# Accuracy Assessment of the East Sacramento Valley Natural Vegetation Map

*Photo: T. Keeler-Wolf*

*Prepared by:*

**California Department of Fish and Wildlife Vegetation Classification and Mapping Program**

*Prepared for:*

**Strategic Growth Council**

and

**California Department of Water Resources Central Valley Flood Protection Program**

*Funded by:*

**California Wildlife Conservation Board and Department of Fish and Game**

**January 16, 2013**

## Introduction

In 2012, the Geographic Information Center (GIC) at California State University, Chico, completed the East Sacramento Valley Natural Vegetation (ESVNV) map covering portions of Butte, Yuba, Sutter, Placer and Sacramento Counties with funding from the Strategic Growth Council and Department of Water Resources. The map covers parts of these five counties within the Great Valley ecological region (Miles and Goudey 1997) not previously mapped as urban or agriculture by the Department of Water Resources (http://www.water.ca.gov/landwateruse/lusrvymain.cfm) or included in the Sacramento-San Joaquin Legal Delta or Northern Sierra Nevada Foothills vegetation maps (http://www.dfg.ca.gov/biogeodata/gis/veg.asp (Figure 1).[1] The map classification follows the National Vegetation Classification hierarchy (Faber-Langendoen et al. 2009) promoted by the Ecological Society of America's Vegetation Panel , the Federal Geographic Data Committee (Peet et al. 2008), and the State of California. Mapping standards, attributes, and the map classification are reported in *Eastern Sacramento Valley Natural Vegetation Mapping Standards* (GIC 2012).

To validate the vegetation map, an accuracy assessment effort with field verification was conducted by the California Department of Fish and Wildlife Vegetation Classification and Mapping Program (VegCAMP) staff. 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 2009) require 80% accuracy for vegetation maps.

## Methods

The mapping area was broken into four "modules" with sequential delivery dates to VegCAMP (Figure 2). AA samples (AAs) were allocated by VegCAMP for each map module as it was received from GIC. Sample allocation employed an analysis that balanced three goals: achieving target levels of samples for

[1] GIC completed the Mid-Scale Central Valley Riparian Vegetation Map for the Department of Water Resources in 2011, which covered DWR's Central Valley Flood Protection Plan area (http://tinyurl.com/CVRMP-MediumScale). The classification was to the coarser Group level in the hierarchy of the National Vegetation Classification System (NVCS)( Faber-Langendoen et al. 2009), although it was to the same spatial resolution as the ESVNV map. It covered the riparian corridors both within the ESVNV map area and in much of the rest of the Central Valley. See VegCAMP (2011) for the accuracy assessment of that map.


Figure 1. Eastern Sacramento Valley Natural Vegetation Mapping area in relation to previously mapped adjacent areas of the Legal Delta and Northern Sierra Nevada Foothills.

each module based on budgeted staff time for conducting the accuracy assessment, distributing the samples amongst the vegetated mapping classes, and facilitating access to vegetation polygons based on land ownership and access efficiency.

The first step in the analysis was creating a series of subsets of the submitted vegetation module. The first subset removed polygons that had been previously visited in the field either by crews conducting rapid assessments or reconnaissance surveys.[2] The second subset selected polygons that intersected the California Protected Areas Database (http://www.calands.org/) in order to isolate polygons in publicly accessible areas. The last subset selected polygons within protected areas that were close (<500 m) to roads. The next step was to summarize the number of polygons in the module by map unit and set target numbers by unit, which, for the second through fourth modules, were modified by what had already been sampled in previous units.

Finally, starting with the rarest types and progressing to the most common, potential polygons were selected and examined using imagery for accessibility. All polygons of rare types that weren't selected in the above subsetting process were reexamined to see if they could possibly be assessed from a distance survey if on private land, or if they were not unreasonably further than the cutoff of 500 m from a road on publicly accessible land. Once rarer polygons were selected, the more common ones were selected from the more restrictive subsets. Where possible, stands of different types were selected within reasonable proximity for walking between stands to make surveying more efficient. Polygons were selected in excess of the count targeted for each module and polygons were assigned a priority level, based on whether they were rare, core, or back-up polygons – with rare polygons having highest priority. Polygon priority levels were incorporated into field maps to help staff prioritize the time they would spend accessing particular polygons. To prevent bias, paper and digital maps prepared for AA field crews did not include the vegetation type or other attributes as assigned by GIC. 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.

[2] Rapid Assessments (RAs) are a standardized method of collecting vegetation data used to create a classification (see http://www.cnps.org/cnps/vegetation/protocol.php). Approximately 800 RAs were collected in the ESVNV mapping area and in DWR's Central Valley Flood Protection Plan Area by GIC and VegCAMP staff in 2010 and 2011. Reconnaissance surveys are abbreviated rapid assessments used to help mappers identify the aerial signature of vegetation types; approximately 675 were collected in 2010 in the same area. Under subcontract to GIC, the California Native Plant Society analyzed the RAs collected by GIC, along with approximately 1800 additional vegetation surveys previously collected, to create a classification of the Great Valley Ecoregion (Buck-Diaz et al 2012), which is the basis of the ESVNV classification.

VegCAMP staff contacted the land owners and managers for permission to access the properties and collect data in the allocated polygons. AAs on private property were conducted from public roads.

From March to August 2012, VegCAMP collected 705 field AA s in the ESVNV mapping area using a paper AA form (Appendix A) and Trimble™ Juno handheld data collector/GPS receiver (Figure 2). Crews identified the vegetation type(s) within the allocated polygon using the field key to vegetation types provided in Appendix 3 of Buck-Diaz et al. (2012). A set of digital photographs was taken from the GPS waypoint within or adjacent to the polygon and archived in folders by waypoint identification number(s) associated with the polygon. As AAs were collected, they were entered into a Microsoft Access database, which is archived at the VegCAMP office, and data quality control was performed prior to analysis.

For each module, VegCAMP staff reviewed each AA and removed from consideration those samples that had issues with access, vegetation identification, visibility, or significant changes in land use or vegetation since the date of the imagery on which the map was based. If the field crews could not identify the vegetation type based on the field key, senior VegCAMP staff assigned the correct type based on the species covers recorded for the AA, any additional notes taken by the field crews, and sometimes the field photos. All field calls were reviewed and a "Final call" was recorded in the database when possible.

Scoring compared the vegetation label assigned to each polygon in the map (i.e., the photo-interpreted map unit attribute) with the label assigned by the field crews and reviewed by senior staff. Other attributes (cover, disturbance, height) were not scored but results were provided to GIC so the photointerpreters could learn from and correct any systematic errors.

A fuzzy logic method was used to score each AA, rather than simply denoting if 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 (Table 1), with a total of 5 possible points for each polygon. Scores were summed for each vegetation type, then divided by the total possible score and multiplied by 100 for a percent accuracy. The scores and

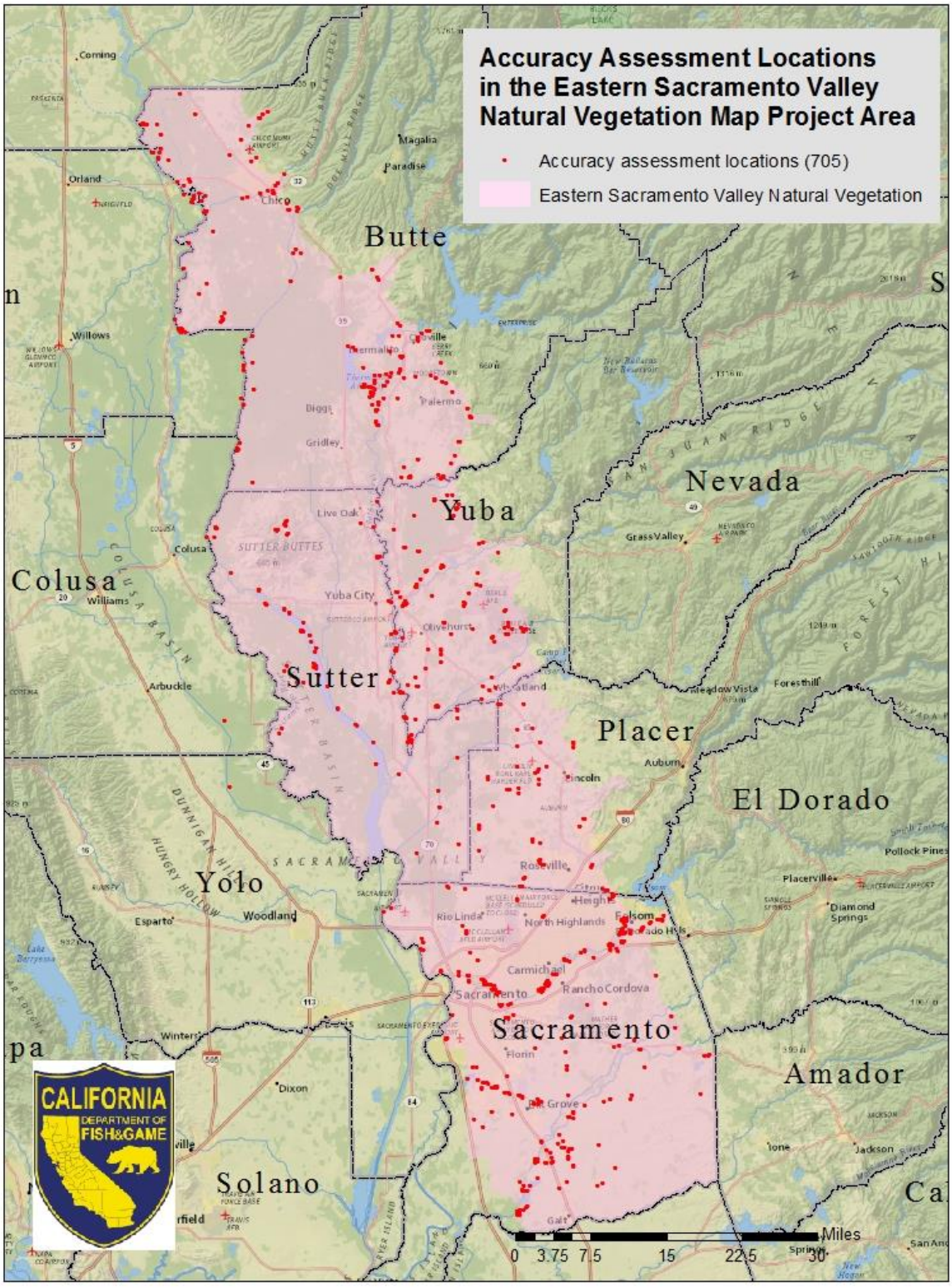


Figure 2. Location of Accuracy Assessment surveys within the ESVNV mapping area.

reviewers' notes were provided back to GIC after each module was completed so systematic errors could be corrected. This modular approach increased the final accuracy of the map product beyond the scores reported here.

Table 1. Fuzzy logic scoring rules

| Reason for Score | Score |
|---|---|
| Photointerpreter (PI) completely correct | 5 |
| Correct Group OR next level up in hierarchy | 4 |
| Threshold/transition between PI call and Final call | 4 |
| Correct Macro Group OR next level up in hierarchy | 3 |
| Based on close ecological similarity | 3 |
| Correct Division | 2 |
| Some floristic/hydrologic similarity | 2 |
| Correct only at Life Form | 1 |
| No similarity above Formation and incorrect Life Form | 0 |
| Survey removed because of a significant change in polygon | no score |
| Survey removed because an inadequate portion of the polygon was viewed | no score |
| Survey removed because field/PI data is incomplete, inadequate or confusing | no score |
| Survey removed; supplementary point (e.g., second point in polygon) | no score |

## Results

A total of 705 AAs were collected within the mapped area. Of these, 87 were removed during analysis for one of the reasons given in Table 1. The final 618 AAs addressed 44 of the 56 mapped vegetation types in the ESVNV area (Table 2). Non-vegetation types (agriculture, urban, bare gravel/sand, and open water) were not assessed.

Table 2. Number of pre-Accuracy Assessment polygons of each class as mapped and number of Accuracy Assessments in each mapped class.

| Map Class | #Polygons | #AAs |
|---|---|---|
| Acer negundo Alliance | 210 | 20 |
| Aesculus californica | 34 | 3 |
| Ailanthus altissima Provisional Semi-natural stands | 19 | 2 |
| Alnus rhombifolia Alliance | 29 | 3 |
| Arctostaphylos manzanita Alliance | 3 | 0 |
| Arctostaphylos viscida Alliance | 1 | 0 |
| Artemisia douglasiana Alliance | 21 | 5 |

| | | |
|---|---|---|
| Arundo donax Semi-natural Stands | 46 | 9 |
| Baccharis pilularis Alliance | 177 | 6 |
| California Annual Forbs and Grasses Group (CFG) | 595 | 28 |
| California Broadleaf Forest and Woodland Group (WVO) | 1 | 1 |
| California Introduced Annual and Perennial Herbaceous Group (CAI) | 3661 | 28 |
| Californian Mixed Annual/Perennial Freshwater Vernal Pool / Swale Group (VPB) | 204 | 14 |
| California Vernal Pool and Grassland Matrix Mapping Unit (VPG) | 462 | 35 |
| California Warm Temperate Marsh/Seep Group (WTM) | 251 | 15 |
| Ceanothus cuneatus Alliance | 5 | 0 |
| Cephalanthus occidentalis Alliance | 4 | 0 |
| Distichlis spicata Alliance | | 0 |
| Eichhornia crassipes Provisional Semi-Natural Stands | 11 | 1 |
| Eucalyptus (globulus, camaldulensis) Semi-natural stands | 106 | 18 |
| Fraxinus latifolia Alliance | 2 | 0 |
| Freshwater Emergent Marsh Group (FEM) | 20 | 3 |
| Heterotheca oregona Alliance | 51 | 7 |
| Introduced North American Mediterranean Forest Group (IMF) | 18 | 5 |
| Juglans hindsii Special and Semi-natural Stands | 196 | 18 |
| Juniperus californica Alliance | 1 | 0 |
| Leymus triticoides Alliance | 1 | 0 |
| Ludwigia (hexapetala, peploides) Semi-Natural Stands | 428 | 16 |
| Managed annual wetland vegetation Mapping Unit (i.e. duck clubs) | 97 | 12 |
| Myriophyllum spp. Alliance | 17 | 1 |
| Naturalized Temperate Pacific Freshwater Vegetation Group (NTF) | 5 | 1 |
| Naturalized Warm-Temperate Riparian/Wetland Group (NRW) | 801 | 11 |
| Ornamental Trees Mapping Unit | 55 | 13 |
| Persicaria lapathifolia-Xanthium strumarium Alliance | 17 | 2 |
| Pinus sabiniana Alliance | 78 | 13 |
| Platanus racemosa Alliance | 101 | 19 |
| Populus fremontii Alliance | 2424 | 35 |
| Quercus douglasii Alliance | 2043 | 33 |
| Quercus lobata Alliance | 2215 | 47 |
| Quercus wislizeni Alliance | 674 | 24 |
| Riparian Evergreen and Deciduous Woodland Group (RWF) | 4 | 0 |
| Riparian Introduced Scrub Group (RIS) | 3 | 0 |
| Robinia pseudoacacia Provisional Semi-natural stands | 10 | 2 |
| Rosa californica Alliance | 1 | 0 |
| Rubus armeniacus Semi-natural Stands | 479 | 23 |
| Salix exigua Alliance | 795 | 31 |
| Salix gooddingii Alliance | 1158 | 23 |
| Salix laevigata Alliance | 20 | 4 |

| | | |
|---|---|---|
| Salix lasiolepis Alliance | 392 | 19 |
| Salix lucida Alliance | 1 | 0 |
| Sambucus nigra Alliance | 34 | 6 |
| Schoenoplectus californicus-Schoenoplectus acutus Mapping Unit | 256 | 18 |
| Southwestern North American Riparian Wash/Scrub Group (RWS) | 9 | 2 |
| Tamarix spp. Semi-natural Stands | 1 | 0 |
| Temperate Freshwater Floating Mat Group (TFF) | 114 | 11 |
| Typha (angustifolia, domingensis, latifolia) Mapping Unit | 412 | 20 |
| Vitis californica Provisional Alliance | 113 | 11 |
| Subtotal | 18886 | 618 |
| Non-Vegetation Types | | |
| AGR - Agriculture | 528 | |
| BGS - Bare Gravel and Sand | 262 | |
| URB- Urban | 474 | |
| WAT - Open water | 1261 | |
| Subtotal | 2525 | |
| Total | 21411 | |

Note that the numbers in the second column of Table 2 refer to the "pre-AA" numbers of polygons that were mapped of each type. After AA, GIC made corrections, often refining to Alliance level what had been originally mapped as Group level.

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 represents 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 producers of mapped data how easily a mapping class may be recognized on the imagery (Story and Congalton 1986, Lea and Curtis 2010).

A contingency table displaying the users' and producers' accuracy for the map is found in Table 3. Note that the table does not include fuzzy scores, only the numbers of assessed polygons. In some cases, the Final Call was to Alliance level, when in fact the mapper was only expected to map to Group level, such as for herbaceous types. If the mapper chose the correct Group in such a case, a full score would be given, though the assessment would not show up on the diagonal indicating a correct call.

| Observed Classes ("Final Call") | Mapped Vegetation Classes: Acer negundo | Aesculus californica | Ailanthus altissima Provisional | Alnus rhombifolia | Artemisia douglasiana Provisional | Arundo donax | Baccharis pilularis | CAI | Cephalanthus occidentalis | CFG | Cynodon dactylon - Crypsis ssp. - Paspalum spp. | Eichhornia crassipes | Eucalyptus (globulus, camaldulensis) | FEM | Fraxinus latifolia | Heterotheca oregona | IMF | Juglans hindsii and Hybrids | Ludwigia (hexapetala, peploides) | Managed annual wetland vegetation | Myriophyllum spp. | NRW | NTF | Nuphar lutea | Ornamental trees | Persicaria lapathifolia–Xanthium strumarium | Pinus sabiniana | Platanus racemosa | Populus fremontii | Quercus douglasii | Quercus lobata | Quercus wislizeni | RIS | Robinia pseudoacacia | Rosa californica | Rubus armeniacus | RWF | RWS | Salix exigua | Salix gooddingii | Salix laevigata | Salix lasiolepis | Sambucus nigra | Schoenoplectus (acutus, californicus) | Sesbania punicea | TFF | Typha (angustifolia, domingensis, latifolia) | Vitis californica Provisional | VPB | VPG | WTM | WVO | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Acer negundo | 15 | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 22 |
| Aesculus californica | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| Ailanthus altissima Provisional | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Alnus rhombifolia | | | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 |
| Artemisia douglasiana Provisional | | | | | 1 | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 |
| Arundo donax | | | | | | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 5 |
| Baccharis pilularis | | | | | | | 5 | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | 8 |
| CAI | | | | | 2 | | | 27 | | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 2 | | | 37 |
| Cephalanthus occidentalis | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | 1 |
| CFG | | | | | | | | | | 15 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | 17 |
| Cynodon dactylon - Crypsis ssp. - Paspalum spp. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| Distichlis spicata | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| Eichhornia crassipes | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| Eucalyptus (globulus, camaldulensis) | | | | | | | | | | | | | 16 | | | | 1 | | | | | | | | | | | | 1 | | | | | | | | | | | 1 | | | | | | | | | | 19 |
| FEM | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Fraxinus latifolia | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | 2 |
| Heterotheca oregona | | | | | | | | | | | | | | | | 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 7 |
| IMF | | | | | | | | | | | | | | | | | 3 | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | 4 |
| Juglans hindsii and Hybrids | 1 | | | | | | | | | | | | | | | | | 9 | | | | | | | | | | | | 3 | | 1 | | | | | | | | | | | | | | | | | 14 |
| Ludwigia (hexapetala, peploides) | | | | | | | | | | | | | | | | | | | 16 | | 1 | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 19 |
| Managed annual wetland vegetation | | | | | | | | | | | | | | | | | | | | 12 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 13 |
| Myriophyllum spp | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| NRW | | | | | 1 | | | | | | | | | | | | | | | | | 6 | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | 8 |
| NTF | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| Nuphar lutea | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Ornamental trees | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | | 11 | | | | | | | | | | | | | | | | | | | | | 1 | | | 14 |
| Persicaria lapathifolia–Xanthium strumarium | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | 1 |
| Pinus sabiniana | | | | | | | | | | | | | | | | | | | | | | | | | | | 5 | | | | | 1 | | | | | | | | | | | | | | | | | 6 |
| Platanus racemosa | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | 8 | | | 1 | | | | | | | | | | | | | 1 | | | | 11 |
| Populus fremontii | 1 | | | | | | | | | | | | 1 | | | | | 2 | | | | | | | | | 1 | 8 | 22 | 1 | 2 | | | | | | | 1 | 8 | | 3 | | | | | | | 50 |
| Quercus douglasii | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | | | 16 | 3 | 3 | | | | | | | | | | | | | | | | 25 |
| Quercus lobata | 1 | | 1 | | | | | | | | | | | | | | | 2 | | | | | | 1 | | | | 1 | 3 | 13 | 33 | 5 | | | | | | 5 | 1 | | 3 | | | | | | 1 | 70 |
| Quercus wislizeni | | 1 | | | | | | | | | | | | | | | | | | | | | | 1 | | | 4 | 1 | 1 | 3 | 5 | 15 | | | | | | | | | 1 | | | | | | | 32 |
| RIS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | 1 |
| Robinia pseudoacacia | | | | | | | | | | | | | 1 | | | | | 2 | | | | | | | | | | | | | 2 | | | 2 | | | | | | | | | | | | | | | 7 |
| Rosa californica | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | 1 |
| Rubus armeniacus | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 20 | | | | | 1 | | | | | | | 22 |
| RWF | | | 1 | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | 1 | | | | | | | | 1 | | | | | | | | | | | 4 |
| RWS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | 1 |
| Salix exigua | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | 24 | | 1 | 4 | | | | | 1 | | 33 |
| Salix gooddingii | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | 1 | | 3 | 9 | 2 | 2 | | | | 1 | | | 19 |
| Salix laevigata | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Salix lasiolepis | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | 5 | | | | 1 | | | 7 |
| Sambucus nigra | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | 1 |
| Schoenoplectus (acutus, californicus) | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 9 | | | 5 | | | 15 |
| Sesbania punicea | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| TFF | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 11 | | | 11 |
| Typha (angustifolia, domingensis, latifolia) | | | | | | | | | | | | | 2 | | | | | | | | | 1 | | | | 1 | | | | | | | | | | | | | | | | | | | 6 | | 13 | | | 4 | 27 |
| Vitis californica Provisional | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | 8 | | | 9 |
| VPB | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 7 | 1 | 2 | 10 |
| VPG | | | | | | | | | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 32 | | 40 |
| WTM | | | | | 1 | | | 1 | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | 4 | | 10 |
| WVO | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 |
| Grand Total | 20 | 3 | 2 | 3 | 5 | 9 | 6 | 28 | 0 | 28 | 0 | 1 | 18 | 3 | 0 | 7 | 5 | 18 | 16 | 12 | 1 | 11 | 1 | 0 | 13 | 2 | 13 | 19 | 35 | 33 | 47 | 24 | 0 | 2 | 0 | 23 | 0 | 2 | 31 | 23 | 4 | 19 | 6 | 18 | 0 | 11 | 20 | 11 | 14 | 35 | 15 | 1 | 618 |

**Table 3.** Accuracy Assessment Contingency Table. Column headings are vegetation classes as mapped by the photointerpreters. Row headings are classes as observed in the field. Entries in the table are the number of AA polygons. The diagonal indicates completely correct AAs. Users' (or commission) errors can be seen by reading down the table, showing how many polygons in each map class were incorrectly labeled. For example, two polys mapped as Arundo donax are actually Acer negundo and two are actually Salix exigua. Producers' (omission) errors are read across the table, and show how many stands of a vegetation class were not mapped (missed), for example, the sampled stand of Ailanthus altissima was missed because it was incorrectly mapped as Acer negundo. Note that the map was scored using fuzzy logic rules, rather than simply right/wrong (see text).

Despite every attempt to sample adequate numbers of all mapped types, 30 map units had a sample size of n<5, resulting in approximately 57% of all map types with reportable results. For the assessed map units, the overall users' accuracy averaged 88.8% and producers' accuracy averaged 90.2% (Table 4). **Since the preferred accuracy for fine-scale vegetation mapping products is 80%, the map exceeded the standard overall.**

Table 4. Users' and producers' average fuzzy accuracy scores per type for classes with more than five Accuracy Assessments.

| Mapping Class | Users' Count | Users' Accuracy | Producers' Count | Producers' Accuracy |
|---|---|---|---|---|
| Acer negundo Alliance | 20 | 92.0 | 22 | 92.0 |
| Arundo donax Alliance | 9 | 80.0 | 5 | 100.0 |
| Baccharis pilularis Alliance | 6 | 90.0 | 8 | 77.5 |
| California Annual Forbs and Grasses Group (CFG) | 28 | 90.0 | 17 | 92.9 |
| California Introduced Annual and Perennial Herbaceous Group (CAI) | 28 | 99.3 | 37 | 90.3 |
| California Vernal Pool and Grassland Matrix Mapping Unit (VPG) | 14 | 80.0 | 10 | 92.0 |
| California Warm Temperate Marsh/Seep Group (WTM) | 15 | 64.0 | 10 | 80.0 |
| Californian Mixed Annual/Perennial Freshwater Vernal Pool / Swale Group (VPG) | 35 | 97.1 | 40 | 94.5 |
| Eucalyptus (globulus, camaldulensis) Semi-natural Stands | 18 | 94.4 | 19 | 91.6 |
| Heterotheca oregona Alliance | 7 | 100.0 | 7 | 100.0 |
| Juglans hindsii Special and Semi-natural Stands | 18 | 82.2 | 14 | 92.9 |
| Ludwigia (hexapetala, peploides) Semi-Natural Stands | 16 | 100.0 | 19 | 94.7 |
| Managed annual wetland vegetation Mapping Unit | 12 | 100.0 | 13 | 96.9 |
| Naturalized Warm-Temperate Riparian/Wetland Group (NRW) | 11 | 63.6 | 8 | 87.5 |
| Ornamental trees Mapping Unit | 13 | 89.2 | 14 | 88.6 |
| Pinus sabiniana Alliance | 13 | 75.4 | 6 | 93.3 |
| Platanus racemosa Alliance | 19 | 85.3 | 11 | 92.7 |
| Populus fremontii Alliance | 35 | 88.6 | 50 | 84.8 |
| Quercus douglasii Alliance | 33 | 84.8 | 25 | 88.0 |
| Quercus lobata Alliance | 47 | 91.1 | 70 | 85.6 |
| Quercus wislizeni Alliance | 24 | 91.7 | 32 | 81.8 |
| Robinia pseudoacacia Semi-natural Stands | 2 | 100.0 | 7 | 71.4 |
| Rubus armeniacus Semi-natural Stands | 23 | 90.4 | 22 | 95.5 |
| Salix exigua Alliance | 31 | 92.9 | 33 | 89.7 |
| Salix gooddingii Alliance | 23 | 86.1 | 19 | 81.0 |
| Salix lasiolepis Alliance | 19 | 71.6 | 7 | 88.6 |

| | | | | |
|---|---|---|---|---|
| Schoenoplectus californicus-Schoenoplectus acutus Mapping Unit | 18 | 95.6 | 15 | 98.7 |
| Temperate Freshwater Floating Mat Group (TFF) | 11 | 100.0 | 11 | 100.0 |
| Typha (angustifolia, domingensis, latifolia) Mapping Unit | 20 | 94.0 | 27 | 88.9 |
| Vitis californica Provisional Alliance | 11 | 94.5 | 9 | 95.6 |
| **Average Accuracy** | | **88.8** | | **90.2** |

Scoring was completed on a module-by-module basis, and GIC made corrections after the AA scoring for each module including both to type and to polygon delineations based on notes from the field. As stated previously, because corrections were made prior to map completion, and photointerpreters learned from the module-by-module feedback, the accuracy of the map is higher than reported here (although to what degree cannot be determined).

After the ESVNV map was completed by GIC, VegCAMP staff filled in gaps between the ESVNV map area and the Northern Sierra Nevada Foothills mapping area that were a remnant of changes in the GIC mapping area between the medium scale and fine scale phases of mapping. Approximately 133,900 acres were mapped by VegCAMP and were thus not assessed for accuracy; however, 98.8% of the area mapped by VegCAMP is agricultural or urban, which was not assessed for accuracy in the remainder of the map.

# References


Buck-Diaz, J., S. Batiuk and J. Evens. 2012. Vegetation alliances and associations of the Great Valley Ecoregion, California. California Native Plant Society.

Congalton, R. and K. Green. 1999. Assessing the accuracy of remotely sensed data: principles and practices. Lewis Publishers, New York.

Faber-Langendoen, D., D. Tart and R. Crawford. 2009. Contours of the revised U.S. National Vegetation Classification standard. *Bulletin of the Ecological Society of America* **90**:87-93.

Federal Geographic Data Committee (FGDC). 2008. National Vegetation Classification Standard, Version 2 FGDC-STD-005-2008 (version 2). Vegetation Subcommittee, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey. Reston, VA. 55 pp. + Appendices.

Foody, G. 2002. Status of land cover classification accuracy assessment. Remote Sens Environ 80:185–201.

Gopal, S. and C. Woodcock. 1994. Theory and methods for accuracy assessment of thematic maps using fuzzy sets. Photogramm Eng Remote Sens 60:181–188.

Geographical Information Center (GIC). 2012. Eastern Sacramento Valley Natural Vegetation Mapping Standards. Report to the Strategic Growth Council. GIC, California State University, Chico.

Hagen, A. 2003. Fuzzy set approach to assessing similarity of categorical maps. Int J Geogr Inf Sci 17(3):235–249.

Lea, C. and A. Curtis. 2010. Thematic accuracy assessment procedures: National Park Service Vegetation Inventory, version 2.0. Natural Resource Report NPS/2010/NRR—2010/204. National Park Service, Fort Collins, Colorado.

Metzler, J. and S. Sader . 2005. Agreement assessment of spatially explicit regression-derived forest cover and traditional forest industry stand type maps. Photogramm Eng Remote Sens 71(11):1303–1309.

Miles, S. and C. Goudey. 1997. Ecological subregions of California. Technical Report R5-EM-TP-005. USDA Forest Service, Pacific Southwest Research Station, San Francisco, CA.

Peet, R. 2008. A decade of effort by the ESA Vegetation Panel leads to a new federal standard. *Bulletin of the Ecological Society of America* **89**:210-211.

Story, M. and R. Congalton. 1986. Accuracy assessment: a users' perspective. Photogrammetric Engineering and Remote Sensing 52:397–399.

Vegetation Classification and Mapping Program (VegCAMP). 2011. Accuracy Assessment of Mid-Scale Central Valley Riparian Vegetation Map. Prepared for California Department of Water Resources. California Department of Fish and Game Vegetation Classification and Mapping Program. Sacramento, CA.

# Appendix A: Accuracy Assessment Form, CVRP/SGC Fine Scale (11/13/2012)

| **Surveyors** (circle recorder)**:** | **Date:** |
|---|---|

| **Waypoint ID:** | **GPSname: Projected? Yes / No / Base / Digitized** If projected or digitized, enter base Waypoint ID:<br>**Bearing: _____(degrees) Distance: _____ (meters)** |
|---|---|
| **Polygon UID:** | Base UTMs / projected UTMs (circle one)<br>UTME _ _ _ _ _ _ _ _ _ _ UTMN _ _ _ _ _ _ _ _ _ _ PDOP: +/- |

| **Strata** | **Species** | **% cover** | | **Strata** | **Species** | **% cover** | |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

| | |
|---|---|
| Notes: (including recommendations for line-work revision, state of veg. "discernability" based on season and topography, classification interpretation, homogeneity and unusual sightings of plants or animals) | |
| Alliance | |
| Map Unit (group code and name) | |
| Camera/Photos | |
| Tree Height | 2-5m 5-10m 10-15m >15m NA |
| Tree Size (dbh) | <1"dbh 1-6"dbh 6-11"dbh 11-24"dbh >24"dbh multi-layered NA |
| Hardwood Cover: _____% | Conifer Cover: _____% Total Tree Cover: _____% Shrub Cover: _____% |
| Herb Cover | <2% 2-9% 10-39% 40-59% >60% NA |
| | Total Cover: _____% |
| Isolated Tree | Yes (tree cover <5%) NA |
| Clearing Disturbance | <5% 5-25% 25-50% >50% |
| Invasive Plants | <5% 5-25% 25-50% >50% |
| Restoration | No Yes |
| Estimated area of identifiable vegetation viewed | Radius (m) _____ or rough % of polygon viewed from point _____ |
| Linework ok ☐ | Only 1 vegetation type in this polygon ☐ Vegetation change since imagery taken ☐ |