alliance | *Typha (angustifolia, latifolia, domingensis)* Herbaceous Alliance | 7111100 | Cattail (narrowleaf, broadleaf, southern) |
| 123 | *Typha species* (generic) | *Typha (angustifolia, latifolia, domingensis)* | *Typha (angustifolia, latifolia, domingensis)* Association | *Typha (angustifolia, latifolia, domingensis)* Alliance | 7111101 | Cattail (narrowleaf, broadleaf, southern) |

| Mapping Code | Vegetation Name 1999-2006 | Vegetation Name 2009 | Vegetation Name 2012 (2015 Original) | Vegetation Name 2015 Revised | 2015 Mapping Code | Common Name |
|---|---|---|---|---|---|---|
| 125 | *Typha angustifolia* (dead stalks) | *Typha (angustifolia, latifolia, domingensis)* (dead stalks) | *Typha (angustifolia, latifolia, domingensis)* (dead stalks) mu | *Typha (angustifolia, latifolia, domingensis)* Alliance | 7111102 | Cattail (narrowleaf, broadleaf, southern) |
| 120 | *Typha angustifolia/Polygonum-Xanthium-Echinochloa* | *Typha (angustifolia, latifolia, domingensis)-Polygonum* spp.*-Xanthium strumarium-Echinochloa crus-galli* | *Typha (angustifolia, latifolia, domingensis) – Echinochloa crus-galli* Association | *Typha (angustifolia, latifolia, domingensis)* Alliance | 7111103 | Cattail (narrowleaf, broadleaf, southern)-Smartweed-Rough Cocklebur-Barnyard Grass |
| 126 | *Typha angustifolia/Distichlis* | *Typha (angustifolia, latifolia, domingensis)-Distichlis spicata* | *Typha (angustifolia, latifolia, domingensis) – Distichlis spicata* Association | *Typha (angustifolia, latifolia, domingensis)* Alliance | 7111104 | Cattail (narrowleaf, southern, broadleaf)-Salt grass |
| 129 | *Typha angustifolia/Phragmites* | *Typha (angustifolia, latifolia, domingensis)-Phragmites australis* | *Typha (angustifolia, latifolia, domingensis) – Phragmites australis* Association | *Typha (angustifolia, latifolia, domingensis)* Alliance | 7111105 | Cattail (narrowleaf, broadleaf, southern)-Common Reed |
| 121 | *Typha angustifolia/S. americanus* | *Typha (angustifolia, latifolia, domingensis)-Schoenoplectus americanus* | *Typha (angustifolia, latifolia, domingensis) – Schoenoplectus americanus* Association | *Typha (angustifolia, latifolia, domingensis)* Alliance | 7111106 | Cattail (narrowleaf, broadleaf, southern)-Three-square Bulrush |
| 116 | *Scirpus californicus/S. acutus* | *Schoenoplectus (acutus, californicus)* | *Schoenoplectus californicus – Schoenoplectus acutus* Association | *Schoenoplectus (acutus, californicus*) mu | 7111201 | Bulrush (Hardstem Bulrush, California Bulrush) |
| 115 | | | | *Schoenoplectus (acutus, californicus)* mu | 7111202 | Bulrush (Hardstem Bulrush, California Bulrush) |
| 162 | *Scirpus (californicus* or *acutus)/Rosa* | *Schoenoplectus (acutus, californicus)-Rosa californica* | *Schoenoplectus californicus – Schoenoplectus acutus / Rosa californica* Association | *Schoenoplectus (acutus, californicus) – Rosa californica* Association | 7111203 | Bulrush (California Bulrush, Hardstem Bulrush)-California Rose |
| 158 | *Scirpus (californicus* or *acutus)*/Wetland Herb | *Schoenoplectus (acutus, californicus)*-Wetland herbs | *Schoenoplectus (acutus, californicus)* – Wetland herbs mu | *Schoenoplectus (acutus, californicus)* – Wetland Herbs mu | 7111204 | Bulrush (Hardstem Bulrush, California Bulrush)-Wetland herbs |
| 157 | *Scirpus (californicus* or *acutus)-Typha* spp. | *Schoenoplectus (acutus, californicus)-Typha (angustifolia, latifolia, domingensis)* | *Schoenoplectus (acutus, californicus) – Typha (angustifolia, latifolia, domingensis)* mu | *Schoenoplectus (acutus, californicus) – Typha (angustifolia, latifolia, domingensis)* mu | 7111300 | Bulrush (Hardstem Bulrush, California Bulrush)-Cattail (narrowleaf, broadleaf, southern) |

| Mapping Code | Vegetation Name 1999-2006 | Vegetation Name 2009 | Vegetation Name 2012 (2015 Original) | Vegetation Name 2015 Revised | 2015 Mapping Code | Common Name |
|---|---|---|---|---|---|---|
| 106 | | | | *Phragmites australis* Herbaceous Alliance | 7111400 | Common Reed |
| 103 | *Phragmites australis* | *Phragmites australis* | *Phragmites australis* Association | *Phragmites australis* Herbaceous Alliance | 7111401 | Common Reed |
| 104 | *Phragmites/Scirpus* | *Phragmites australis-Schoenoplectus (acutus, californicus)* | *Phragmites australis – Schoenoplectus* spp. Association | *Phragmites australis* Herbaceous Alliance | 7111402 | Common Reed-Bulrush (Hardstem Bulrush, California Bulrush) |
| 105 | *Phragmites/Xanthium* | *Phragmites australis-Xanthium strumarium* | *Phragmites australis – Xanthium strumarium* mu | *Phragmites australis* Herbaceous Alliance | 7111403 | Common Reed-Rough Cocklebur |
| 117 | | | | *Alisma triviale* Mapping Unit | 7111500 | Water Plaintain |
| 338 | *Potentilla anserina* (generic) | *Potentilla anserina* | *Potentilla anserina* Alliance | *Potentilla anserina* Herbaceous Alliance | 7112100 | Cinquefoil |
| 321 | *Grindelia stricta* var. *stricta* | *Grindelia stricta* var. *stricta* | *Grindelia (stricta)* Alliance | *Grindelia (stricta)* Provisional Herbaceous Alliance | 7121100 | Gumplant |
| 130 | Medium Wetland Graminoids | Medium Wetland Graminoids mu | Medium Wetland Graminoids mu | Western North America Wet Meadow and Low Shrub Carr Macrogroup | 7130000 | Western North America Wet Meadow and Low Shrub Carr Macrogroup |
| 131 | | | | *Juncus arcticus (*var. *balticus, mexicanus)* Herbaceous Alliance | 7131100 | Common Rush |
| 132 | *Juncus balticus* | *Juncus balticus* | *Juncus arcticus* var. *balticus* Association | *Juncus arcticus (*var. *balticus, mexicanus)* Herbaceous Alliance | 7131101 | Common Rush |
| 133 | *Juncus balticus/Conium* | *Juncus balticus-Conium maculatum* | *Juncus arcticus* var. *balticus – Conium maculatum* Association | *Juncus arcticus (*var. *balticus, mexicanus)* Herbaceous Alliance | 7131102 | Common Rush-Poison Hemlock |
| 134 | *Juncus balticus/Lepidium* | *Juncus balticus-Lepidium latifolium* | *Juncus arcticus* var. *balticus – Lepidium latifolium* Association | *Juncus arcticus (*var. *balticus, mexicanus)* Herbaceous Alliance | 7131103 | Common Rush-Perennial Pepperweed |
| 135 | *Juncus balticus/Potentilla* | *Juncus balticus-Potentilla anserina* | *Juncus arcticus* var. *balticus – Potentilla anserina* Association | *Juncus arcticus (*var. *balticus, mexicanus)* Herbaceous Alliance | 7131104 | Common Rush-Cinquefoil |
| 215 | *Leymus* (generic) | *Leymus triticoides* | *Leymus triticoides* Alliance | *Leymus triticoides* Herbaceous Alliance | 7131200 | Creeping Wild Rye |
| 324 | *Lepidium* (generic) | *Lepidium latifolium* | *Lepidium latifolium* Alliance | *Lepidium latifolium* Herbaceous Semi-Natural Alliance | 7132100 | Perennial Pepperweed |

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|---|---|---|---|---|---|---|
| 328 | | | | *Persicaria lapathifolia – Xanthium strumarium* Herbaceous Alliance | 7132200 | Willow Weed-Rough Cocklebur |
| 329 | *Polygonum-Xanthium-Echinochloa* | *Polygonum* spp.-*Xanthium strumarium-Echinochloa crus-galli* | *Persicaria* spp. – *Xanthium strumarium – Echinochloa crus-galli* mu | *Persicaria lapathifolia – Xanthium strumarium* Herbaceous Alliance | 7132201 | Smartweed-Rough Cocklebur-Barnyard Grass |
| 155 | *Crypsis schoenoides* | *Crypsis schoenoides* | *Crypsis schoenoides* mu | *Crypsis schoenoides* mu | 7132301 | Swamp Timothy |
| 161 | *Cynodon dactylon* | *Cynodon dactylon* | *Cynodon dactylon* mu | *Cynodon dactylon* mu | 7132302 | Bermuda Grass |
| 238 | *Polypogon monspeliensis* (generic) | *Polypogon monspeliensis* | *Polypogon monspeliensis* mu | *Polypogon monspeliensis* mu | 7132400 | Rabbitsfoot Grass |
| 336 | *Rumex* (generic) | *Rumex* spp. | *Rumex* spp. mu | Western North America Wet Meadow and Low Shrub Carr Macrogroup | 7132500 | Dock |
| 366 | | | *Salsola soda* mu | *Salsola soda* mu | 7132600 | Opposite-leaf Russian Thistle |
| 299 | | | | Temperate and Boreal Salt Marsh Formation | 8000000 | Temperate and Boreal Salt Marsh Formation |
| 300 | Wetland Herbs | Wetland Herbs mu | Wetland Herbs mu | Temperate and Boreal Salt Marsh Formation | 8000001 | Wetland Herbs |
| 301 | Tall Wetland Herbs | Tall Wetland Herbs mu | Tall Wetland Herbs mu | Temperate and Boreal Salt Marsh Formation | 8000002 | Tall Wetland Herbs |
| 310 | Medium Wetland Herbs | Medium Wetland Herbs mu | Medium Wetland Herbs mu | Temperate and Boreal Salt Marsh Formation | 8000003 | Medium Wetland Herbs |
| 140 | Short Wetland Graminoids | Short Wetland Graminoids mu | Short Wetland Graminoids mu | North American Pacific Coastal Salt Marsh Macrogroup | 8110000 | North American Pacific Coastal Salt Marsh Macrogroup |
| 140 | Short Wetland Graminoids | Short Wetland Graminoids mu | Short Wetland Graminoids mu | North American Pacific Coastal Salt Marsh Macrogroup | 8110001 | North American Pacific Coastal Salt Marsh Macrogroup |
| 340 | Short Wetland Herbs | Short Wetland Herbs mu | Short Wetland Herbs mu | North American Pacific Coastal Salt Marsh Macrogroup | 8110002 | Short Wetland Herbs |

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|---|---|---|---|---|---|---|
| 136 | | | *Bolboschoenus maritimus* Alliance | *Bolboschoenus maritimus* Herbaceous Alliance | 8111100 | Alkali Bulrush |
| 137 | *Scirpus maritimus* | *Bolboschoenus maritimus* | *Bolboschoenus maritimus* Association | *Bolboschoenus maritimus* Herbaceous Alliance | 8111101 | Alkali Bulrush |
| 138 | *Scirpus maritimus/Salicornia* | *Bolboschoenus maritimus-Salicornia pacifica* | *Bolboschoenus maritimus – Salicornia pacifica* Association | *Bolboschoenus maritimus* Herbaceous Alliance | 8111102 | Alkali Bulrush-Pickleweed |
| 139 | *Scirpus maritimus/Sesuvium* | *Bolboschoenus maritimus-Sesuvium verrucosum* | *Bolboschoenus maritimus – Sesuvium verrucosum* Association | *Bolboschoenus maritimus* Herbaceous Alliance | 8111103 | Alkali Bulrush-Western Sea-purslane |
| 156 | *Distichlis* (generic) | *Distichlis spicata* | *Distichlis spicata* Alliance | *Distichlis spicata* Herbaceous Alliance | 8111200 | Salt grass |
| 141 | *Distichlis spicata* | *Distichlis spicata* | *Distichlis spicata* Association | *Distichlis spicata* Association | 8111201 | Salt grass |
| 142 | *Distichlis*/Annual Grasses | *Distichlis spicata*-Annual grasses | *Distichlis spicata* – Annual Grasses Association | *Distichlis spicata* – Annual Grasses Association | 8111202 | Salt grass-Annual grasses Association |
| 145 | *Distichlis/Juncus* | *Distichlis spicata-Juncus balticus* | *Distichlis spicata – Juncus arcticus* var. *balticus* Association | *Distichlis spicata – Juncus arcticus* var. *balticus (J. arcticus* var. *mexicanus)* Association | 8111203 | Salt grass-Common Rush |
| 147 | *Distichlis/Lotus* | *Distichlis spicata-Lotus corniculatus* | *Distichlis spicata – Lotus corniculatus* mu | *Distichlis spicata* Herbaceous Alliance | 8111204 | Salt grass-Bird's-foot Trefoil |
| 148 | *Distichlis/Salicornia* | *Distichlis spicata-Salicornia pacifica* | *Distichlis spicata – Salicornia pacifica* Association | *Distichlis spicata – Salicornia pacifica* Association | 8111205 | Salt grass-Pickleweed |
| 149 | *Distichlis/S. americanus* | *Distichlis spicata-Schoenoplectus americanus* | *Distichlis spicata – Schoenoplectus americanus* mu | *Distichlis spicata – Schoenoplectus americanus* Provisional Association | 8111206 | Salt grass-Three-square Bulrush |
| 153 | *Distichlis/Cotula* | *Distichlis spicata-Cotula coronopifolia* | *Distichlis spicata – Cotula coronopifolia* Association | *Distichlis spicata – Cotula coronopifolia* Association | 8111207 | Salt grass-Brass buttons |
| 154 | *Distichlis/S. maritimus* | *Distichlis spicata-Bolboschoenus maritimus* | *Distichlis spicata – Bolboschoenus maritimus* mu | *Distichlis spicata* Herbaceous Alliance | 8111208 | Salt grass-Alkali Bulrush |
| 160 | *Distichlis-Juncus-Triglochin-Glaux* | *Distichlis spicata-Juncus balticus-Triglochin* spp.-*Glaux maritima* | *Distichlis spicata – Juncus balticus – Triglochin* spp. *– Glaux maritima* mu | *Distichlis spicata – Juncus balticus – Triglochin* spp. *– Glaux maritima* mu | 8111209 | Salt grass-Common Rush-Arrowgrass-Sea Milkwort |
| 323 | *Lepidium/Distichlis* | *Lepidium latifolium-Distichlis spicata* | *Lepidium latifolium – Distichlis spicata* Association | *Distichlis spicata* Herbaceous Alliance | 8111210 | Perennial Pepperweed-Salt grass |

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|---|---|---|---|---|---|---|
| 361 | *Salicornia* (generic) | *Salicornia pacifica* Alliance Only | *Salicornia pacifica* Alliance | *Salicornia pacifica (Salicornia depressa)* Herbaceous Alliance | 8111300 | Pickleweed |
| 346 | *Salicornia virginica* | *Salicornia pacifica* | *Salicornia pacifica* Association | *Salicornia pacifica* Association | 8111301 | Pickleweed |
| 347 | *Salicornia*/Annual Grasses | *Salicornia pacifica*-Annual Grasses | *Salicornia pacifica* – Annual Grasses Association | *Salicornia pacifica* – Annual Grasses Association | 8111302 | Pickleweed-annual Grasses |
| 348 | *Salicornia/Atriplex* | *Salicornia pacifica-Atriplex prostrata* | *Salicornia pacifica – Atriplex prostrata* Association | *Salicornia pacifica (Salicornia depressa)* Herbaceous Alliance | 8111303 | Pickleweed-Fat-hen |
| 350 | *Salicornia/Crypsis* | *Salicornia pacifica-Crypsis schoenoides* | *Salicornia pacifica – Crypsis schoenoides* Association | *Salicornia pacifica – Crypsis schoenoides* Association | 8111304 | Pickleweed-Swamp Timothy |
| 356 | *Salicornia/Sesuvium* | *Salicornia pacifica-Sesuvium verrucosum* | *Salicornia pacifica – Sesuvium verrucosum* Association | *Salicornia pacifica – Sesuvium verrucosum* Association | 8111305 | Pickleweed-Western Sea-purslane |
| 364 | *Salicornia/Polygonum-Xanthium-Echinochloa* | *Salicornia pacifica-Polygonum* spp.*-Xanthium strumarium-Echinochloa crus-galli* | *Salicornia pacifica – Echinochloa crus-galli – Polygonum – Xanthium strumarium* Association | *Salicornia pacifica (Salicornia depressa)* Herbaceous Alliance | 8111306 | Pickleweed-Smartweed-Rough Cocklebur-Barnyard Grass |
| 365 | *Salicornia/Cotula* | *Salicornia pacifica-Cotula coronopifolia* | *Salicornia pacifica – Cotula coronopifolia* Association | *Salicornia pacifica – Cotula coronopifolia* Association | 8111307 | Pickleweed-Brass buttons |
| 163 | | | | *Spartina foliosa* Herbaceous Alliance | 8111400 | California cordgrass |
| 339 | *Atriplex triangularis*(generic) | *Atriplex prostrata* | *Atriplex prostrata* Alliance | *Atriplex prostrata – Cotula coronopifolia* Herbaceous Semi-Natural Alliance | 8112100 | Fat-hen – Brass buttons |
| 342 | *Cotula coronopifolia* | *Cotula coronopifolia* | *Cotula coronopifolia* Association | *Cotula coronopifolia* Semi-Natural Association | 8112101 | Brass buttons |
| 311 | *Atriplex triangularis* | *Atriplex prostrata* | *Atriplex prostrata* Association | *Atriplex prostrata – Cotula coronopifolia* Herbaceous Semi-Natural Alliance | 8112102 | Fat-hen |
| 312 | *Atriplex/Distichlis* | *Atriplex prostrata-Distichlis spicata* | *Atriplex prostrata – Distichlis spicata* Association | *Atriplex prostrata – Cotula coronopifolia* Herbaceous Semi-Natural Alliance | 8112103 | Fat-hen-Salt grass |

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|---|---|---|---|---|---|---|
| 315 | *Atriplex/S. maritimus* | *Atriplex prostrata-Bolboschoenus maritimus* | *Atriplex prostrata – Bolboschoenus maritimus* Association | *Atriplex prostrata – Cotula coronopifolia* Herbaceous Semi-Natural Alliance | 8112104 | Fat-hen-Alkali Bulrush |
| 316 | *Atriplex/Sesuvium* | *Atriplex prostrata-Sesuvium verrucosum* | *Atriplex prostrata – Sesuvium verrucosum* Association | *Atriplex prostrata – Cotula coronopifolia* Herbaceous Semi-Natural Alliance | 8112105 | Fat-hen-Western Sea-purslane |
| 337 | *Atriplex/*Annual Grasses | *Atriplex prostrata*-Annual Grasses | *Atriplex prostrata* – Annual Grasses Association | *Atriplex prostrata – Cotula coronopifolia* Herbaceous Semi-Natural Alliance | 8112106 | Fat-hen-Annual Grasses |
| 355 | | | | *Sesuvium verrucosum* Herbaceous Alliance | 8112200 | Western Sea-purslane |
| 357 | *Sesuvium verrucosum* | *Sesuvium verrucosum* | *Sesuvium verrucosum* Association | *Sesuvium verrucosum* Association | 8112201 | Western Sea-purslane |
| 358 | *Sesuvium/Distichlis* | *Sesuvium verrucosum-Distichlis spicata* | *Sesuvium verrucosum – Distichlis spicata* Association | *Sesuvium verrucosum* Herbaceous Alliance | 8112202 | Western Sea-purslane-Salt grass |
| 359 | *Sesuvium/Lolium* | *Sesuvium verrucosum-Lolium multiflorum* | *Sesuvium verrucosum – Festuca perennis* Association | *Sesuvium verrucosum* Herbaceous Alliance | 8112203 | Western Sea-purslane-Rye Grass |
| 362 | | | *Sesuvium verrucosum – Cotula coronopifolia* Association | *Sesuvium verrucosum* Association | 8112204 | Western Sea-purslane-Brass buttons |
| 360 | *Spergularia/Cotula* | *Spergularia-Cotula coronopifolia* | *Spergularia marina – Cotula coronopifolia* Association | *Spergularia marina* Provisional Herbaceous Alliance | 8112300 | Sand-spurrey |
| 360 | *Spergularia/Cotula* | *Spergularia-Cotula coronopifolia* | *Spergularia marina – Cotula coronopifolia* Association | *Spergularia marina* Provisional Herbaceous Alliance | 8112301 | Sand-spurrey-Brass buttons |
| 111 | | | *Schoenoplectus americanus* Alliance | *Schoenoplectus americanus* Herbaceous Alliance | 8211100 | Three-square Bulrush |
| 114 | *Scirpus americanus* (generic) | *Schoenoplectus americanus* | *Schoenoplectus americanus* Association | *Schoenoplectus americanus* Herbaceous Alliance | 8211101 | Three-square Bulrush |
| 112 | *Scirpus americanus/Potentilla* | *Schoenoplectus americanus-Potentilla anserina* | *Schoenoplectus americanus – Potentilla anserina* Association | *Schoenoplectus americanus* Herbaceous Alliance | 8211102 | Three-square Bulrush-Cinquefoil |
| 113 | *Scirpus americanus/S. californicus-S. acutus* | *Schoenoplectus americanus-Schoenoplectus (acutus, californicus)* | *Schoenoplectus americanus – Schoenoplectus californicus – Schoenoplectus acutus* Association | *Schoenoplectus americanus* Herbaceous Alliance | 8211103 | Three-square Bulrush-Bulrush (Hardstem Bulrush, California Bulrush) |

| Mapping Code | Vegetation Name 1999-2006 | Vegetation Name 2009 | Vegetation Name 2012 (2015 Original) | Vegetation Name 2015 Revised | 2015 Mapping Code | Common Name |
|---|---|---|---|---|---|---|
| 127 | *Scirpus americanus/Lepidium* | *Schoenoplectus americanus-Lepidium latifolium* | *Schoenoplectus americanus – Lepidium latifolium* Association | *Schoenoplectus americanus – Lepidium latifolium* Association | 8211104 | Three-square Bulrush-Perennial Pepperweed |
| 514 | *Atriplex lentiformis* (generic) | *Atriplex lentiformis* | *Atriplex lentiformis* Alliance | *Atriplex lentiformis* Shrubland Alliance | 8212100 | Big Saltbrush |
| 320 | *Frankenia* (generic) | *Frankenia salina* | *Frankenia salina* Alliance | *Frankenia salina* Herbaceous Alliance | 8212200 | Alkali Heath |
| 317 | *Frankenia/Agrostis* | *Frankenia salina-Agrostis* | *Frankenia salina – Agrostis avenacea* Association | *Frankenia salina* – annual grasses mu | 8212201 | Alkali Heath-Annual grasses |
| 318 | *Frankenia/Distichlis* | *Frankenia salina-Distichlis spicata* | *Frankenia salina – Distichlis spicata* Association | *Frankenia salina – Distichlis spicata* Association | 8212202 | Alkali Heath-Salt grass |
| 370 | | | | Temperate Pacific Intertidal Flat Group | 9111100 | Temperate Pacific Intertidal Flat Group |
| 371 | *Potamogeton pectinatus* | *Potamogeton pectinatus* | *Stuckenia pectinata* Association | *Stuckenia pectinata* Association | 9111201 | Pondweed |
| 372 | | | | *Ruppia (cirrhosa, maritima)* Herbaceous Alliance | 9111300 | Ditch-grass/Widgeon-grass |
| 164 | | | *Ludwigia (hexapetala, peploides)* Provisional Herbaceous Semi-Natural Alliance | *Ludwigia (hexapetala, peploides)* Provisional Herbaceous Semi-Natural Alliance | 9211100 | Uruguayan primrose |
| 225 | Cultivated Annual Graminoid | Cultivated Annual Graminoid mu | Cultivated Annual Graminoid mu | Row & Close Grain Crop Formation | 9311000 | Row & Close Grain Crop Formation |
| 910 | Landscape Trees | Landscape Trees mu | Landscape Trees mu | Temperate Tree Developed Vegetation Group | 9411111 | Temperate Tree Developed Vegetation Group |

# Appendix D
# Field Forms and Protocols

# CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE PROTOCOL FOR RECONNAISSANCE FIELD FORM
(May 2015)

This protocol describes the methodology for the reconnaissance technique as recorded in the Recon Field Form – Suisun Marsh dated May 27, 2015. Reconnaissance surveys (recons) are complementary to relevés and rapid assessments, but collect only a small subset of the data gathered using the more detailed methods. Recons are generally used as an aid to digital vegetation mapping, to determine the boundaries of a stand, or to illustrate a particular vegetation signature. For more background on the relevé and rapid assessment sampling methods, see the relevé and rapid assessment protocol at http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=18599.

## Definitions of fields in the form

### I. LOCATIONAL/ENVIRONMENTAL DESCRIPTION

**Recorder:** The full name of the recorder should be provided for the first field form for the day. On successive forms, initials can be recorded.

**Other Surveyors:** The full name 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.

**Date:** Date of the sampling.

**Return?:** Check this box if team members should return to this spot at a later date to take a recon or RA/relevé. This can be used if the phenology is not conducive to identification of the major species, or if there is not enough time to take the survey.

**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.

**Location Name:** The name of the property, park, or the location within large holdings (like USFS or BLM properties).

**GPS name:** The name/number assigned to the GPS unit.

**Projected? Yes / No / Base / Digitized:** 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 surveyors are in the vegetation they are describing and the point is where the observer was standing for photographs. 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 descriptions are associated with this location. However, cardinal photos taken at this point will be stored in a directory of this name.

**Digitized** – An offset point was created on the GPS unit without taking bearing and distance readings. This option should only be used when the imagery on the GPS unit is unique and unmistakable.

**Bearing (°):** The compass bearing from the Base point to the Projected point.

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

**Inclination (°):** The vertical offset from the Base point to the Projected point.

**Base Waypoint ID:** For a projected or digitized point, this is the location where the surveyor was standing when the information was collected. Cardinal photographs will be taken at this point and will be stored on the computer under this ID. Photographs of the stand vegetation will be taken from this point and will be stored on the computer under the Projected point's ID.

**Base / Projected UTMs:** If the point is projected or digitized, circle whether the coordinates of the base point or the offset point have been recorded. These will generally be for the offset point.

**PDOP:** The accuracy of the GPS location. Record the error reading from the GPS unit.

**GPS coordinates:** Record easting (**UTME**) and northing (**UTMN)** from a GPS unit.

**Stand Size:** 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 numbers, and direction of photos. Take four photos in the main cardinal directions (N, E, S, W) clockwise from the north, from the GPS location. This symbol can be used to indicate the cardinal photos:  . If additional photos are taken in other directions, please note the JPG numbers and a description of each photo.

## II. HABITAT AND VEGETATION DESCRIPTION

**Field Alliance/Association name:** Name of alliance or association following the most recent Suisun Marsh classification, using scientific nomenclature, *e.g., Quercus agrifolia*. An alliance is based on the dominant or diagnostic species of the stand, and usually reflects 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.

**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.

**% Cover:**

**Tree:** The total cover of all the trees taking into consideration the porosity, or the holes, in the vegetation. This is an estimate of the absolute tree cover, disregarding the overlap1 of individual trees.

**Shrub:** The total cover of all the shrubs taking into consideration the porosity, or the holes, in the vegetation. This is an estimate of the absolute shrub cover, disregarding the overlap1 of individual shrubs.

**Herb:** The total cover of all the herbs taking into consideration the porosity, or the holes, in the vegetation. This is an estimate of the absolute herbaceous cover, disregarding the overlap1 of individual herbs.

**Total Veg:** 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 overlap1 of the various tree, shrub, and/or herbaceous layers and species.

**Veg Ht (m):** 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
**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.

**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.

**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.

**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.

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

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/A/E | Quercus douglasii | 40/<1/<1 | C |

**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.

**Collections:** 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, add a "T" to the "C" in that column (CT = thrown out after confirmation) or cross out the "C". If the specimen is kept but is still not confidently identified, add a "U" to the "C" (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" (CC = collected and confirmed). If the specimen is later deposited in an herbarium, add a "D" to the existing "C" (CD = collected and deposited) and note the receiving herbarium.

# Accuracy Assessment Protocol
# Suisun Marsh

4/5/2016

This protocol describes accuracy assessment (AA) data collection procedures. The primary purpose of the AA fieldwork is to supply data to test the accuracy of a specific vegetation map. The information collected can also contribute additional data for the classification of vegetation communities. The primary sampling units are the vegetation polygons delineated by photo interpreters in the creation of the vegetation map.

If an entire AA polygon cannot be fully investigated due to terrain or other reasons, as much of the polygon as can be evaluated should be assessed.

Note that a delineated polygon may differ from the conventional definition of a stand of vegetation. A stand is the basic physical unit of vegetation in a landscape. It has no set size. Some stands of vegetation are very small while some may be several square kilometers in size. A stand is defined by two main unifying characteristics:

1) It has compositional integrity. Throughout the site, the combination of species is similar. The stand is differentiated from adjacent stands by a discernable boundary that may be abrupt or indistinct.

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, 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 of vegetated ground to meet the requirements of a stand, it must be homogeneous.

A properly delineated polygon may contain more than one stand. One example is a stand that is below the minimum mapping unit (MMU); it cannot be mapped separately and will be absorbed into the surrounding vegetation type. Another example is vegetation that is difficult to accurately identify on photo imagery. Several similar-looking stands may be grouped into one polygon and assigned a vegetation type at a high level, such as group.

**Selecting a location to sample within a polygon (for subsamples only):**

If assessing a large polygon, it may be difficult to summarize the species composition, cover, and structure of the entire area. We are also usually trying to capture the most information as efficiently as possible. Thus, we may be forced to select a representative portion to sample.

When taking a subsample, the main point to remember is to select an area that, in as many ways as possible, is representative of that polygon. This means that you are not randomly selecting a sample location; on the contrary, you are actively using your own best judgment to find a representative example of the polygon.

Selecting an assessment site requires that you see enough of the polygon you are sampling to feel comfortable in choosing a representative sample location. If possible, take a brief walk through the polygon and figure out where the boundary lines are drawn. Look for variations in species composition and in stand structure. In the process, decide whether the polygon includes more than one mappable vegetation type or if the stand boundaries don't seem to match up with the polygon delineation. **If more than one vegetation type is present, fill out an AA form for each type ONLY IF each type is mappable (i.e., it is large enough to meet MMU and can be delineated without creating unreasonably-shaped polygons).** For the Suisun project, the MMU is ¼ acre and the minimum width is 10 feet. Small variations in vegetation that are repeated throughout the polygon should be included in your subsample. Once you assess the variation within the polygon, attempt to find an area that captures the stand's species composition and structural condition to sample.

**************

**NOTE:** In the Suisun Marsh, it is necessary to walk through polygons of tall herbaceous vegetation. Although the tall herbs may seem dominant from a distance, shorter herbs may actually be more abundant on closer inspection. The vegetation type might key to the shorter herbs. The radius and % of polygon viewed must reflect the area actually visited for these polygons.

**************

**How to enter fields on the form:**

**Recorder:** The full name of the recorder should be provided for the first field form for the day. On successive forms, initials can be recorded.

**Other 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.

**Date:** The date the AA point was sampled. Use the standard U.S. format of "month-day- year" or use letters to write out the month.

**Waypoint ID:** The waypoint number assigned by the GPS device when marking and storing a waypoint for the sample location.

*Note that the GPS point should be taken away from the edge of the polygon, and near the center of the subsample (if one is used).*

**Polygon UID:** The unique identifier (UID) assigned to each polygon, included in the GPS data and on paper maps.

**Location Name:** The name of the property, park, or the location within large holdings (like USFS or BLM properties).

**GPS name:** The name/number assigned to the GPS unit.

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

> **Yes** - The point is a projected, or offset point. The surveyors used a bearing and distance to project the point into the polygon they are describing.

**No** - The surveyor is within the boundary of the polygon being assessed and the point is where the observer was standing for photographs. 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 descriptions are associated with this location. However, cardinal photos taken at this point will be stored in a directory of this name.

**Digitized** – An offset point was created on the GPS unit without taking bearing and distance readings. This option should only be used when the imagery on the GPS unit is unique and unmistakable.

**If Projected = Yes**

**Bearing (°):** The compass bearing from the Base point to the Projected point.

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

**Inclination (°):** The vertical offset from the Base point to the Projected point.

**If Projected = Yes or Digitized**

**Base Waypoint ID:** The location where the surveyor was standing when the information was collected. Cardinal photographs will be taken at this point and will be stored on the computer under this ID. Photographs of the stand vegetation will be taken from this point and will be stored on the computer under the Projected point's ID.

**Base UTMs / Projected UTMs:** If the point is projected or digitized, circle whether the UTM coordinates of the base point or the offset point have been recorded. These will generally be for the offset point.

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

**PDOP:** The accuracy of the GPS location, when taking the UTM field reading using positional dilution of precision (PDOP). It is typical for commercial GPS units to be accurate with a PDOP value of 1 to 5.The lower the error number, the more accurate the GPS reading.

*Note: if your GPS device does not report accuracy in PDOP, cross this out and record the accuracy value and unit instead.*

**Decimal degrees:** *Use this only if your GPS unit will not record UTM coordinates.* Latitude–Longitude reading in decimal degrees. Record the information from your GPS unit.

**Species list and coverage**

List up to eight species that are dominant or that are characteristically consistent throughout the stand. These species may or may not be abundant, but they should be constant representatives in the survey. When different layers of vegetation occur in the stand, make sure to list species from each stratum. As a general guide, make sure to list at least 1-2 of the most abundant species per stratum.

**Strata:**

**T = Overstory tree.** A woody perennial plant that has a single trunk.

**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.

**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.

**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.

**N = Non-vascular** Includes mosses, liverworts, hornworts, and algae.

**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.

**C:** If a species collection is made, it should be indicated 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, add a "T" to the "C" in that column (CT = thrown out after confirmation) or cross out the "C". If the specimen is kept but is still not confidently identified, add a "U" to the "C" (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" (CC = collected and confirmed). If the specimen is later deposited in an herbarium, add a "D" to the existing "C" (CD = collected and deposited) and note the receiving herbarium.

**Notes**: Describe the stand age or seral stage, disturbance history, nature and extent of land use, and other site environmental and vegetation factors. Include recommendations for line-work revision, discernibility of the vegetation based on season and topography, problems with classification interpretation, homogeneity of vegetation, and unusual sightings of plants or animals.

**Map Unit Name:** Enter the vegetation type name here**.** Refer to the Suisun Marsh Vegetation Key to select the type. If the vegetation in this polygon does not exactly match the descriptions in the key, enter the best-fitting vegetation type here and the second-best type in the next field.

**Secondary Map Unit Name** (Optional): Assign a second-best-fitting name for the vegetation within the polygon. Assign a secondary code **only** if there is some ambiguity in assigning the polygon to a primary vegetation. Note the reason for assigning a secondary call within the "*Confidence in map unit ID"* field below.

**Confidence in map unit ID? L M H Explain:** Note the level of confidence you feel in the map unit identification by circling low, moderate, or high. This is an area to describe how well the stand characteristics match the Vegetation Key. Are all diagnostic species present in proper proportions? If not, how do they differ? If a secondary type is identified, what made the stand type ambiguous? ***Note that if you choose low or moderate confidence, you should have a secondary call, as an alternative way to classify the vegetation.***

**Linework problems:** Check the box if the polygon boundary line does not surround a distinct vegetation type. Examples for which you would check the box include situations where there is more than one type of mappable vegetation within the polygon, when a portion of the boundary includes part of an adjacent stand, or when the stand continues beyond the polygon boundary. If checked, provide comments in the Notes section to explain.

**More than 1 vegetation type in this polygon:** Check if there is more than one vegetation type within the polygon. If the polygon includes more than one type, take a separate GPS point and fill out an AA form for each ***mappable*** vegetation type. If these other types are smaller than the MMU, and therefore would not be expected to be mapped, just note the additional vegetation types in the Notes section.

**Vegetation change since imagery taken:** Check the box if the vegetation in the polygon has changed since the aerial imagery used as the base of the vegetation map was taken. If yes, provide a description in the Notes section of how the vegetation has changed (for example: burned, developed, visible dominance change over time).

**Camera Name/Photo #s:** Write the name camera, JPG numbers, and direction of photos. *Take four photos in the main cardinal directions (N, E, S, W) clockwise from the north, from the GPS location.* This symbol can be used to indicate the cardinal photos: 

. Make sure to take additional photos of the general composition of the stand if the cardinal photos do not do an adequate job; note the JPG numbers and a description of each photo.

**Veg Height:** Circle the height range of the modal vegetation height.

**Total Veg Cover:** Circle the range of the total aerial cover of all vascular vegetation. This is an estimate of the absolute vegetation cover, disregarding overlap of the various tree, shrub, and/or herbaceous layers and species.

**Estimated area of identifiable vegetation viewed:**

Enter the **radius in meters** of the area around your GPS point that you were able to assess** within the polygon.

OR

Enter a rough estimate of the **percent of the polygon** that you were able to assess** from your point AND any additional area that you were able to view while driving or walking around or through the polygon.

**** For polygons that appear to be dominated by tall herbaceous vegetation, assess means actually walking through the polygon, or getting close enough to see the short herbs growing amongst the taller ones. In Suisun, it is possible to believe an entire field is the taller vegetation type when in fact most of the field would key to a shorter vegetation type.**

# Appendix E

# 2015 Vegetation Mapping Attributes and Descriptions

All attributes were interpreted using the Suisun Marsh 2015 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).

The attributes for this map include three potentially different names for vegetation type. **Original_2015** is the name assigned to a polygon during the initial 2015 mapping effort. Following analysis of the original map, the Suisun vegetation hierarchy was revised and some vegetation types were consolidated into more inclusive types. **MapClass** contains names from this revised hierarchy. The MapClass was then crosswalked to a vegetation type that conforms to the structure and standards of the National Vegetation Classification System (NVCS). This name is reflected in the **NVCSName** and **NVCSLevel**.

**NVCSName**: The NVCS-compliant vegetation type (see description above). Since the NVCS does not include categories for human land use or otherwise unvegetated land, those descriptions were drawn from the California Wildlife Habitat Relationship.

**NVCSLevel**: The hierarchy level of the NVCS. Starting at the lowest, finest level, these are: association, alliance, group, macrogroup, division, formation, formation subclass, and class.

**MapClass**: The finest level of vegetation type mapped (alliance, association, group, macrogroup or mapping unit); or land use for polygons that are not natural vegetation. This field is the name used per the revised 2015 mapping classification.

**MapClassCode**: Numeric code corresponding to the MapClass.

**Original_2015**: The name used per the original (2012) mapping classification, before revising the map classes based on the Accuracy Assessment (see text of report for discussion)

**Original_2015_Code**: The mapping code associated with the 2012 vegetation name.

**Cov_2015**: 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_2015**: 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_2015**: 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_2015**: Any additional useful information.

**ID_2015**: 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 restricted from natural tidal influence.
Slough (3): Generally applied to the wide, naturally occurring (at least not linear) waterways affected by tides.

**MgmtRegion**: Each polygon falls within one of the four numbered management Regions described in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan (USDI Bureau of Reclamation et al. 2013) and is attributed accordingly as 1, 2, 3 or 4.

**Lepidium**: This field identifies if *Lepidium latifolium* is present in the polygon.

**UID**: Unique identifier for each polygon.

**CalVegName**: A crosswalk to the CalVeg vegetation system. Note that there may be a one-to-many relationship between CalVeg and NVCS.

**CalVegCode**: The two letter code for the crosswalked CalVeg vegetation system. Note that there may be a one-to-many relationship between CalVeg and NVCS.

**CWHRType**: A crosswalk to the California Wildlife Habitat Relationships (CWHR) system. Note that there is usually a one-to-many relationship between CWHR and NVCS.

**CWHRCode**: The three letter code for the crosswalked CWHR habitat type. Note that there is usually a one-to-many relationship between CWHR and NVCS.

**GlobalRank**: The global rarity rank of the plant community (only for polygons mapped to the alliance level).

G1: Fewer than 6 viable occurrences and/or 2000 acres worldwide;
G2: 6-20 viable occurrences and/or 2000-10,000 acres worldwide;
G3: 21-100 viable occurrences and/or 10,000-50,000 acres worldwide;
G4: Greater than 100 viable occurrences and/or greater than 50,000 acres worldwide;
G5: Community demonstrably secure due to secure worldwide abundance.

**StateRank**: The state rarity rank of the plant community (only for polygons mapped to the alliance level).

S1: Fewer than 6 viable occurrences and/or 2000 acres statewide;
S2: 6-20 viable occurrences and/or 2000-10,000 acres statewide;
S3: 21-100 viable occurrences and/or 10,000-50,000 acres statewide;
S4: Greater than 100 viable occurrences and/or greater than 50,000 acres statewide;
S5: Community demonstrably secure due to secure statewide abundance.

**Rare**: Rarity of the vegetation type. Alliances and associations with state ranks of S1-S3 are considered rare.

**Y –** Rare
**N –** Not Rare

**CaCode**: California Natural Community Codes - unique code assigned to alliances and associations.

**NVCSAlliance**: The NVCS-compliant alliance (if applicable) which contains this vegetation type.

**NVCSGroup**: The NVCS-compliant group (if applicable) which contains this vegetation type.

**NVCSMG**: The NVCS-compliant macrogroup (if applicable) which contains this vegetation type.

# Appendix F

## Salt Marsh Harvest Mouse habitat by vegetation mapping type

Note: some mapping types at group level and higher could not be rated as potential habitat.

| Mapping Code | Mapping type | Potential Habitat |
|---|---|---|
| **1** | Bare Ground Mapping Unit | No |
| **2** | Agriculture | No |
| **4** | Road / Trails Mapping Unit | No |
| **6** | Slough Mapping Unit | No |
| **7** | Tidal Mudflat Mapping Unit | No |
| **8** | Railroad Track Mapping Unit | No |
| **9** | Ditch Mapping Unit | No |
| **11** | Open Water Mapping Unit | No |
| **15** | Developed Mapping Unit | No |
| **1000000** | **Warm Temperate Forest Formation** | No |
| **1100000** | **Madrean Forest and Woodland Division** | No |
| **1110000** | **California Forest and Woodland Macrogroup** | No |
| 1111000 | Californian Broadleaf Forest and Woodland Group | No |
| 1111100 | *Quercus agrifolia* Alliance | No |
| 1111101 | *Quercus agrifolia* Association | No |
| 1111102 | *Quercus agrifolia / Salix lasiolepis* Association | No |
| 1111200 | *Quercus lobata* Alliance | No |
| **2000000** | **Cool Temperate Forest Formation** | No |
| **2100000** | **North American Introduced Evergreen Broadleaf and Conifer Forest Division** | No |
| **2110000** | **Introduced North American Mediterranean Woodland and Forest Macrogroup** | No |
| 2110100 | *Eucalyptus (globulus, camaldulensis)* Semi-Natural Alliance | No |
| 2110101 | *Eucalyptus globulus* Semi-Natural Association | No |
| 2110200 | *Ailanthus altissima* Semi-Natural Alliance | No |
| **2120000** | **Southwestern North American Riparian, Flooded and Swamp Forest Macrogroup** | No |
| 2121000 | Southwestern North American Riparian Evergreen and Deciduous Woodland Group | No |
| 2121100 | *Salix laevigata* Alliance | No |
| 2121101 | *Salix laevigata / Salix lasiolepis* Association | No |
| 2122000 | Southwestern North American Riparian/Wash Scrub Group | Not rated |
| 2122100 | *Salix exigua* Alliance | No |
| 2122101 | *Salix exigua* Association | No |
| 2122200 | *Rosa californica* Alliance | Yes |
| 2122210 | *Rosa californica* Association | Yes |

| Mapping Code | Mapping type | Potential Habitat |
|---|---|---|
| 2122212 | *Rosa californica – Baccharis pilularis* Association | Yes |
| 2122300 | *Baccharis salicifolia* Shrubland Alliance | Yes |
| 2123000 | Southwestern North American Introduced Riparian Scrub Group | No |
| 2123100 | *Arundo donax* Semi-Natural Alliance | No |
| 2123101 | *Arundo donax* Semi-Natural Association | No |
| 2123200 | *Tamarix* spp. Shrubland Semi-Natural Alliance | No |
| **3000000** | **Western North America Flooded and Swamp Forest Division** | No |
| **3100000** | **Western Cordilleran montane–boreal riparian scrub Macrogroup** | No |
| 3111000 | Vancouverian Riparian Deciduous Forest Group | No |
| 3111100 | *Fraxinus latifolia* Alliance | No |
| 3111101 | *Fraxinus latifolia* Planted Stands Mapping Unit | No |
| **4000000** | **Mediterranean Grassland and Forb Meadow Formation** | Not rated |
| **4100000** | **California Grassland and Meadow Division** | Not rated |
| **4110000** | **California Annual and Perennial Grassland Macrogroup** | Not rated |
| 4111000 | Mediterranean California Naturalized Annual and Perennial Grassland Group | Yes |
| 4111100 | *Brassica nigra* and Other Mustards Semi-Natural Alliance | No |
| 4111101 | *Brassica nigra* Semi-Natural Association | No |
| 4111102 | *Raphanus sativus* Semi-Natural Association | No |
| 4111200 | *Bromus (diandrus, hordeaceus) – Brachypodium distachyon* Semi-Natural Alliance | Yes |
| 4111300 | *Centaurea (solstitialis, melitensis)* Semi-Natural Alliance | No |
| 4111400 | *Conium maculatum – Foeniculum vulgare* Semi-Natural Alliance | No |
| 4111401 | *Conium maculatum* Semi-Natural Association | No |
| 4111402 | *Foeniculum vulgare* Semi-Natural Association | No |
| 4111500 | *Cortaderia (jubata, selloana)* Semi-Natural Herbaceous Alliance | No |
| 4111600 | *Festuca perennis* Semi-Natural Alliance | Yes |
| 4111601 | *Festuca perennis – Lepidium latifolium* Semi-Natural Association | Yes |
| 4111602 | *Festuca perennis – Lotus corniculatus* Semi-Natural Association | Yes |
| 4111603 | *Festuca perennis – Rumex* spp. Mapping Unit | Yes |
| 4111604 | *Hordeum marinum – Festuca perennis* Mapping Unit | Yes |
| 4111700 | *Elytrigia pontica* Mapping Unit | Yes |
| 4111800 | *Agrostis avenacea* Mapping Unit | Yes |
| 4111900 | *Vulpia* spp. *– Euthamia occidentalis* Mapping Unit | Yes |
| **5000000** | **Temperate Grassland, Meadow, and Shrubland Formation** | Not rated |
| **5100000** | **Vancouverian and Rocky Mountain Grassland and Shrubland Division** | Not rated |
| **5110000** | **Western North American Temperate Grassland and Meadow Macrogroup** | Not rated |
| 5111000 | Vancouverian and Rocky Mountain Naturalized Perennial Grassland Group | Not rated |
| 5111100 | *Phalaris aquatica* Herbaceous Semi-Natural Alliance | Yes |
| 5111101 | *Phalaris aquatica* Herbaceous Semi-Natural Association | Yes |
| **5120000** | **Vancouverian Lowland Grassland and Shrubland Macrogroup** | Not rated |
| 5121000 | Naturalized Non-Native Deciduous Scrub Group | Not rated |

| Mapping Code | Mapping type | Potential Habitat |
|---|---|---|
| 5121100 | *Rubus armeniacus* Shrubland Semi-Natural Alliance | Yes |
| **6000000** | **Temperate and Boreal Scrub and Herb Coastal Vegetation Formation** | Not rated |
| **6100000** | **Pacific Coast Scrub and Herb Littoral Vegetation Division** | Not rated |
| **6110000** | **Vancouverian Coastal Dune and Bluff Macrogroup** | Not rated |
| 6111000 | California Coastal Evergreen Bluff and Dune Scrub Group | Not rated |
| 6111100 | *Baccharis pilularis* Shrubland Alliance | Yes |
| 6111101 | *Baccharis pilularis* / Annual Grass-Herb Association | Yes |
| 6112000 | California–Vancouverian Semi-Natural Littoral Scrub and Herb Vegetation Group | No |
| 6112100 | *Carpobrotus edulis* or Other Ice Plants Herbaceous Semi-Natural Alliance | No |
| **7000000** | **Temperate and Boreal Freshwater Marsh Formation** | Not rated |
| **7100000** | **Western North American Freshwater Marsh Division** | Not rated |
| **7110000** | **Western North American Freshwater Marsh Macrogroup** | Not rated |
| 7111000 | Arid West Freshwater Emergent Marsh Group | Not rated |
| 7111100 | *Typha (angustifolia, domingensis, latifolia*) Herbaceous Alliance | No |
| 7111101 | *Typha (angustifolia, latifolia, domingensis)* Association | No |
| 7111102 | *Typha (angustifolia, latifolia, domingensis)* (dead stalks) Mapping Unit | No |
| 7111103 | *Typha (angustifolia, latifolia, domingensis) – Echinochloa crus-galli* Association | No |
| 7111104 | *Typha (angustifolia, latifolia, domingensis) – Distichlis spicata* Association | No |
| 7111105 | *Typha (angustifolia, latifolia, domingensis) – Phragmites australis* Association | Yes |
| 7111106 | *Typha (angustifolia, latifolia, domingensis) – Schoenoplectus americanus* Association | Yes |
| 7111200 | *Schoenoplectus (acutus, californicus)* Alliance | Yes |
| 7111201 | *Schoenoplectus californicus – Schoenoplectus acutus* Association | Yes |
| 7111202 | *Schoenoplectus (acutus, californicus)* Mapping Unit | Yes |
| 7111203 | *Schoenoplectus (acutus, californicus) / Rosa californica* Provisional Association | Yes |
| 7111300 | *Schoenoplectus (acutus, californicus) – Typha (angustifolia, latifolia, domingensis)* Mapping Unit | Yes |
| 7111400 | *Schoenoplectus (acutus, californicus)* – Wetland Herbs Mapping Unit | Yes |
| 7111401 | *Calystegia sepium – Euthamia occidentalis* Mapping Unit | No |
| 7111500 | *Phragmites australis* Herbaceous Alliance | Yes |
| 7111501 | *Phragmites australis* Association | Yes |
| 7111502 | *Phragmites australis – Schoenoplectus* spp. Association | Yes |
| 7111503 | *Phragmites australis – Xanthium strumarium* Mapping Unit | No |
| 7111600 | *Alisma triviale* Mapping Unit | No |
| 7112000 | Vancouverian Coastal/Tidal Marsh and Meadow Group | Not rated |
| 7112100 | *Potentilla anserina* Alliance | Yes |
| **7120000** | **Western North America Vernal Pool Macrogroup** | Not rated |
| 7121000 | Californian Mixed Annual/Perennial Freshwater Vernal Pool/Swale Bottomland Group | Not rated |

| Mapping Code | Mapping type | Potential Habitat |
|---|---|---|
| 7121100 | *Grindelia (camporum, stricta)* Provisional Herbaceous Alliance | Yes |
| **7130000** | **Western North America Wet Meadow and Low Shrub Carr Macrogroup** | Not rated |
| 7131000 | Californian Warm Temperate Marsh/Seep Group | Not rated |
| 7131100 | *Juncus arcticus (*var. *balticus, mexicanus)* Herbaceous Alliance | Yes |
| 7131101 | *Juncus arcticus* var. *balticus* Association | Yes |
| 7131102 | *Juncus arcticus* var. *balticus – Conium maculatum* Association | Yes |
| 7131103 | *Juncus arcticus* var. *balticus – Lepidium latifolium* Association | Yes |
| 7131104 | *Juncus arcticus* var. *balticus – Potentilla anserina* Association | Yes |
| 7131200 | *Leymus triticoides* Alliance | Yes |
| 7132000 | Naturalized Warm-Temperate Riparian And Wetland Group | Yes |
| 7132100 | *Lepidium latifolium* Herbaceous Semi-Natural Alliance | Yes |
| 7132200 | *Persicaria lapathifolia – Xanthium strumarium* Provisional Herbaceous Alliance | Yes |
| 7132201 | *Polygonum* spp. *– Xanthium strumarium – Echinochloa crus-galli* Mapping Unit | Yes |
| 7132300 | *Cynodon dactylon – Crypsis* spp. *– Paspalum* spp. Moist Semi-Natural Alliance | Yes |
| 7132301 | *Crypsis schoenoides* Mapping Unit | Yes |
| 7132302 | *Cynodon dactylon* Mapping Unit | No |
| 7132400 | *Polypogon monspeliensis* Mapping Unit | Yes |
| 7132500 | *Rumex* spp. Mapping Unit | Yes |
| 7132600 | *Salsola soda* Mapping Unit | No |
| **8000000** | **Temperate and Boreal Salt Marsh Formation** | Not rated |
| **8100000** | **Temperate and Boreal Pacific Coastal Salt Marsh Division** | Not rated |
| **8110000** | **North American Pacific Coastal Salt Marsh Macrogroup** | Not rated |
| 8111000 | Temperate Pacific Tidal Salt and Brackish Meadow Group | Not rated |
| 8111100 | *Bolboschoenus maritimus* Herbaceous Alliance | Yes |
| 8111101 | *Bolboschoenus maritimus* Association | Yes |
| 8111102 | *Bolboschoenus maritimus – Salicornia pacifica* Association | Yes |
| 8111103 | *Bolboschoenus maritimus – Sesuvium verrucosum* Association | Yes |
| 8111200 | *Distichlis spicata* Herbaceous Alliance | Yes |
| 8111201 | *Distichlis spicata* Association | Yes |
| 8111202 | *Distichlis spicata* – Annual Grasses Association | Yes |
| 8111203 | *Distichlis spicata – Juncus arcticus* var. *balticus (J. arcticus* var. *mexicanus*) Association | Yes |
| 8111204 | *Distichlis spicata – Lotus corniculatus* Mapping Unit | No |
| 8111205 | *Distichlis spicata – Salicornia pacifica* Association | Yes |
| 8111206 | *Distichlis spicata – Schoenoplectus americanus* Provisional Association | Yes |
| 8111207 | *Distichlis spicata – Cotula coronopifolia* Association | Yes |
| 8111208 | *Distichlis spicata – Bolboschoenus maritimus* Mapping Unit | Yes |
| 8111209 | *Distichlis spicata – Juncus balticus – Triglochin* spp. *– Glaux maritima* Mapping Unit | Yes |

| Mapping Code | Mapping type | Potential Habitat |
|---|---|---|
| 8111210 | *Lepidium latifolium – Distichlis spicata* Semi-Natural Association | Yes |
| 8111300 | *Salicornia pacifica (Salicornia depressa)* Herbaceous Alliance | Yes |
| 8111301 | *Salicornia pacifica* Tidal Association | Yes |
| 8111302 | *Salicornia pacifica* – Annual Grasses Association | Yes |
| 8111303 | *Salicornia pacifica – Atriplex prostrata* Association | Yes |
| 8111304 | *Salicornia pacifica – Crypsis schoenoides* Association | Yes |
| 8111305 | *Salicornia pacifica – Sesuvium verrucosum* Association | Yes |
| 8111306 | *Salicornia pacifica – Echinochloa crus-galli – Polygonum – Xanthium strumarium* Association | Yes |
| 8111307 | *Salicornia pacifica – Cotula coronopifolia* Association | Yes |
| 8111400 | *Spartina foliosa* Herbaceous Alliance | Yes |
| 8112000 | Western North American Disturbed Alkaline Marsh and Meadow Group | Not rated |
| 8112100 | *Atriplex prostrata – Cotula coronopifolia* Herbaceous Semi-Natural Alliance | Yes |
| 8112101 | *Cotula coronopifolia* Semi-Natural Association | Yes |
| 8112102 | *Atriplex prostrata* Semi-Natural Association | Yes |
| 8112103 | *Atriplex prostrata – Distichlis spicata* Semi-Natural Association | Yes |
| 8112104 | *Atriplex prostrata – Bolboschoenus maritimus* Semi-Natural Association | Yes |
| 8112105 | *Atriplex prostrata – Sesuvium verrucosum* Semi-Natural Association | Yes |
| 8112106 | *Atriplex prostrata* – Annual Grasses Semi-Natural Association | Yes |
| 8112200 | *Sesuvium verrucosum* Herbaceous Alliance | Yes |
| 8112201 | *Sesuvium verrucosum* Association | Yes |
| 8112202 | *Sesuvium verrucosum – Distichlis spicata* Association | Yes |
| 8112203 | *Sesuvium verrucosum – Festuca perennis* Association | Yes |
| 8112204 | *Sesuvium verrucosum – Cotula coronopifolia* Association | Yes |
| 8112300 | *Spergularia marina* Provisional Herbaceous Alliance | No |
| 8112301 | *Spergularia marina – Cotula coronopifolia* Mapping Unit | No |
| **8200000** | **Western North American Interior Alkali–Saline Wetland Division** | Not rated |
| **8210000** | **Warm Semi-Desert/Mediterranean Alkali–Saline Wetland Macrogroup** | Not rated |
| 8211000 | Southwestern North American Alkali Marsh/Seep Vegetation Group | Not rated |
| 8211100 | *Schoenoplectus americanus* Herbaceous Alliance | Yes |
| 8211101 | *Schoenoplectus americanus* Association | Yes |
| 8211102 | *Schoenoplectus americanus – Potentilla anserina* Association | Yes |
| 8211103 | *Schoenoplectus americanus* – S*choenoplectus californicus – Schoenoplectus acutus* Association | Yes |
| 8211104 | *Schoenoplectus americanus – Lepidium latifolium* Association | Yes |
| 8212000 | Southwestern North American Salt Basin and High Marsh Group | Not rated |
| 8212100 | *Atriplex lentiformis* Shrubland Alliance | Yes |
| 8212200 | *Frankenia salina* Herbaceous Alliance | Yes |
| 8212201 | *Frankenia salina* – Annual grasses Mapping Unit | Yes |
| 8212202 | *Frankenia salina – Distichlis spicata* Association | Yes |
| **9000000** | **Hydromorphic Vegetation (Aquatic Vegetation) Class** | No |

| Mapping Code | Mapping type | Potential Habitat |
|---|---|---|
| **9100000** | **Marine and Estuarine Saltwater Aquatic Vegetation Formation** | No |
| **9110000** | **Temperate Pacific Saltwater Aquatic Vegetation Division** | No |
| **9111000** | **Temperate Pacific Intertidal Shore Macrogroup** | No |
| 9111100 | Temperate Pacific Intertidal Flat Group | No |
| 9111200 | *Stuckenia (pectinata) – Potamogeton* spp. Alliance | No |
| 9111201 | *Stuckenia pectinata* Association | No |
| 9111300 | *Ruppia (cirrhosa, maritima)* Herbaceous Alliance | No |
| **9200000** | **North American Freshwater Aquatic Vegetation Division** | No |
| **9210000** | **Western North American Freshwater Aquatic Vegetation Macrogroup** | No |
| 9211000 | Naturalized Temperate Pacific Freshwater Vegetation Group | No |
| 9211100 | *Ludwigia (hexapetala, peploides)* Provisional Herbaceous Semi-Natural Alliance | No |
| **9310000** | **Herbaceous Agricultural Vegetation Subclass** | No |
| **9311000** | **Row & Close Grain Crop Formation** | No |
| **9312000** | **Fallow Field and Weed Vegetation Formation** | No |
| **9312100** | **Cropland Fallow Field Division** | No |
| **9312110** | **Fallow Field Macrogroup** | No |
| **9410000** | **Herbaceous & Woody Developed Vegetation Subclass** | No |
| **9411000** | **Other Developed Vegetation Formation** | No |
| **9411100** | **Other Developed Vegetation Division** | No |
| 9411111 | Temperate Tree Developed Vegetation Group | No |

# Appendix G

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, 2012, and 2015.

| Potential SMHM Habitat | Tidal | | | | | | | Leveed | | | | | | | Total | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Acres | | | Change in Acres | | Percent Change | | Acres | | | Change in Acres | | Percent Change | | Acres | | | Change in Acres | | Percent Change | |
| | 1999 | 2012 | 2015 | 1999-2015 | 2012-2015 | 1999-2015 | 2012-2015 | 1999 | 2012 | 2015 | 1999-2015 | 2012-2015 | 1999-2015 | 2012-2015 | 1999 | 2012 | 2015 | 1999-2015 | 2012-2015 | 1999-2015 | 2012-2015 |
| **Management Region 1** | 1529.3 | 2105.1 | 2329.6 | 800.3 | 224.5 | 52.3% | 10.7% | 11758.5 | 9731.6 | 8545.0 | -3213.5 | -1186.6 | -27.3% | -12.2% | 13287.8 | 11836.7 | 10874.6 | -2413.2 | -962.1 | -18.2% | -8.1% |
| **Management Region 2** | 1360.8 | 1876.2 | 2088.6 | 727.8 | 212.3 | 53.5% | 11.3% | 5558.4 | 5308.6 | 5321.9 | -236.5 | 13.4 | -4.3% | 0.3% | 6919.3 | 7184.8 | 7410.5 | 491.2 | 225.7 | 7.1% | 3.1% |
| **Management Region 3** | 448.9 | 605.3 | 597.3 | 148.5 | -8.0 | 33.1% | -1.3% | 3114.1 | 3064.4 | 2375.6 | -738.5 | -688.9 | -23.7% | -22.5% | 3562.9 | 3669.8 | 2972.9 | -590.0 | -696.9 | -16.6% | -19.0% |
| **Management Region 4** | 2316.5 | 3218.7 | 2643.9 | 327.3 | -574.8 | 14.1% | -17.9% | 21018.8 | 19525.1 | 19780.7 | -1238.2 | 255.5 | -5.9% | 1.3% | 23335.4 | 22743.8 | 22424.5 | -910.8 | -319.3 | -3.9% | -1.4% |
| **Marsh-wide** | 5655.5 | 7805.4 | 7659.4 | 2003.9 | -146.0 | 35.4% | -1.9% | 41449.8 | 37629.7 | 36023.1 | -5426.7 | -1606.6 | -13.1% | -4.3% | 47105.3 | 45435.1 | 43682.5 | -3422.8 | -1752.6 | -7.3% | -3.9% |

# Appendix H

## 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, 2012, and 2015.

| Species | Tidal | | | | | | | Leveed | | | | | | | Total | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Acres | | | Change in Acres | | Percent Change | | Acres | | | Change in Acres | | Percent Change | | Acres | | | Change in Acres | | Percent Change | |
| | 1999 | 2012 | 2015 | 1999-2015 | 2012-2015 | 1999-2015 | 2012-2015 | 1999 | 2012 | 2015 | 1999-2015 | 2012-2015 | 1999-2015 | 2012-2015 | 1999 | 2012 | 2015 | 1999-2015 | 2012-2015 | 1999-2015 | 2012-2015 |
| **Management Region 1** | | | | | | | | | | | | | | | | | | | | | |
| *Arundo donax* Association | 0 | 0.7 | 2.2 | 2.2 | 1.6 | N/A | 238.6% | 0.7 | 1.3 | 0 | -0.7 | -1.3 | -100.0% | -100.0% | 0.7 | 2.0 | 2.2 | 1.5 | 0.3 | 222.9% | 13.2% |
| *Carpobrotus edulis* Association | 0 | 0 | 1.9 | 1.9 | 1.9 | N/A | N/A | 0 | 1.7 | 0 | 0 | -1.7 | N/A | -100.0% | 0 | 1.7 | 1.9 | 1.9 | 0.3 | N/A | 16.1% |
| *Cortaderia selloana* Association | 0 | 0 | 0.3 | 0.3 | 0.3 | N/A | N/A | 7.6 | 3.5 | 3.6 | -4.0 | 0 | -52.7% | 1.4% | 7.6 | 3.5 | 3.9 | -3.7 | 0.4 | -48.6% | 10.2% |
| *Eucalyptus* spp. | 0 | 0 | 0.9 | 0.9 | 0.9 | N/A | N/A | 52.6 | 131.6 | 91.0 | 38.4 | -40.7 | 73.0% | -30.9% | 52.6 | 131.6 | 91.8 | 39.2 | -39.8 | 74.6% | -30.2% |
| *Lepidium latifolium** | 49.6 | 75.9 | 134.1 | 84.5 | 58.1 | 170.4% | 76.5% | 224.5 | 201.4 | 183.4 | -41.1 | -17.9 | -18.3% | -8.9% | 274.1 | 277.3 | 317.5 | 43.4 | 40.2 | 15.8% | 14.5% |
| Mediterranean Grasses Group** | 16.9 | 5.6 | 0.5 | -16.5 | -5.1 | -97.3% | -91.9% | 667.8 | 257.2 | 80.5 | -587.2 | -176.7 | -87.9% | -68.7% | 684.7 | 262.8 | 81.0 | -603.7 | -181.8 | -88.2% | -69.2% |
| *Phragmites australis* | 102.8 | 285.1 | 454.6 | 351.9 | 169.5 | 342.4% | 59.4% | 82.4 | 215.6 | 162.4 | 80.0 | -53.1 | 97.1% | -24.6% | 185.2 | 500.7 | 617.1 | 431.9 | 116.4 | 233.2% | 23.2% |
| *Salsola soda* Provisional Alliance | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 0 | 4.8 | 29.9 | 29.9 | 25.1 | N/A | 520.8% | 0 | 4.8 | 29.9 | 29.9 | 25.1 | N/A | 520.8% |
| **Management Region 2** | | | | | | | | | | | | | | | | | | | | | |
| *Arundo donax* Association | 0.2 | 0 | 0 | -0.2 | 0 | -100.0% | N/A | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 0.2 | 0 | 0 | -0.2 | 0 | -100% | N/A |
| *Carpobrotus edulis* Association | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 0 | 0 | 0.4 | 0.4 | 0.4 | N/A | N/A | 0 | 0 | 0.4 | 0.4 | 0.4 | N/A | N/A |
| *Cortaderia selloana* Association | 0.8 | 0 | 0 | -0.8 | 0 | -100.0% | N/A | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 0.8 | 0 | 0 | -0.8 | 0 | -100% | N/A |
| *Eucalyptus* spp. | 3.2 | 3.5 | 2.2 | -1.0 | -1.3 | -30.9% | -38.1% | 29.7 | 26.3 | 27.0 | -2.7 | 0.7 | -9.0% | 2.7% | 32.8 | 29.8 | 29.2 | -3.7 | -0.6 | -11.1% | -2.1% |
| *Lepidium latifolium** | 99.6 | 199.3 | 250.7 | 151.2 | 51.5 | 151.9% | 25.8% | 167.3 | 146.0 | 261.9 | 94.6 | 115.9 | 56.5% | 79.4% | 266.9 | 345.3 | 512.7 | 245.8 | 167.4 | 92.1% | 48.5% |
| Mediterranean Grasses Group** | 14.5 | 0.0 | 0.6 | -13.9 | 0.6 | -95.9% | N/A | 103.0 | 29.9 | 36.8 | -66.2 | 6.8 | -64.3% | 22.8% | 117.5 | 29.9 | 37.4 | -80.1 | 7.4 | -68.2% | 24.8% |
| *Phragmites australis* | 17.2 | 94.8 | 125.8 | 108.6 | 31.0 | 632.2% | 32.6% | 53.6 | 224.1 | 226.1 | 172.6 | 2.0 | 322.0% | 0.9% | 70.8 | 318.9 | 351.9 | 281.2 | 33.0 | 397.3% | 10.3% |
| *Salsola soda* Provisional Alliance | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 0 | 0 | 8.2 | 8.2 | 8.2 | N/A | N/A | 0 | 0 | 8.2 | 8.2 | 8.2 | N/A | N/A |

*Note: *Lepidium* is any vegetation type with *Lepidium* in the name, plus 2015 polygons that look like they have *Lepidium* in them, or were identified as *Lepidium* in the 2012 map.

** The Mediterranean Grasses Group in this table is a subset of the Mediterranean California Naturalized Annual and Perennial Grassland Group for species with a height of 1-2 meters. It represents *Conium maculatum*, *Foeniculum vulgare*, and *Brassica nigra*, called "tall weeds" in the report.

| Species | Tidal | | | | | | | Leveed | | | | | | | Total | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Acres | | | Change in Acres | | Percent Change | | Acres | | | Change in Acres | | Percent Change | | Acres | | | Change in Acres | | Percent Change | |
| | 1999 | 2012 | 2015 | 1999-2015 | 2012-2015 | 1999-2015 | 2012-2015 | 1999 | 2012 | 2015 | 1999-2015 | 2012-2015 | 1999-2015 | 2012-2015 | 1999 | 2012 | 2015 | 1999-2015 | 2012-2015 | 1999-2015 | 2012-2015 |
| **Management Region 3** | | | | | | | | | | | | | | | | | | | | | |
| *Arundo donax* Association | 0.6 | 0 | 0 | -0.6 | 0 | -100% | N/A | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 0.6 | 0 | 0 | -0.6 | 0.0 | -100% | N/A |
| *Carpobrotus edulis* Association | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 0 | 0 | 0 | 0 | 0 | N/A | N/A |
| *Cortaderia selloana* Association | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 0 | 0 | 0 | 0 | 0 | N/A | N/A |
| *Eucalyptus* spp. | 0 | 0.3 | 0.2 | 0.2 | -0.1 | N/A | -32.2% | 1.6 | 6.8 | 7.1 | 5.5 | 0.3 | 350.5% | 4.0% | 1.6 | 7.1 | 7.3 | 5.7 | 0.2 | 365.1% | 2.3% |
| *Lepidium latifolium** | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 4.1 | 2.2 | 2.6 | -1.5 | 0.3 | -36.7% | 15.4% | 4.1 | 2.2 | 2.6 | -1.5 | 0.3 | -36.7% | 15.4% |
| Mediterranean Grasses Group** | 1.6 | 0 | 0.7 | -0.9 | 0.7 | -54.7% | N/A | 17.7 | 25.6 | 35.5 | 17.8 | 9.9 | 100.8% | 38.6% | 19.3 | 25.6 | 36.2 | 17.0 | 10.6 | 88.0% | 41.4% |
| *Phragmites australis* | 1.2 | 21.4 | 31.6 | 30.4 | 10.2 | 2531.2% | 47.7% | 25.1 | 153.9 | 137.0 | 111.9 | -16.9 | 445.5% | -11.0% | 26.3 | 175.2 | 168.5 | 142.2 | -6.7 | 540.6% | -3.8% |
| *Salsola soda* Provisional Alliance | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 0 | 0 | 0 | 0 | 0 | N/A | N/A |
| **Management Region 4** | | | | | | | | | | | | | | | | | | | | | |
| *Arundo donax* Association | 1.1 | 0 | 0.1 | -1.0 | 0.1 | -91.4% | N/A | 2.1 | 3.7 | 3.7 | 1.6 | 0 | 73.3% | 0.8% | 3.3 | 3.7 | 3.8 | 0.5 | 0.1 | 16.7% | 3.5% |
| *Carpobrotus edulis* Association | 1.6 | 0.2 | 0.1 | -1.4 | -0.1 | -93.1% | -56.7% | 5.5 | 6.3 | 30.7 | 25.2 | 24.4 | 460.8% | 385.0% | 7.0 | 6.6 | 30.8 | 23.8 | 24.2 | 338.4% | 368.4% |
| *Cortaderia selloana* Association | 1.2 | 1.8 | 2.2 | 1.0 | 0.3 | 83.3% | 18.1% | 0.2 | 0.2 | 0.2 | 0.1 | 0 | 36.2% | 17.7% | 1.4 | 2.0 | 2.4 | 1.0 | 0.4 | 77.2% | 18.1% |
| *Eucalyptus* spp. | 9.5 | 3.4 | 4.5 | -5.1 | 1.0 | -53.2% | 30.0% | 111.6 | 159.9 | 156.0 | 44.4 | -3.9 | 39.8% | -2.4% | 121.1 | 163.4 | 160.5 | 39.4 | -2.9 | 32.5% | -1.7% |
| *Lepidium latifolium** | 26.4 | 5.5 | 107.6 | 81.2 | 102.1 | 307.6% | 1858.5% | 384.7 | 153.9 | 202.0 | -182.7 | 48.1 | -47.5% | 31.2% | 411.1 | 159.4 | 309.6 | -101.5 | 150.2 | -24.7% | 94.2% |
| Mediterranean Grasses Group** | 1.5 | 0.0 | 3.1 | 1.6 | 3.1 | 108.7% | N/A | 443.3 | 16.8 | 268.8 | -174.5 | 252.0 | -39.4% | 1499.7% | 444.8 | 16.8 | 271.9 | -172.9 | 255.1 | -38.9% | 1518.1% |
| *Phragmites australis* | 240.4 | 492.9 | 570.8 | 330.4 | 77.9 | 137.4% | 15.8% | 170.4 | 998.5 | 1238.6 | 1068.2 | 240.1 | 626.7% | 24.0% | 410.8 | 1491.4 | 1809.4 | 1398.6 | 318.0 | 340.4% | 21.3% |
| *Salsola soda* Provisional Alliance | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 0 | 0 | 28.9 | 28.9 | 28.9 | N/A | N/A | 0 | 0 | 28.9 | 28.9 | 28.9 | N/A | N/A |

*Note: *Lepidium* is any vegetation type with *Lepidium* in the name, plus 2015 polygons that look like they have *Lepidium* in them, or were identified as *Lepidium* in the 2012 map.

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| Species | Tidal | | | | | | | Leveed | | | | | | | Total | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Acres | | | Change in Acres | | Percent Change | | Acres | | | Change in Acres | | Percent Change | | Acres | | | Change in Acres | | Percent Change | |
| | 1999 | 2012 | 2015 | 1999-2015 | 2012-2015 | 1999-2015 | 2012-2015 | 1999 | 2012 | 2015 | 1999-2015 | 2012-2015 | 1999-2015 | 2012-2015 | 1999 | 2012 | 2015 | 1999-2015 | 2012-2015 | 1999-2015 | 2012-2015 |
| **Marsh-wide** | | | | | | | | | | | | | | | | | | | | | |
| *Arundo donax* Association | 1.9 | 0.7 | 2.3 | 0.4 | 1.7 | 23% | 253.3% | 2.8 | 5.0 | 3.7 | 0.9 | -1.3 | 31.1% | -25.6% | 4.7 | 5.7 | 6.1 | 1.3 | 0.4 | 27.9% | 6.9% |
| *Carpobrotus edulis* Association | 1.6 | 0.2 | 2.0 | 0.5 | 1.8 | 31% | 718.9% | 5.5 | 8.0 | 31.0 | 25.6 | 23.1 | 467.5% | 289.1% | 7.0 | 8.2 | 33.1 | 26.0 | 24.8 | 370.9% | 302.0% |
| *Cortaderia selloana* Association | 2.0 | 1.8 | 2.5 | 0.5 | 0.6 | 24% | 35.2% | 7.8 | 3.8 | 3.8 | -4.0 | 0.1 | -50.7% | 2.2% | 9.8 | 5.6 | 6.3 | -3.5 | 0.7 | -35.5% | 13.1% |
| *Eucalyptus* spp. | 12.7 | 7.3 | 7.7 | -4.9 | 0.4 | -39% | 6.1% | 195.4 | 324.6 | 281.1 | 85.7 | -43.5 | 43.8% | -13.4% | 208.1 | 331.9 | 288.8 | 80.7 | -43.1 | 38.8% | -13.0% |
| *Lepidium latifolium** | 175.5 | 280.7 | 492.4 | 316.9 | 211.7 | 181% | 75.4% | 780.6 | 503.5 | 649.9 | -130.7 | 146.4 | -16.7% | 29.1% | 956.2 | 784.2 | 1142.3 | 186.2 | 358.1 | 19.5% | 45.7% |
| Mediterranean Grasses Group** | 34.5 | 5.6 | 4.9 | -29.6 | -0.7 | -86% | -12.9% | 1231.8 | 329.6 | 421.6 | -810.2 | 92.0 | -65.8% | 27.9% | 1266.3 | 335.2 | 426.5 | -839.8 | 91.3 | -66.3% | 27.2% |
| *Phragmites australis* | 361.6 | 894.3 | 1182.8 | 821.2 | 288.5 | 227% | 32.3% | 331.6 | 1592.0 | 1764.2 | 1432.6 | 172.2 | 432.1% | 10.8% | 693.1 | 2486.3 | 2947.0 | 2253.9 | 460.7 | 325.2% | 18.5% |
| *Salsola soda* Provisional Alliance | 0 | 0 | 0 | 0 | 0 | N/A | N/A | 0 | 4.8 | 67.0 | 67.0 | 62.2 | N/A | 1292.3% | 0 | 4.8 | 67.0 | 67.0 | 62.2 | N/A | 1292.3% |

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# Appendix I

## Accuracy Assessment Contingency Table