# Accuracy assessment of Los Peñasquitos Lagoon vegetation map

The Los PeñasquitosLagoon vegetation map is based on extensive field surveys from mid 2013 to early 2015 and interpretation of aerial imagery and LIDAR elevation data. The accuracy assessment described here was performed in the autumn of 2016. A total of 58 plots from 19 categories were evaluated. The final map accuracy was 69% using a traditional error matrix, and 89% with a fuzzy logic scoring system.

## Methods

### GIS methods

We started by performing simple QA/QC tests on the existing map. We corrected topology errors and standardized the attribute table so that each hierarchical level of the Manual of California Vegetation (MCV) classification (Group, Alliance, and Association) was recorded in a separate field. Many polygons were below the suggested minimum mapping unit (MMU) of 0.1 hectares, so we manually merged adjacent polygons based on the extent of shared perimeter and mapping rules associated with each category. We retained salt panne, mudflat, and water polygons that were below the MMU due to the importance of these habitats. In addition, polygons that were enclosed by these habitat types (such as islands of *Salicornia pacifica* surrounded by water) were allowed as exceptions to the MMU rule, as were polygons on the perimeter of the mapped area. Polygons initially mapped as salt panne, mudflat, or water that were later changed to a different category based on examination in the field were also allowed as exceptions to the MMU rule.

We did an initial examination of the number of polygons from each alliance to determine how to allocate the sampling effort for the field-based accuracy assessment. The initial goal was to perform a field assessment of at least one polygon for each alliance with fewer than five total polygons, three field assessment polygons for alliances with five to 15 polygons, and five for alliances with greater than 15 polygons. We focused the accuracy assessment effort on marsh areas, and did not examine categories such as Upland, Developed, or Disturbed. Using targeted geographic regions of the mapping area, we selected polygons for field assessment randomly from the alliances of interest. Due to time limitations, both of the “mudflat” polygons and two of the “salt panne” polygons were assessed using geotagged photographs that were taken during other field work in October 2016. Although the map was produced at the association level, we allocated sampling polygons at the alliance level to reduce the complexity of sample selection.

After field work was complete, we merged adjacent polygons of the same association to improve map aesthetics. In a few cases, we left adjacent polygons of the same category because the relevé notes provided useful information about differences in polygons that would be lost if the polygon information was merged. We updated the final map with revised categories for all field-assessed polygons. We also updated polygons that were not explicitly part of the accuracy assessment effort, but were shown in the field to be incorrectly classified.

### Field methods

We conducted field work from October – November 2016 using an abbreviated form of the rapid assessment protocol developed by the California Native Plant Society (CNPS). In a full rapid assessment, extensive site information and cover estimates of up to 20 species are recorded. In the abbreviated form of this protocol, we estimated cover of up to six dominant species, although we often noted additional unusual or noteworthy species. We used polygon boundaries loaded onto the mobile phone app “Collector” (produced by ESRI) to determine our location in the field, and also carried printed maps to take additional notes in the field. Our field maps showed only the polygon boundaries and did not have any information on the original mapped alliances.

When possible, we took geo-tagged photographs from the center of the polygons and walked the extent to assess species cover. Three polygons were assessed using only Google Street view photos, an additional five polygons were assessed only from adjacent roads or trails, and one polygons was assessed after walking through less than 20% of the polygon due to access issues.

We followed the membership rules listed in the Vegetation Classification Manual for Western San Diego County as closely as possible to assign alliances to the accuracy assessment polygons based on cover estimates. Two alliances were listed only in the Manual of California Vegetation (*Juncus* (*oxymeris*, *xiphioides*) Provisional Alliance and *Carpobrotus edulis* or Other Ice Plants Herbaceous Semi-Natural Stands).

It was impossible to adequately document cover of the annual grass *Festuca perennis* (formerly *Lolium perenne*) because the accuracy assessment effort took place in the autumn, when only dead stems from the previous year’s growth were visible. In an effort to remain consistent with the previous mapping rules, we classified stands with greater than 15% absolute cover of dead *Festuca perennis* present from the previous growing season as provisional *Festuca perennis* associations of the mapped alliance. The goal is that this might approximate the 30% threshold for live *Festuca perennis* listed in the Vegetation Mapping for TMDL Compliance document. Polygons with previous relevé data indicating *Festuca perennis* cover of 30% or greater consistently across the polygon were also classified as *Festuca perennis* associations*.* Only two polygons had such high *Festuca perennis* cover and low native vegetation cover documented to be considered *“Festuca perennis* semi-natural stands”. The associations listed as part of this project (*Baccharis salicifolia*/*Festuca perennis* Provisional Association, *Frankenia salina*-*Festuca perennis* Provisional Association, *and Salicornia pacifica*-*Festuca perennis* Provisional Association) are not yet recognized in the Vegetation Classification Manual for Western San Diego County or the Manual of California Vegetation.

### Accuracy assessment scoring

Once the field polygons had been assigned final classifications, we performed the accuracy assessment in two ways. We produced a traditional error matrix to calculate the percent accuracy at the alliance level, group, and macrogroup level, and also used a “fuzzy logic” system to score the association level accuracy. In the “fuzzy logic” system, we used scores from 0 – 5 to give higher weight to field polygons that were a closer match to the mapped category. The scores were mostly based on a comparison of the hierarchy level, although we also examined the cover of the diagnostic species as assessed in the field. If it seemed reasonable that the discrepancy in classification was due to sampling season (such as the seasonally flooded Cressa truxillensis Alliance, which was previously classified as Water), we scored the comparison as being correct. The scoring system is shown in Table 1.

Table : Fuzzy logic scoring system adapted from California Native Plant Society

|  |  |
| --- | --- |
| score | Description |
| 0 | Completely wrong life form, minimal ecological similarity |
| 1 | Same life-form (e.g, shrub, tree, or herb-grass) |
| 2 | Matchat three levels up from lowest level classified, usually Macrogroup |
| 3 | Match at two levels up from lowest level classified, usually Group |
| 4 | Match at one level up from lowest level classified, usually Alliance, or diagnostic species cover within 20% of established threshold |
| 5 | Perfect match |

## Results

We examined a total of 58 polygons from 19 categories, representing 8% of the total polygons across the project area (Table 2). Although we originally intended to allocate field polygons using the thresholds specified earlier, the original mapped classification did not always match the field-assessed classification, resulting in a deviation from the original targeted number of samples. Due to time constraints, we were not able to complete all of the less abundant categories and instead focused our efforts on the more common categories. The full listing of mapping categories, including the hierarchy from macrogroup, group, alliance, and association, is provided in the Appendix.

The overall level of accuracy assessed using the traditional scoring system is 69% at the alliance level , 76% at the group level, and 81% at the macrogroup level (Tables 3-5). There was considerable confusion between *Salicornia pacifica* and *Frankenia salina* alliances. These two species occur in close proximity and visually similar in aerial imagery. Many of the field-assessed polygons had percent cover values of these species close to the threshold values for determining the classification. The process of estimating cover values is somewhat subjective, so some of the discrepancy in classification is likely to be due to inter-observer variation. One of the limitations of the traditional scoring system is that it treats all misclassifications as equal, even though some classifications are more ecologically similar than others. Some of this error due to misclassification is reduced when comparing the group and macrogroup levels, but since the very similar *Salicornia pacifica* and *Frankenia salina* alliances are organized within different macrogroups, this confusion is still treated as an error at the macrogroup level.

The “fuzzy logic” approach produced an accuracy of 89% at the association level (Table 6). Many of the *Salicornia pacifica* and *Frankenia salina* alliances discrepancies were given high scores in this approach, better representing the reality that these two alliances are quite similar in the field.

There were initially 61 accuracy assessment plots, but three were later removed from the analysis. Polygon number 8 was removed because the initial mapping effort had observed high cover of non-native annual plants, but it was not possible to adequately document those plants during the most recent field assessment conducted in the fall. Polygon 53 was removed because the initial merging procedure resulted in a more heterogenous polygon than should have been assessed in the field, and it was not possible to later separate the percent cover values. Polygon 58 was removed because we were unable to walk through the majority of the polygon due to dense growth of *Rubus* sp., and it was not possible to view the polygon from other vantage points.

Table : Count of accuracy assessment polygons and total mapped polygons for each alliance. Mapping categories shown with an asterisk (\*) are not formally recognized as alliances in the Manual of California Vegetation (either unvegetated categories or categories at the group rather than alliance level.)

|  |  |  |
| --- | --- | --- |
| Alliance | Accuracy assessment count | Total count |
| *Ambrosia chamissonis*-*Abronia maritima* Alliance | 1 | 2 |
| *Arthrocnemum subterminale* Alliance | 1 | 10 |
| *Arundo donax* Semi-Natural Stands | 2 | 6 |
| *Baccharis salicifolia* Alliance | 3 | 22 |
| Beach\* | 0 | 1 |
| *Bolboschoenus maritimus* Alliance | 0 | 3 |
| *Carpobrotus edulis* or Other Ice Plants Semi-Natural Stands | 1 | 2 |
| Channel\* | 0 | 5 |
| *Cressa truxillensis*… Alliance (seasonal water) | 1 | 4 |
| Developed\* | 0 | 20 |
| *Distichlis spicata* Alliance | 0 | 5 |
| Disturbed\* | 0 | 7 |
| *Festuca perennis* Semi-Natural Stands | 0 | 2 |
| *Frankenia salina* Alliance | 12 | 82 |
| *Isocoma menziesii* Alliance | 4 | 23 |
| *Juncus* (*oxymeris, xiphioides*) Provisional Alliance | 0 | 1 |
| *Juncus acutus* Provisional Alliance | 1 | 10 |
| Mediterranean ... Grassland Semi-Natural Stands\* | 1 | 1 |
| Mudflat\* | 2 | 52 |
| Naturalized ... Riparian and Semi-Natural Stands\* | 0 | 7 |
| *Platanus racemosa* Alliance | 1 | 1 |
| *Pluchea sericea* Alliance | 1 | 2 |
| *Salicornia pacifica* (*Salicornia depressa*) Alliance | 5 | 144 |
| *Salix gooddingii* Alliance | 4 | 6 |
| *Salix lasiolepis* Alliance | 3 | 35 |
| Salt panne\* | 6 | 69 |
| *Schoenoplectus acutus* Alliance | 0 | 1 |
| *Schoenoplectus americanus* Alliance | 1 | 6 |
| *Schoenoplectus californicus* Alliance | 0 | 4 |
| *Typha* (*angustifolia, domingensis, latifolia*) Alliance | 8 | 22 |
| Upland\* | 0 | 76 |
| Water\* | 0 | 71 |
|   |  |   |
| Total | 58 | 702 |

Table : Error matrix showing agreement between mapped and ground reference polygons at the alliance level. Mapping categories shown with an asterisk (\*) are not formally recognized as alliances in the Manual of California Vegetation (either unvegetated categories or categories at the group rather than alliance level.)



Overall accuracy: 69%

Table 4: Error matrix showing agreement between mapped and ground reference polygons at the group level.



Overall accuracy: 76%

Table 5: Error matrix showing agreement between mapped and ground reference polygons at the macrogroup level.



Overall accuracy: 81%

Table 6: Fuzzy logic scores for each accuracy assessment polygon. Numbers showed in grey were not considered as part of the final score due to issues encountered during the analysis.

|  |  |  |  |
| --- | --- | --- | --- |
| Accuracy assessment ID | Original association | Ground reference association | Score |
| 1 | Frankenia salina-Festuca perennis Provisional Association | Frankenia salina Alliance\* | 5 |
| 2 | Salicornia pacifica-Frankenia salina Association | Frankenia salina Alliance\* | 4 |
| 3 | Frankenia salina Alliance\* | Frankenia salina-Festuca perennis Provisional Association | 5 |
| 4 | Frankenia salina Alliance\* | Salicornia pacifica-Frankenia salina Association | 4 |
| 5 | Baccharis salicifolia Association | Baccharis salicifolia Association | 5 |
| 6 | Frankenia salina-Festuca perennis Provisional Association | Salicornia pacifica-Festuca perennis Provisional Association | 4 |
| 7 | Salicornia pacifica-Frankenia salina Association | Frankenia salina Alliance\* | 1 |
| 8 |  |  |  |
| 9 | Salt Panne\* | Salt panne\* | 5 |
| 10 | Salt Panne\* | Salt panne\* | 5 |
| 11 | Frankenia salina Alliance\* | Frankenia salina Alliance\* | 5 |
| 12 | Salicornia pacifica-Frankenia salina Association | Frankenia salina Alliance\* | 4 |
| 13 | Frankenia salina-Festuca perennis Provisional Association | Frankenia salina-Festuca perennis Provisional Association | 5 |
| 14 | Isocoma menziesii Provisional Association | Isocoma menziesii Provisional Association | 5 |
| 15 | Salicornia pacifica Association | Frankenia salina Alliance\* | 4 |
| 16 | Salix gooddingii Association | Salix gooddingii Association | 5 |
| 17 | Schoenoplectus americanus Association | Schoenoplectus americanus Association | 5 |
| 18 | Frankenia salina Alliance\* | Frankenia salina Alliance\* | 5 |
| 19 | Isocoma menziesii/Distichlis spicata Association | Isocoma menziesii/Distichlis spicata Association | 5 |
| 20 | Salix lasiolepsis Association | Salix lasiolepis Association | 5 |
| 21 | Salix lasiolepsis Association | Salix lasiolepis Association | 5 |
| 22 | Salt Panne\* | Salt panne\* | 5 |
| 23 | Typha (angustifolia, domingensis, latifolia) Alliance\* | Typha (angustifolia, domingensis, latifolia) Alliance\* | 5 |
| 24 | Salix lasiolepsis Association | Salix gooddingii Association | 4 |
| 25 | Water\* | Cressa truxillensis Provisional Association (seasonal water) | 5 |
| 26 | Typha (angustifolia, domingensis, latifolia) Alliance\* | Typha (angustifolia, domingensis, latifolia) Alliance\* | 5 |
|  |  | (continued on next page) |  |
| 27 | Baccharis salicifolia Association | Salix gooddingii Association | 4 |
| 28 | Isocoma menziesii Provisional Association | Isocoma menziesii Provisional Association | 5 |
| 29 | Isocoma menziesii/Distichlis spicata Association | Isocoma menziesii/Distichlis spicata Association | 5 |
| 30 | Schoenoplectus californicus Association | Typha (angustifolia, domingensis, latifolia) Alliance\* | 4 |
| 31 | Typha (angustifolia, domingensis, latifolia) Alliance\* | Typha (angustifolia, domingensis, latifolia) Alliance\* | 5 |
| 32 | Salt Panne\* | Salt panne\* | 5 |
| 33 | Schoenoplectus americanus Association | Typha (angustifolia, domingensis, latifolia) Alliance\* | 4 |
| 34 | Salicornia pacifica-Festuca perennis Provisional Association | Salicornia pacifica-Festuca perennis Provisional Association | 5 |
| 35 | Salt Panne\* | Salicornia pacifica Association | 4 |
| 36 | Arthrocnemum subterminale Association | Arthrocnemum subterminale-Salicornia pacifica Association | 5 |
| 37 | Frankenia salina-Festuca perennis Provisional Association | Frankenia salina Alliance\* | 5 |
| 38 | Baccharis salicifolia Association | Baccharis salicifolia/Festuca perennis Provisional Association | 5 |
| 39 | Baccharis salicifolia Association | Baccharis salicifolia/Festuca perennis Provisional Association | 5 |
| 40 | Salix lasiolepsis Association | Salix gooddingii Association | 2 |
| 41 | Carpobrotus edulis or Other Ice Plants Semi-Natural Stands\* | Carpobrotus edulis or Other Ice Plants Semi-Natural Stands\* | 5 |
| 42 | Arundo donax Semi-Natural Stands | Arundo donax Semi-Natural Stands\* | 5 |
| 43 | Arundo donax Semi-Natural Stands | Arundo donax Semi-Natural Stands\* | 5 |
| 44 | Typha (angustifolia, domingensis, latifolia) Alliance\* | Typha (angustifolia, domingensis, latifolia) Alliance\* | 5 |
| 45 | Mudflat\* | Mudflat\* | 5 |
| 46 | Mudflat\* | Mudflat\* | 5 |
| 47 | Salt Panne\* | Salt panne\* | 5 |
| 48 | Salt Panne\* | Salt panne\* | 5 |
| 49 | Eucalyptus (globulus, camaldulensis) Semi-Natural Alliance\* | Platanus racemosa-Populus fremontii… Association | 1 |
| 50 | Juncus acutus Provisional Association | Juncus acutus Provisional Association | 5 |
| 51 | Ambrosia chamissonis... Association | Ambrosia chamissonis-Abronia maritima… Association | 5 |
| 52 | Juncus acutus Provisional Association | Frankenia salina-Distichlis spicata Association | 3 |
| 53 |  |  |  |
| 54 | Frankenia salina-Distichlis spicata Association | Salicornia pacifica-Frankenia salina Association | 4 |
| 55 | Arthrocnemum subterminale- Salicornia pacifica Association | Frankenia salina-Distichlis spicata Association | 3 |
| 56 | Pluchea sericea Association | Pluchea sericea Association | 5 |
| 57 | Typha (angustifolia, domingensis, latifolia) Alliance\* | Typha (angustifolia, domingensis, latifolia) Alliance\* | 5 |
|  |  | (continued on next page) |  |
| 58 |  |  |  |
| 59 | Salix lasiolepsis Association | Salix lasiolepis Association | 5 |
| 60 | Distichlis spicata-Annual Grasses Association | Mediterranean … Grassland Semi-Natural Stands\* | 1 |
| 61 | Schoenoplectus californicus Association | Typha (angustifolia, domingensis, latifolia) Alliance\* | 4 |
|  |  |  |  |
|  |  | Overall accuracy: | 89% |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

## Appendix: Classification Hierarchy

# Macrogroup

##  Group

 Alliance

 Association

# California Coastal Scrub

## Central and south coastal California seral scrub

Isocoma menziesii Alliance

 Isocoma menziesii Provisional Association

 Isocoma menziesii/Distichlis spicata Association

# California Annual and Perennial Grassland

## Mediterranean California naturalized annual and perennial grassland

Festuca perennis Semi-Natural Stands

 Festuca perennis Semi-Natural Stand Type

# Madrean Warm Semi-Desert Wash Woodland/Scrub

## Sonoran-Coloradan semi-desert wash woodland/scrub

Pluchea sericea Alliance

 Pluchea sericea Association

# Southwestern North American Riparian, Flooded and Swamp Forest

## Southwestern North American introduced riparian scrub

Arundo donax Semi-Natural Stands

## Southwestern North American riparian evergreen and deciduous woodland

 Platanus racemosa Alliance

 Platanus racemosa-Populus fremontii/Salix lasiolepis Association

Salix gooddingii Alliance

 Salix gooddingii Association

## Southwestern North American riparian/wash scrub

Baccharis salicifolia Alliance

 Baccharis salicifolia Association

 Baccharis salicifolia/Festuca perennis Provisional Association

Salix lasiolepis Alliance

 Salix lasiolepis Association

# North American Pacific Coastal Salt Marsh

## Temperate Pacific tidal salt and brackish meadow

 Bolboschoenus maritimus Alliance

 Bolboschoenus maritimus Association

Distichlis spicata Alliance

 Distichlis spicata-Annual Grasses Association

Salicornia pacifica (Salicornia depressa) Alliance

 Salicornia pacifica Association

 Salicornia pacifica-Festuca perennis Provisional Association

 Salicornia pacifica-Frankenia salina Association

Salicornia pacifica-Jaumea carnosa Association

Salicornia pacifica-Jaumea carnosa-Frankenia salina

# Warm Semi-Desert/Mediterranean Alkali-Saline Wetland

## Southwestern North American salt basin and high marsh group

Arthrocnemum subterminale Alliance

 Arthrocnemum subterminale Association

Arthrocnemum subterminale-Salicornia pacifica Association

Frankenia salina Alliance

 Frankenia salina-Distichlis spicata Association

 Frankenia salina-Festuca perennis Provisional Association

Juncus acutus Provisional Alliance\*

 Juncus acutus Provisional Association

Juncus acutus-Jaumea carnosa Provisional Association

## Southwestern North American alkali marsh/seep vegetation

Schoenoplectus americanus Alliance

 Schoenoplectus americanus Association

# Western North America Vernal Pool

## Californian mixed annual/perennial freshwater vernal pool / swale bottomland

Cressa truxillensis-Distichlis spicata Alliance

Cressa truxillensis Provisional Association

# Western North American Freshwater Marsh

## Arid West freshwater emergent marsh

 Schoenoplectus acutus Alliance

 Schoenoplectus acutus Association

Schoenoplectus californicus Alliance

 Schoenoplectus californicus Association

Typha (angustifolia, domingensis, latifolia) Alliance

# Western North America Wet Meadow and Low Shrub Carr

## Naturalized warm-temperate riparian and wetland group

Naturalized Warm-Temperate Riparian and Wetland Semi-Natural Stands

## Californian warm temperate marsh/seep

 Juncus (oxymeris, xiphioides) Provisional Alliance

 Juncus xiphioides Provisional Association

# Vancouverian Coastal Dune and Bluff

## California-Vancouverian semi-natural littoral scrub and herb vegetation

Carpobrotus edulis or Other Ice Plants Herbaceous Semi-Natural Stands

## Vancouverian/Pacific dune mat

Ambrosia chamissonis-Abronia maritima Alliance

 Ambrosia chamissonis-Abronia maritima-Cakile maritima Association

# Other mapping units

 Beach

 Channel

 Developed

 Disturbed

 Mudflat

 Salt panne

 Upland

 Water