# CEAP Wetlands Assessment in California's Central Valley: Progress Report

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NRCS Natural Resources Conservation Service

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# INTRODUCTION

The U. S. Department of Agriculture, (USDA) administers a variety of programs intended to assist farmers and ranchers in addressing natural resource concerns on private lands. Among these is the Wetland Reserve Program (WRP) administered by the USDA, Natural Resource Conservation Service (NRCS), created as part of the 1990 Farm Bill (Gray 2005). The WRP focuses on restoring degraded wetlands or those that have been converted to agricultural production. In California, NRCS has focused WRP on restoring freshwater wetlands that have seasonal or semi-permanent water regimes. During 2000 – 2006, USDA restored more than 15,000 ha of freshwater wetlands in two areas of California, the Central Valley (CCV) and Upper Klamath River Basin (UKB).

Although WRP in California is widely viewed as benefiting ecological functions, there has been little or no evaluation or quantification of the ecological services provided to society from this program. Federal accountability initiatives require that federal agencies demonstrate the effectiveness of their programs in meeting program objectives and goals. Furthermore, assessing the effectiveness of conservation programs is important because the results from these assessments can help guide future implementation of conservation programs. Results of this research will be used to develop spatially explicit integrated landscape models of ecosystem service benefits that may be expected from implementation of conservation practices or from expanding the program.

## *Objectives*

The objective of this research was to quantify ecosystem services provided by palustrine emergent wetlands restored or enhanced by USDA in the CCV (WRP easements). Ecosystem services are derived from wetland functions and were assessed along three gradients; 1) climatic, 2) management and 3) age of restoration. We measured the following ecological services in WRP wetlands along these gradients:

1. Native pollinator (bee) services,
2. Biodiversity (plants, amphibians and birds),
3. Soil erosion and sediment retention,
4. Floodwater storage,

5. Nitrogen and phosphorus retention, and
6. Carbon accumulation.

***Study Area***

The primary study area will be the Tulare, San Joaquin, and Sacramento Basins of the CCV (Figure 1). The Central Valley is an elongated sedimentary basin about 650 km long, 120 km wide, covering an area of 108,800 $km^2$ (Schoenherr 1992). It is often subdivided into the Sacramento River Valley in the north and San Joaquin and Tulare Valleys in the south. Topography is relatively flat throughout the valley, with elevation ranging from 120 m in the north and south to below sea level near San Francisco Bay (Schoenherr 1992). Boundaries of the valley are not precisely defined since valley grasslands grade into oak – grassland savannas of the foothills everywhere except the south where desert conditions exist. Climate of the valley is Mediterranean with warm, dry summers and mild, wet winters.

Air temperature varies little throughout the valley with average July highs being 37.1$^oC$ in both Bakersfield and Redding, while average December lows in Bakersfield (2.9$^oC$) and are only slightly warmer than in Redding (2.7$^oC$). Annual precipitation, however, exhibits a distinct gradient, ranging from 16 cm in Bakersfield, to 46 cm in Sacramento and 100 cm in Redding. Throughout the valley, more than 90% of annual precipitation falls as rain during November – May. Native vegetation in the Central Valley was predominantly grasslands dominated by bunchgrasses, with extensive riparian forests and freshwater marshes. Freshwater marshes, fed by winter precipitation and snowmelt runoff, formerly covered about 1,638,000 ha of the valley. The largest freshwater wetland area in California was associated with Tulare, Buena Vista and Kern Lakes. These lakes contained as much as 3,360 km of freshwater marsh habitats along their shorelines, although the amount would vary naturally.

Today, most of the wetlands (94%) in the CCV have been lost. Area of wetland habitats in the CCV prior to 1900 was estimated to be 1.6-2.0 million ha (Hartman and Goldstein 1994). Wetland area in the CCV had been reduced to 153,000 ha. Since the 1980's, however, restoration programs have increased wetland coverage in the CCV to over 200,000 ha (Dahl 2006), Central Valley Joint Venture 2006). Human activities leading to wetland loss in the CCV are varied, but agricultural development and urbanization are chief among them.

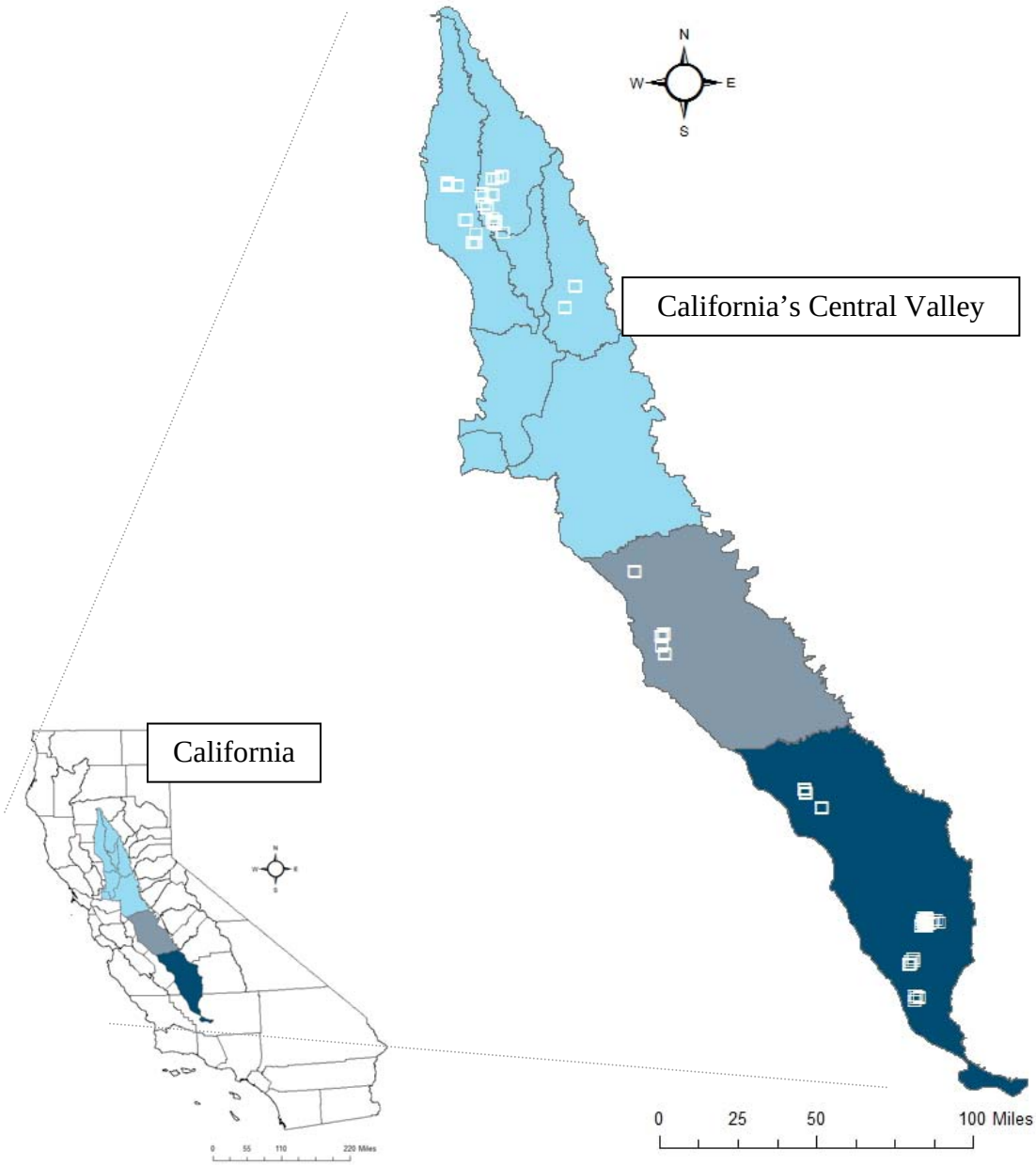


Figure 1. Location of sampling sites (white squares) on California's Central Valley. The CCV was divided into three major sub-basins shown from north to south; Sacramento (light blue); San Joaquin (gray) and Tulare (dark blue).

A secondary study area will include the Upper Klamath River Basin (UKRB) region of California and Oregon. The UKRB encompasses an area of 20,720 $km^2$ in northern California and southern Oregon. Paulustrine emergent wetlands once cover expansive areas in the UKRB, but most have been converted to agricultural lands. The UKRB is located within the southern Cascade physiographic region. Soils of the UKRB are of volcanic, alluvial and wetland or lake bed origin. Climate of the area grades from Mediterranean to undifferentiated upland. Summers are hot and winters short but cold.

## METHODS

### *Site selection*

In 2008 we conducted a baseline survey of 44 WRP easements in the Tulare, San Joaquin and Sacramento basins. Key elements included sampling across gradients of; (1) management intensities, (2) restoration age and (3) precipitation from the arid Tulare Basin to the more temperate Sacramento Basin (Figure 1). Data collection began in February 2008. Within the three sub-basins, wetlands were stratified by restoration age and management intensity (Table 1). Easements were categorized into two broad age classes, relatively young (less than 5 years since restoration) and relatively old (more than 5 years since restoration work). Criteria for classification by management intensity were largely based on water management (Table 2).

We also surveyed an additional nine WRP wetland easements in the UKRB during 2008. The nine easements in the UKRB were all riparian wetlands. Surveys of UKRB wetlands in 2008 were intended to gather information with which to characterize wetlands. While amphibian surveys were completed on UBRB wetlands in 2008, all other measures will be gathered in 2009.

Wetland Reserve Program easements in the CCV are typically divided into manageable units known as “cells”, separated by levees. Hydrologic connectivity is usually maintained between cells via canals, drainage ditches or swales (Figure 3). Edaphic, vegetation, and morphological variables were collected from representative cells of each WRP easement.

### *Climate*

Average annual precipitation and temperature information was obtained from the National Oceanic and Atmospheric Administration’s National Climatic Data Center (NOAA) and the USGS Geospatial gateway.

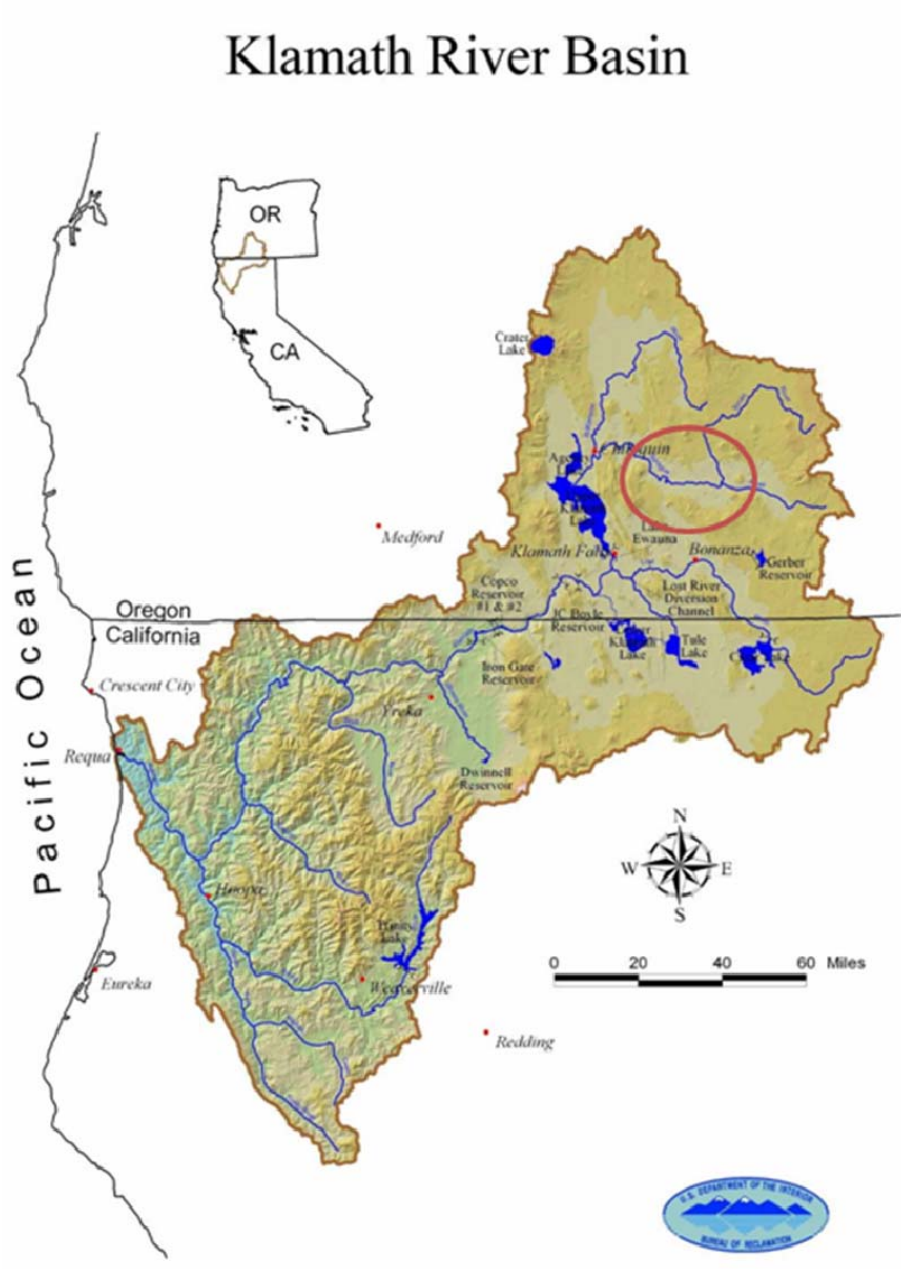


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Figure 2. Map of the Klamath River Basin, California and Oregon with CEAP wetland assessment area along the Sprague River highlighted.

Table 1. Allocation of sample sites by restoration age and management intensity among sub-basins within California's Central Valley (2008).

| | | ***SUB-BASINS*** | | |
|---|---|---|---|---|
| **Management Intensity** | **Restoration Age[1]** | **Sacramento** | **San Joaquin** | **Tulare** |
| Low[2] | < 5 yr | 3 | 1 | 3 |
| Low | > 5 yr | 3 | | 3 |
| Intermediate | < 5 yr | 3 | 2 | 3 |
| Intermediate | > 5 yr | 3 | 1 | 2 |
| High | < 5 yr | 3 | | 3 |
| High | > 5 yr | 3 | 1 | 1 |
| Reference[3] | -- | 3 | | 3 |
| **TOTALS** | | **21** | **5** | **18** |

[1] Refers to time since initial earthwork was carried out to February 2008. [2] Low management sites included unrestored sites, where no conservation practices were applied as of July 2008. [3] Reference sites included National Wildlife Refuges (Sacramento and Kern) and Wildlife Preserves (Cosumnes River, Audubon)

Table 2. Criteria for classification into the three management intensity categories.

| ***Management Intensity*** | ***Criteria*** |
|---|---|
| Low/ None | No active management following restoration or less than 50% of time since restoration. No recent flooding or drainage. |
| Intermediate | Flooded, drained annually or more than 50% of time since restoration. Intermittent weed control and emergent cover management. |
| High | Flooded, drained annually since restoration. Regular weed control, moist soil management, emergent cover. Mowed, disked, burned, grazed, chemical weed control . |

***Vegetation***

Estimates derived for each wetland basin included the percentage of area covered by open water and emergent vegetation, wetland cover type, and adjacent land use. Detailed vegetation information was gathered following procedures developed by USGS-Northern Prairie Wildlife Research Center (Kantrud and Newton 1996). Four equally spaced transects radiating out from the WRP cell center to the cell boundary were established. The width (m) of all wetland vegetation zones, as delineated by plant species composition, bisected by transects was estimated and average water depth (cm) recorded. Within each of these zones, a 1-$m^2$ quadrat was randomly sited along each transect. Vegetation cover (%) by taxon (Daubenmire 1959), litter depth (cm), and visual obstruction at plot center (Robel 1970) were estimated. Vegetation biomass estimates were collected by placing a 0.25-$m^2$ quadrat in the center of the 1-$m^2$ quadrat and clipping all above ground biomass (live and dead). Plant taxa outside of the quadrat that were not collected were recorded[1]. Biomass clippings were made within the shallow marsh zone, but if no shallow marsh was found, then clippings from the next wettest zone were collected. Biomass samples were stored in paper bags and returned to Humboldt State University for determination of dry mass. Following dry mass determination, samples were shipped to the Colorado State University Soil-Water-Plant Testing Laboratory for determination of total phosphorus (TP), total nitrogen (TN) total carbon (TC) and inorganic carbon (TIC) following standard methods (Klute 1986, Page et al. 1982).

***Soils***

Following vegetation surveys, soil samples were collected at depths of 0–15 cm ($n$ = 3) from each WRP cell. Soil cores were examined to determine presence of an O-horizon. If present, the depth of the O-horizon was measured, separated from the remaining portion of the core and the two segments bagged separately in plastic Ziploc packets. If no O-horizon could be determined visually, the top 1 cm of the core was bagged separately. Samples were stored at about 4$^{o}$C, until bulk density assessments were made at Humboldt State University. Completely dry samples were then sent to the Colorado State University Soil-Water-Plant Testing Laboratory for determination of TP, TN, TC and TIC using standard methods (Klute 1986, Page et al. 1982).

[1] Rare, endangered or threatened species when encountered were not collected for biomass estimates.

***Pollinators***

Native bees were sampled to assess WRP easements support of pollinators. A one hectare sampling plot was established within each WRP easement. Dry upland or moist bottomland meadows were selected as these are the most likely to support flowering plants used by bees. Efforts were made to maintain at least 2 km distance between sites, particularly where WRP easements were in close proximity.

Bee collection methods consisted of placing 15 pans (Solo brand PB6-0099 6 oz bowls) along two 50 m long transects, spaced at 5 m intervals. Five pans were painted fluorescent yellow, 5 fluorescent blue and 5 were left unpainted white. Pans were filled with a solution of 1 Tsp of Dawn brand blue soap per gallon of water, set in place before 9:00 am on the morning of data collection and left in place for at least 3 hr. Pan traps were collected in the afternoon, bees in pans were strained into a Whirlpak bag filled with 75% alcohol. Bees were then stored in a cooler until processing and identification at Humboldt State University. Bees were also netted (2 persons, 30 min each) along each transect. A sample of the host plant was also collected and placed in kill jars along with the netted bee. A GPS reading was taken at the approximate center of each plot. Percent cover of flowers in bloom was estimated using the Braun-Blanquet releve method (California Native Plant Society). A Kestrel ® weather station (model 3000) was used to record temperature, relative humidity and wind speed. Cloud cover was estimated following methods established by the USDA Pacific Southwest Research Station.

***Amphibians***

Amphibians were surveyed via three methods; visual encounter, eye shine and auditory recording. For visual encounters, surveyors wore polarized sunglasses to help reduce reflective glare and captured individuals for identification and/or voucher collection purposes using dipnets. Survey zones included the waterline and shallow water zone (< 1 m) and all potential microhabitats.

Eye shine surveys were conducted to complement visual encounter surveys and to account for the nocturnal activities of adult anuran species. Surveyors used Miti Max II Halogen® headlamps and carried dipnets and aquarium nets to locate and capture individuals for identification and/or voucher collection purposes[2]. Binoculars were used in conjunction with the

[2] Federal permit number: TE175386-0

lights to better locate and identify individuals. Surveyors walked slowly along the waterline around the perimeter of the wetland, stopping every 2-3 m to scan for the reflective eye-shine of amphibians. Potential hiding cover, such as ledges, debris, rocks and logs were explored.

Auditory surveys were conducted using a SM1 Song Meter installed along the northern perimeter of a representative wetland within the WRP. The instrument was programmed to record at 5 min intervals every hour between 2200 and 0500.

To prevent the spread of disease, all organic matter was removed from nets, traps, boots and other surfaces that came into contact with water or possible sources of contamination before leaving each WRP site. These items were scrubbed with a Quat-128™ solution (1:60) and rinsed with clean water at a location that is a minimum of 30 m away from aquatic features.

### *Birds*

Birds using wetlands were recorded at 79 sites located within 47 WRP easements during 2008. Each bird census was completed in the morning, before 100 hr. Designated observers walked the wetland perimeter and recorded all birds observed. Two methods were used i.e., point counts along transects and visual recordings. The former method was used where a tree line was present.

## PRELIMINARY RESULTS

### *Vegetation*

Vegetation samples were collected for nutrient analysis to estimate carbon sequestration (e.g., biomass) and nutrient sequestration. Samples were submitted to the Colorado State University Soil-Water-Plant Testing Laboratory for determination of total phosphorous, total nitrogen, total carbon, and total inorganic carbon in November 2008.

Five wetland zones were identified in CCV WRP easements starting from the wetland center; the open water zone, deep marsh zone, shallow marsh zone, wet meadow zone and wetland low prairie (upland) zone. Wetland zones were determined based on plant species composition, which reflects water permanence, underlying soils and groundwater. Visual obstruction in all three sub-basins was highest in the shallow marsh zone followed by the low-prairie zone (Figure 3). Younger sites tended to have larger upland zones than older sites, whereas older sites had larger wet-meadow and shallow marsh zones (Figure 4). All

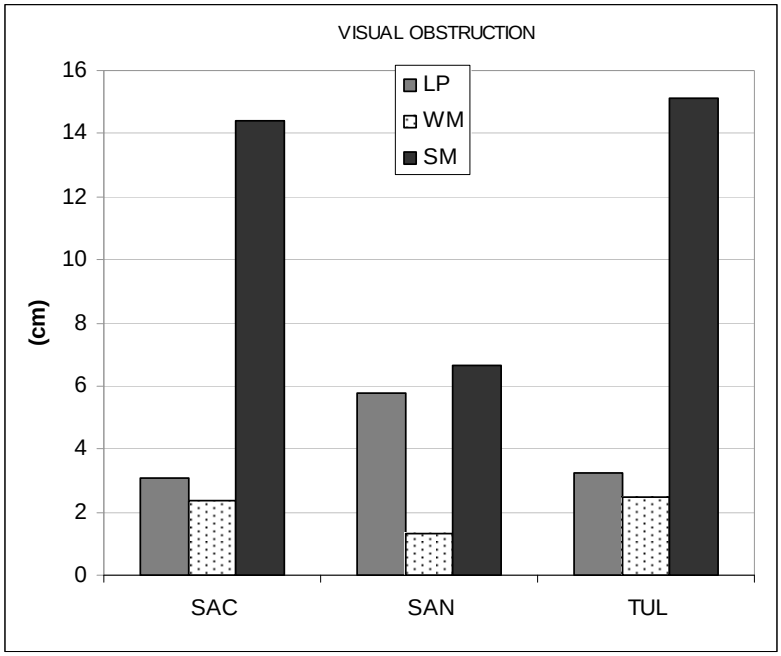


Figure 3. Visual obstruction measured at WRP easements classified by sub-basin; SAC = Sacramento, SAN = San Joaquin and TUL = Tulare. Visual obstruction was estimated within each wetland zone i.e., LP = Low Prairie, WM = Wet Meadow and SM = Shallow Marsh.

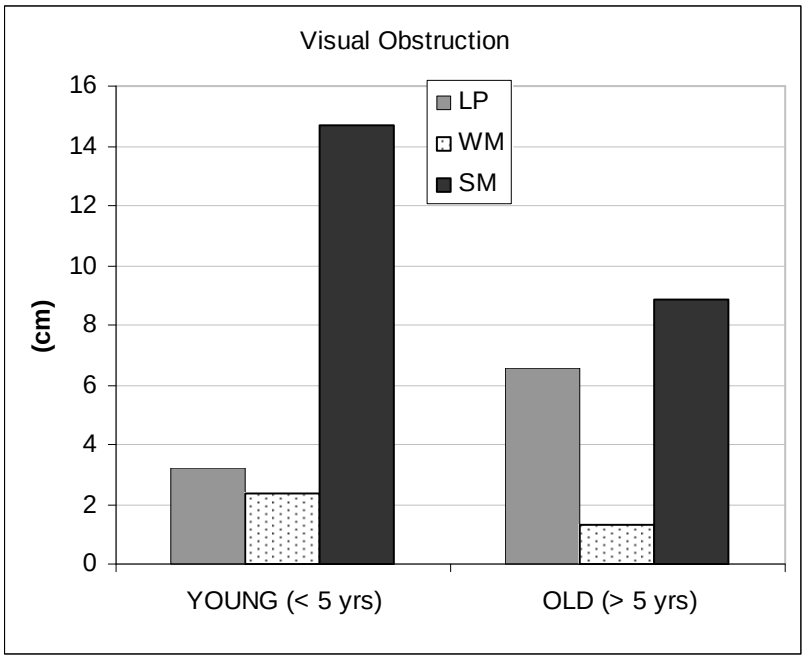


Figure 4. Visual obstruction measured at WRP easements by restoration age. Visual obstruction was estimated within each wetland zone i.e., LP = Low Prairie, WM = Wet Meadow and SM = Shallow Marsh.

management intensities appeared to have relatively larger shallow marsh (Figure 5). Visual obstruction was greatest in the shallow marsh zone in both younger and older sites. Width and visual obstruction of each zone was measured in the field. Wetland easements in the San Joaquin and Tulare sub-basins had higher proportions of upland than other zonal types, whereas those in the Sacramento sub-basin exhibited larger wet-meadow zones (Figure 6). Younger and less intensively managed sites exhibited larger upland zones (Figures 7 and 8).

Vegetation biomass (g $m^{-1}$) was highest in the Sacramento sub-basin (Figure 9) and in older sites (Figure 10). Vegetation biomass was similar across management intensities (Figure 11).

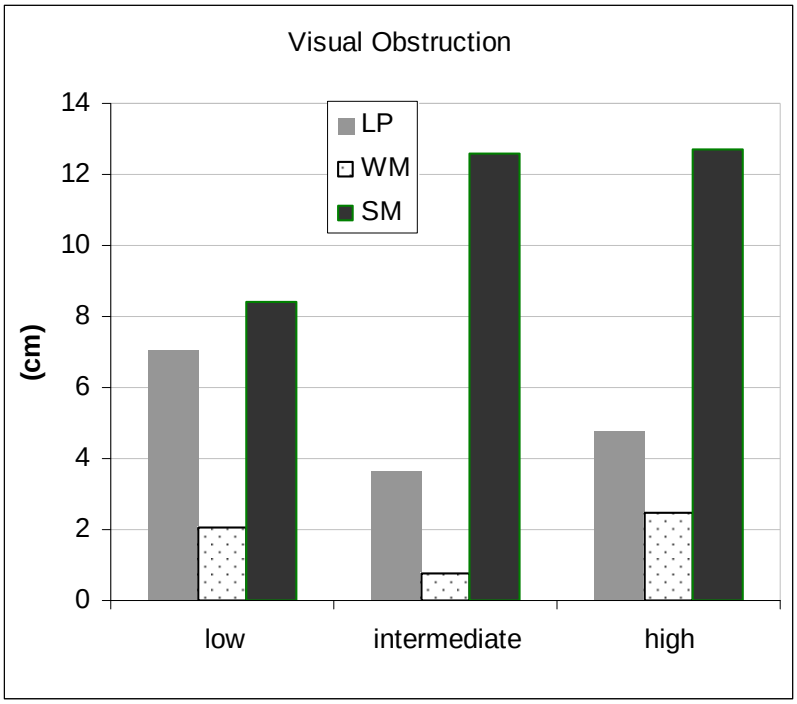


Figure 5. Visual obstruction measured at WRP easements by management intensity. Visual obstruction was estimated within each wetland zone i.e., LP = Low Prairie, WM = Wet Meadow and SM = Shallow Marsh.

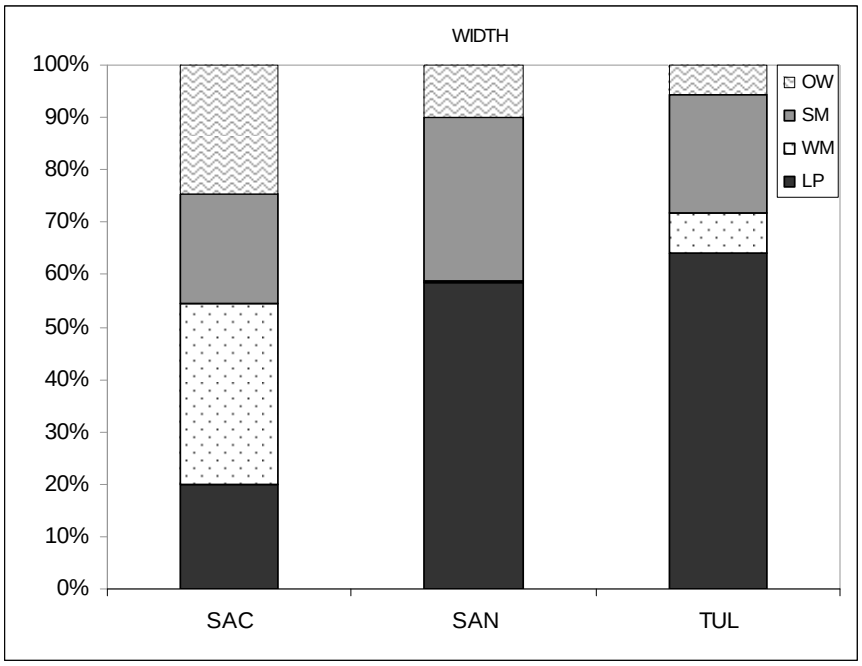


Figure 6. Width of each wetland zone i.e., LP = Low Prairie, WM = Wet Meadow, SM = Shallow Marsh and OW = Open Water, classified by sub-basin; SAC = Sacramento, SAN = San Joaquin and TUL = Tulare.

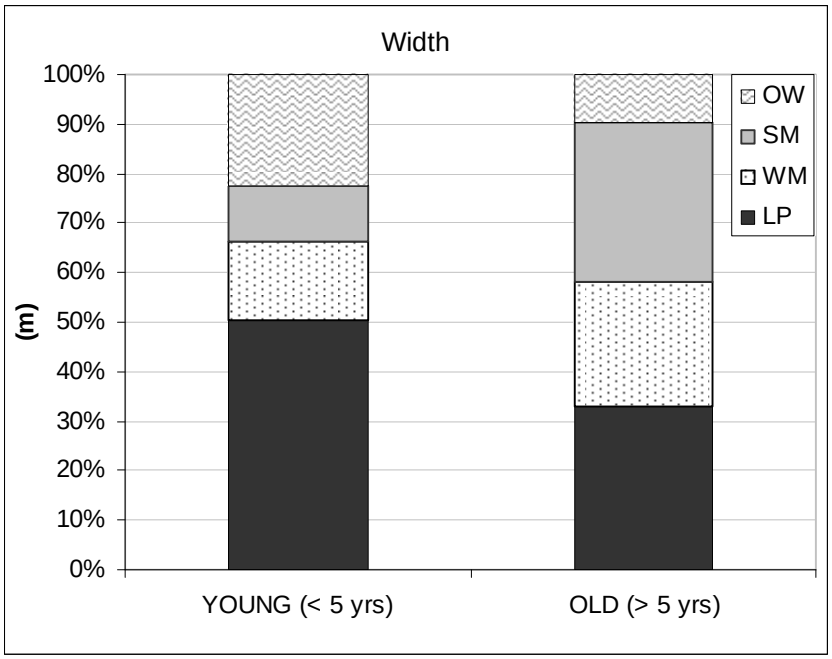


Figure 7. Width of each wetland zone i.e., LP = Low Prairie, WM = Wet Meadow, SM = Shallow Marsh and OW = Open Water, classified by restoration age.

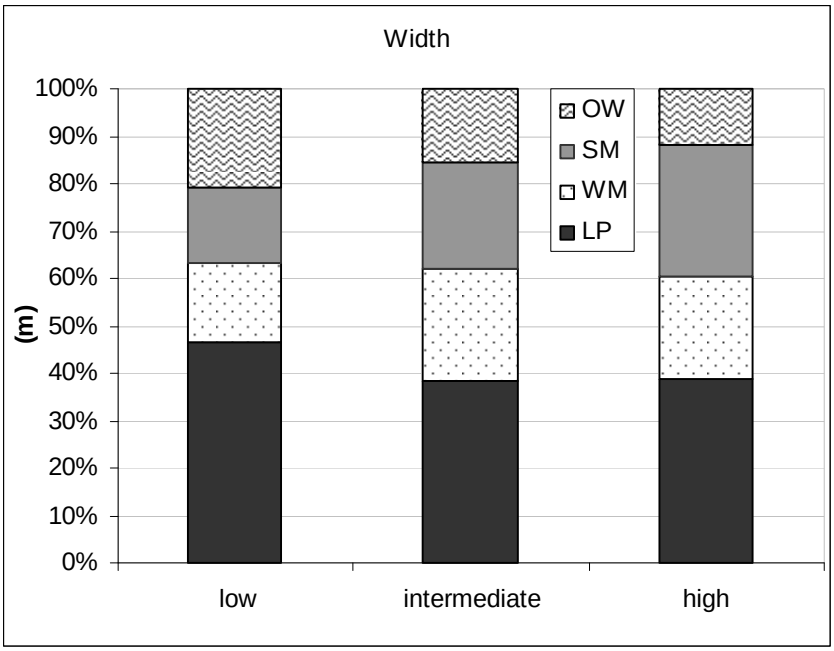


Figure 8. Width of each wetland zone i.e., LP = Low Prairie, WM = Wet Meadow, SM = Shallow Marsh and OW = Open Water, classified by management intensity.

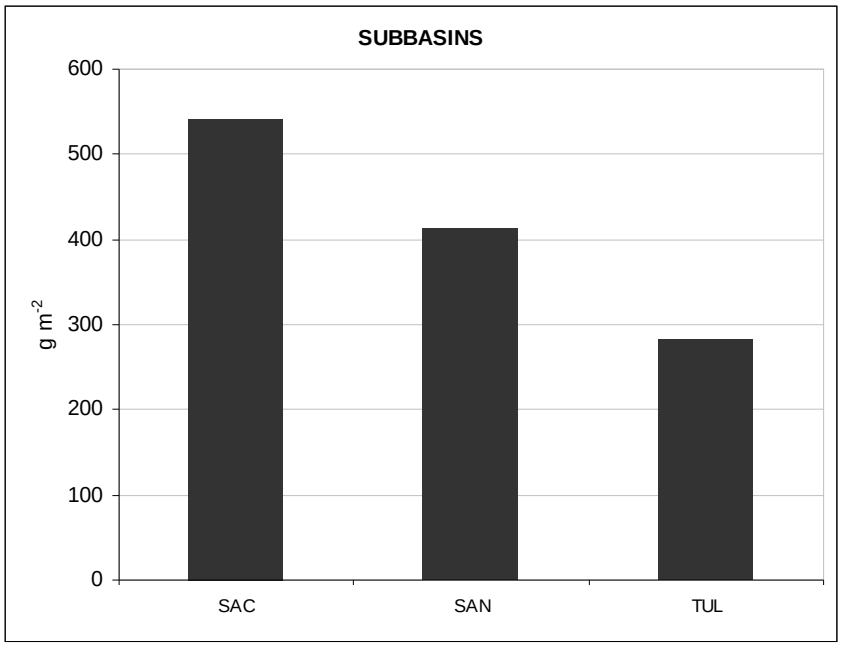


Figure 9. Vegetation biomass (g $m^{-2}$) by sub-basin; SAC = Sacramento, SAN = San Joaquin and TUL = Tulare.

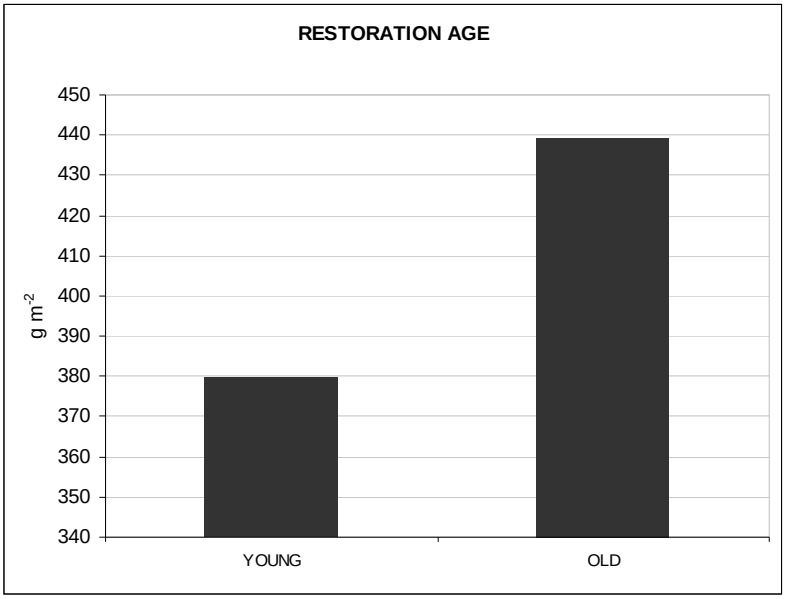


Figure 10. Vegetation biomass (g $m^{-2}$) by restoration age.

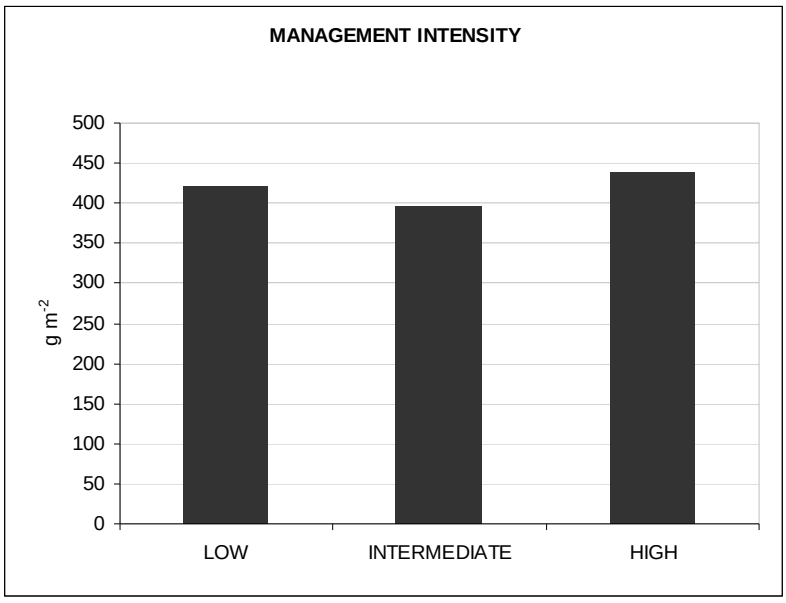


Figure 11. Vegetation biomass (g $m^{-2}$) by management intensity.

***Soils***

Soil samples were collected for nutrient analysis to estimate carbon sequestration and nutrient sequestration. Samples were submitted to the Colorado State University Soil-Water-Plant Testing Laboratory for determination of total phosphorous, total nitrogen, total carbon, and total inorganic carbon in November 2008. Litter depth and O-horizon measurements collected in the field are presented here. Litter depth appeared to be greatest in the Tulare sub-basin (Figure 12), and older sites had deeper litter layers (Figure 13). Intensively managed sites had greater litter depths than low or intermediate sites (Figure 14). O-horizon depths were greatest in the San-Joaquin sub-basin (Figure 15). Older sites had deeper O-horizons (Figures 16), whereas low management intensity sites exhibited deeper O-horizons (Figure 17).

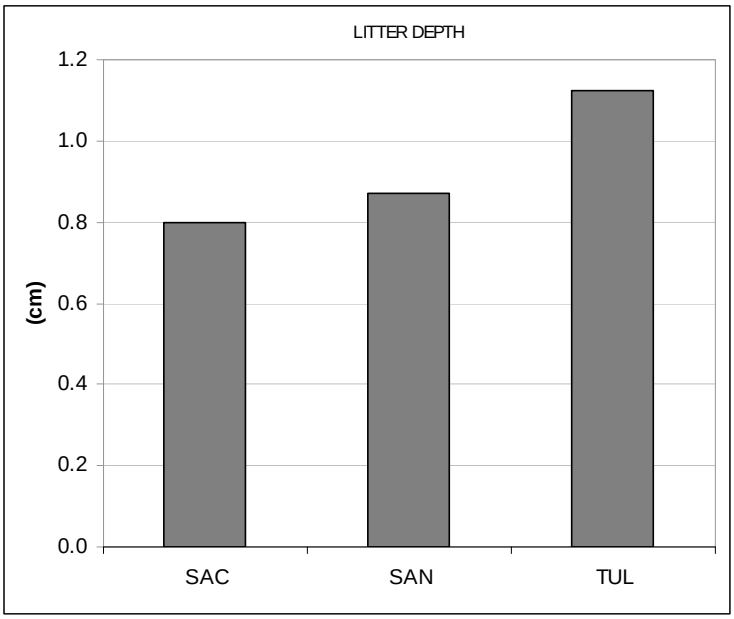


Figure 12. Litter depth by sub-basin; SAC = Sacramento, SAN = San Joaquin and TUL = Tulare.

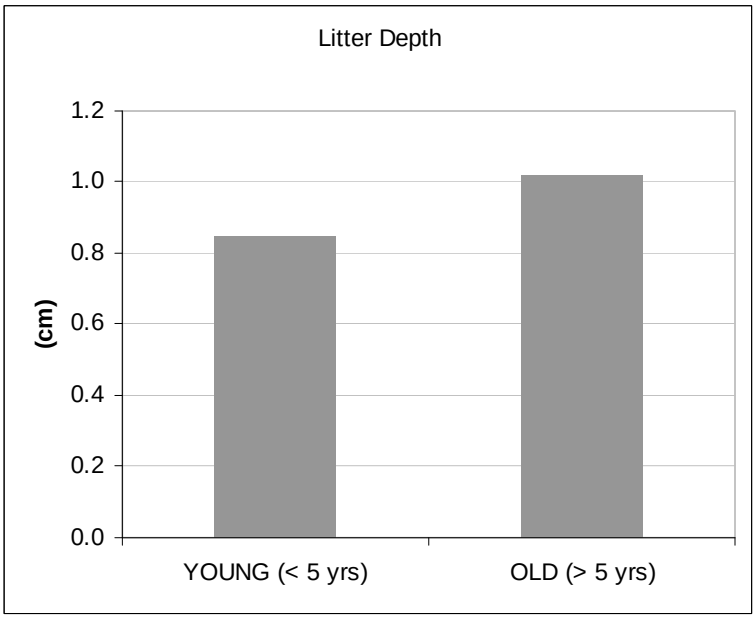


Figure 13. Litter depth by restoration age.

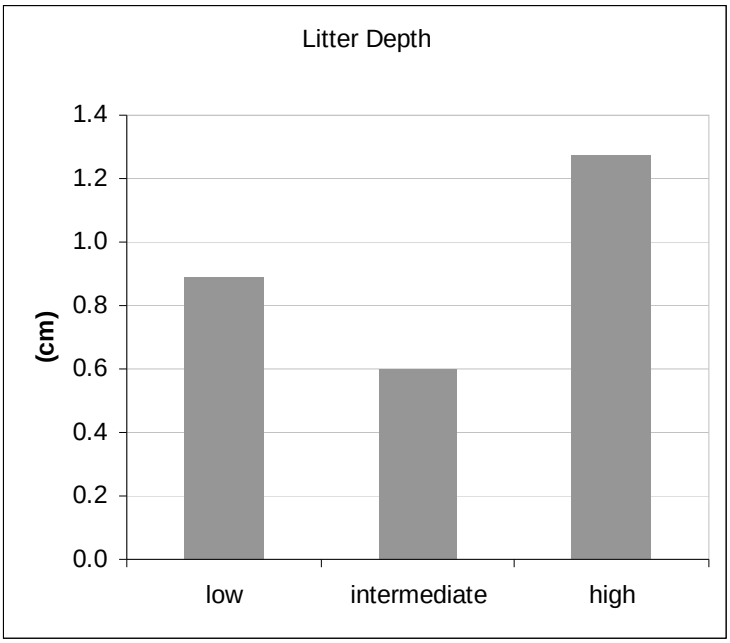


Figure 14. Litter depth by management intensity.

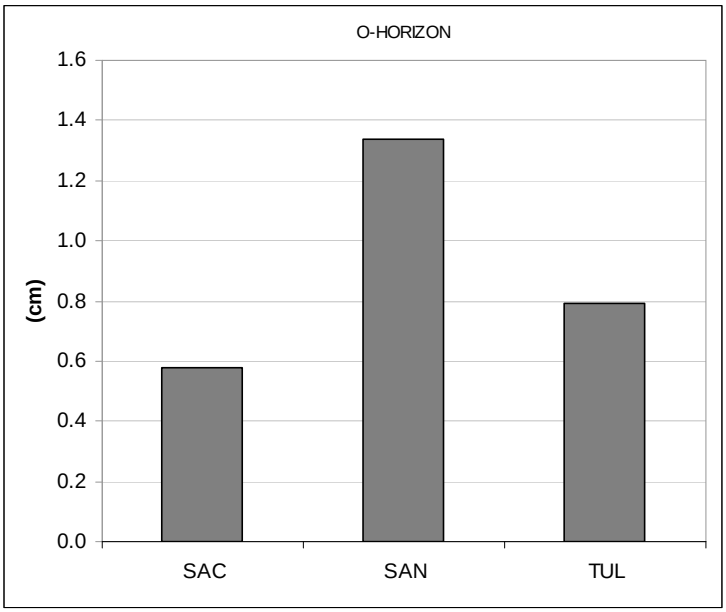


Figure 15. Soil O-horizon by sub-basin; SAC = Sacramento, SAN = San Joaquin and TUL = Tulare.

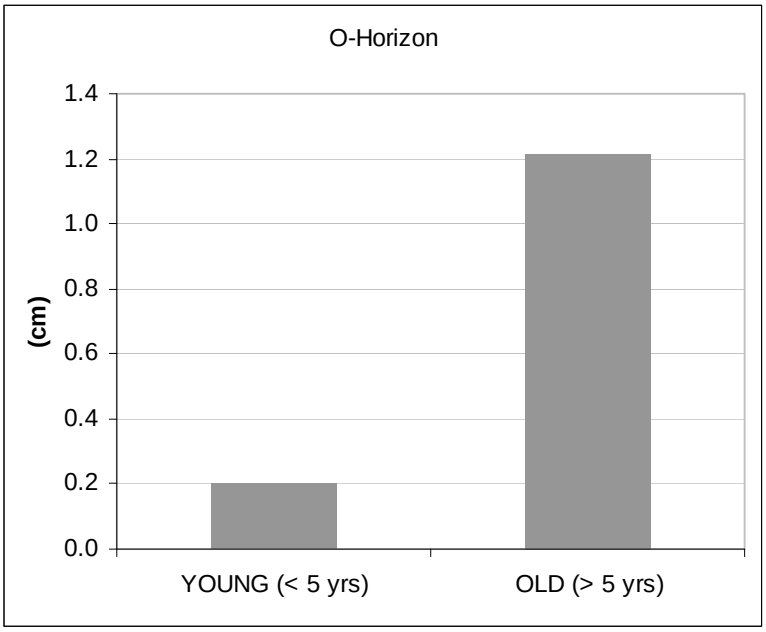


Figure 16. Soil O-horizon by restoration age.

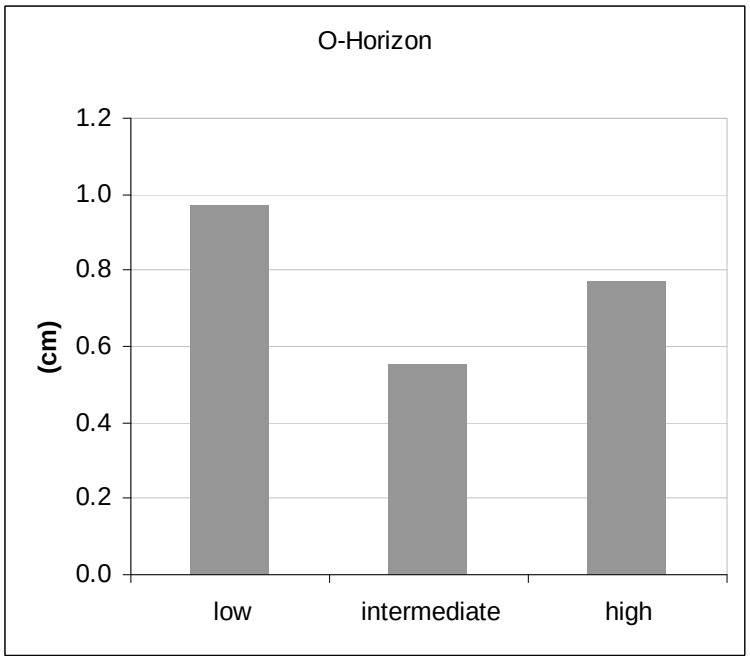


Figure 17. Soil O-horizon by management intensity.

***Pollinators***

A census of bee pollinators was conducted in the spring and summer of 2008. Preparation and of bee samples was conducted at Humboldt State University (Figure 18) and taxonomic identification is currently underway. Of more than 20,000 individuals captured by pan trapping and netting, more than 80% were classified as honey bees (*Apis malifera*) (Figure 19). Bees were collected on more than 50 flowering plants (Table 3). The highest number of bees (native and honey) was captured on black mustard flowers (*Brassica nigra*).

Figure 18. Pinned bees collected in California's Central Valley from March-May 2008 (Photo: Kim McFarland).

Table 3: Abundance of native and honey bees (*Apis malifera*) collected in California's Central Valley (March-May 2008) and associated flowering plants.

| ***Family*** | ***Genus*** | ***Specific epithets*** | ***Common Name*** | ***Native bees*** | ***Honey bees*** |
|---|---|---|---|---|---|
| Aizoaceae | *Sesuvium* | *verricosum* | Western sea-purslane | 11 | 2 |
| Apiaceae | *Conium* | *maculatum* | poison hemlock | 8 | 57 |
| Apiaceae | *Torilis* | *arvensis* | torilis | 1 | 0 |
| Asclepoadaceae | *Asclepias* | *sp.* | milkweed | 0 | 3 |
| Asteraceae | *Anthemis* | *cotula* | stinkweed | 39 | 206 |
| Asteraceae | *Centaurea* | *solstitialis* | yellow star-thistle | 7 | 6 |
| Asteraceae | *Chicorium* | *intybus* | chickory | 30 | 74 |
| Asteraceae | *Cirsium* | *vulgare* | bull thistle | 1 | 26 |
| Asteraceae | *Hemizonia* | *Pungens ssp. pungens* | common spikeweed | 8 | 0 |
| Asteraceae | *Lasthenia* | *sp.* | goldfields | 122 | 228 |
| Asteraceae | *Picris* | *echoides* | oxtongue | 0 | 1 |
| Asteraceae | *Silybum* | *marianum* | blessed milk thistle | 27 | 138 |
| Asteraceae | *Sonchus* | *arvensis* | perennial sow thistle | 10 | 0 |
| Asteraceae | *Taraxacum* | *officinale* | dandelion | 3 | 0 |
| Boraginaceae | *Amsinkia* | *sp.* | fiddleneck | 8 | 1 |
| Boraginaceae | *Heliotropium* | *curassavicum* | heliotrope | 6 | 0 |
| Brassicaceae | *(unknown)* | *sp.* | mustard | 17 | 56 |
| Brassicaceae | *Brassica* | *nigra* | black mustard | 125 | 3043 |
| Brassicaceae | *Capsella* | *bursa-pastoris* | shepard's purse | 1 | 0 |
| Brassicaceae | *Lepidium* | *latifolium* | pepperwort | 1 | 55 |
| Brassicaceae | *Raphanus* | *sativus* | radish | 56 | 269 |
| Brassicaceae | *Sinapis* | *arvensis* | charlock | 98 | 47 |
| Brassicaceae | *Sisymbrium* | *altissimum* | tumble mustard | 54 | 0 |
| Brassicaceae | *Sisymbrium* | *irio* | london rocket | 67 | 1 |
| Caryophyllaceae | *Silene sp.* | *sp.* | campion | 13 | 29 |
| Caryophyllaceae | *Spergularia* | *macrotheca* | sand-spurrey | 4 | 0 |
| Convolvulaceae | *Convolvulus* | *arvensis* | bindweed | 103 | 92 |
| Convolvulaceae | *Cressa* | *truxillensis* | alkali weed | 1 | 0 |

Table 3. (Continued).

| ***Family*** | ***Genus*** | ***Specific epithets*** | ***Common Name*** | ***Native bees*** | ***Honey bees*** |
|---|---|---|---|---|---|
| Fabaceae | *Astragalas* | *sp.* | milkvetch | 1 | 0 |
| Fabaceae | *Lotus* | *corniculatus* | birdfoot trefoil | 49 | 302 |
| Fabaceae | *Melilotus* | *alba* | white sweetclover | 5 | 32 |
| Fabaceae | *Melilotus* | *indica* | sourclover | 125 | 91 |
| Fabaceae | *Trifolium* | *fragiferum* | strawberry clover | 0 | 4 |
| Fabaceae | *Vicia* | *benghalensis* | vetch | 1 | 0 |
| Fabaceae | *Vicia* | *villosa ssp. varia* | hairy vetch | 46 | 2 |
| Geraniaceae | *Erodium* | *circulatum* | red stem filaree | 11 | 4 |
| Geraniaceae | *Erodium* | *sp.* | erodium | 1 | 0 |
| Hydrophyllaceae | *Nemophila* | *menziesii* | baby blue-eyes | 0 | 0 |
| Hydrophyllaceae | *Phacelia* | *ciliata* | valley pacelia | 109 | 3 |
| Lamiaceae | *Marrubium* | *vulgare* | horehound | 3 | 1 |
| Lamiaceae | *Mentha* | *pulegium* | pennyroyal | 2 | 27 |
| Lamiaceae | *Stachys* | *ajugoides* | hedge nettle | 1 | 0 |
| Liliaceae | *Brodiaea* | *elegans ssp. elegans* | harvest brodiaea | 2 | 0 |
| Lythracea | *Lythrum* | *hyssopifolium* | loosestrife | 7 | 7 |
| Malvaceae | *Malva* | *leprosa* | alkali-mallow | 1 | 9 |
| Malvaceae | *Malva* | *parviflora* | cheeseweed | 7 | 4 |
| Onagraceae | *Epilobium* | *densiflorum* | willow herb | 1 | 0 |
| Plantaginaceae | *Plantago* | *sp.* | plantain | 0 | 1 |
| Polygonaceae | *Rumex* | *crispus* | dock | 0 | 2 |
| Polygonaceae | *Rumex* | *pulcher* | dock | 1 | 0 |
| Rosaceae | *Rosa* | *californica* | california rose | 3 | 24 |
| Rosaceae | *Rosa* | *sp.* | rose | 5 | 62 |
| Rosaceae | *Rubus* | *discolor* | himalayan blackberry | 7 | 65 |
| Rosaceae | *Rubus* | *sp.* | rubus | 5 | 157 |
| Salicaceae | *Salix* | *sp.* | willow | 46 | 26 |
| Verbenaceae | *Phyla* | *lanceolata* | phyla | 6 | 79 |

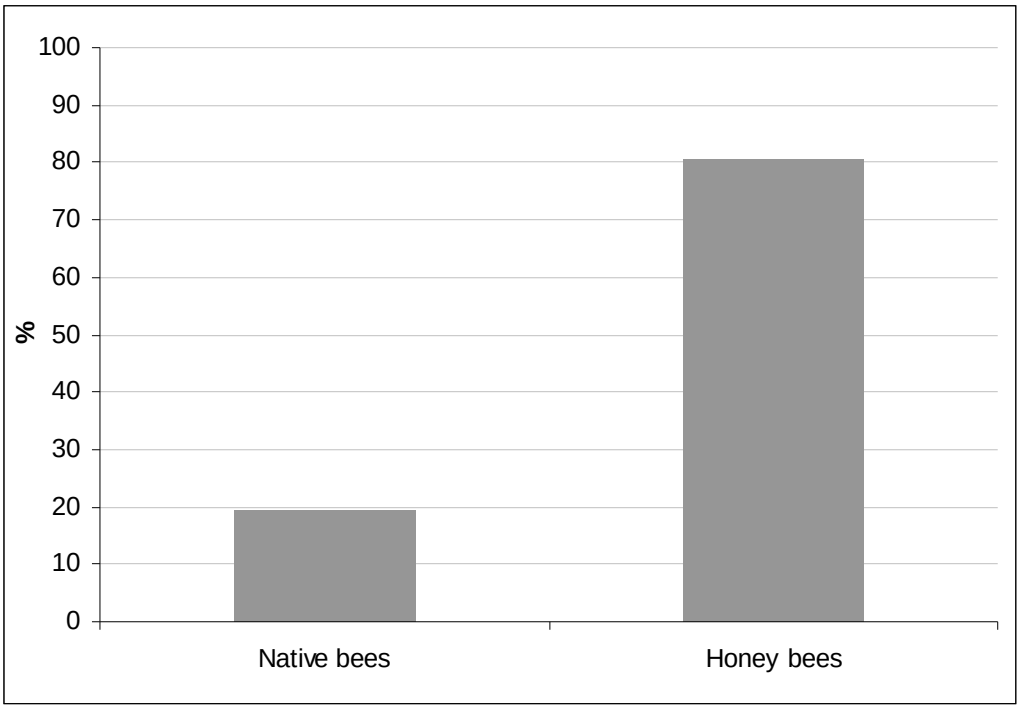


Figure 19. Percentage of bees collected at selected WRP easements in 2008.

### *Amphibians*

Four amphibian species were observed on CCV WRPs. These included the American bullfrog (*Rana catesbeiana*), Pacific tree frog (*Pseudacris regilla*), Western toad (*Bufo boreas*) and the Western spadefoot toad (*Spea hammondii*). The most common species across all WRP easements was the Pacific tree frog followed by the American bullfrog (Figure 20). More species were recorded in the Tulare sub-basin than the Sacramento and San Joaquin (Figure 21). All species except the Pacific tree frog were more common on older WRP easements than younger ones (Figure 22). All species occurred more commonly on intensively managed sites than other management regimes (Figure 23).

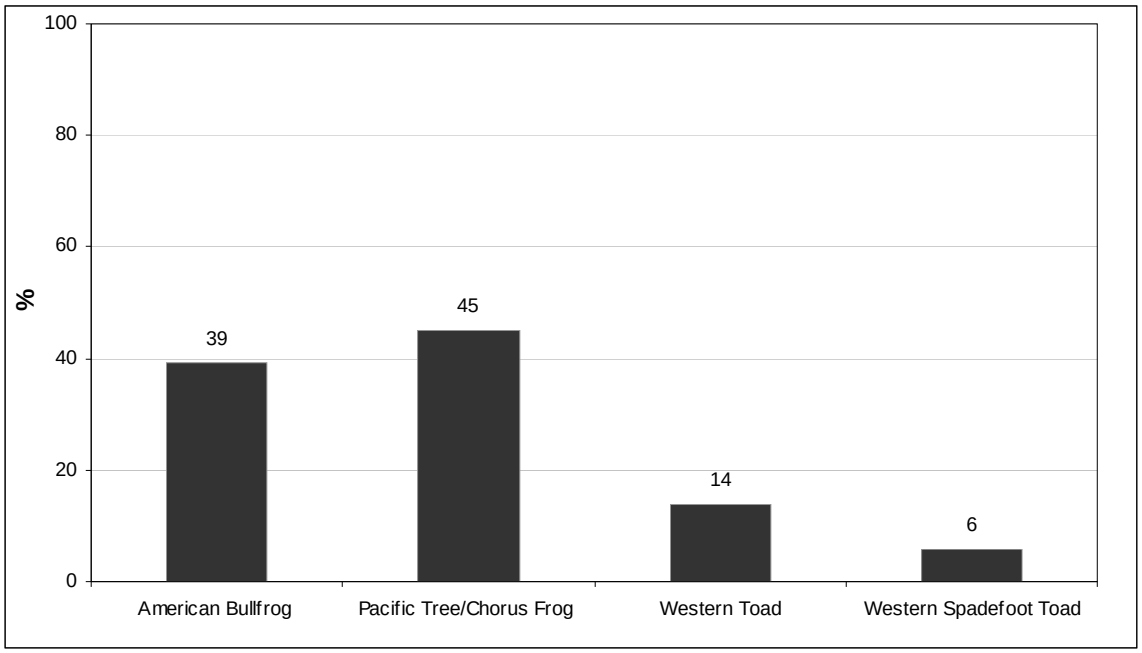


Figure 20. Percent occurrence of each amphibian species recorded on selected WRP easements in 2008.

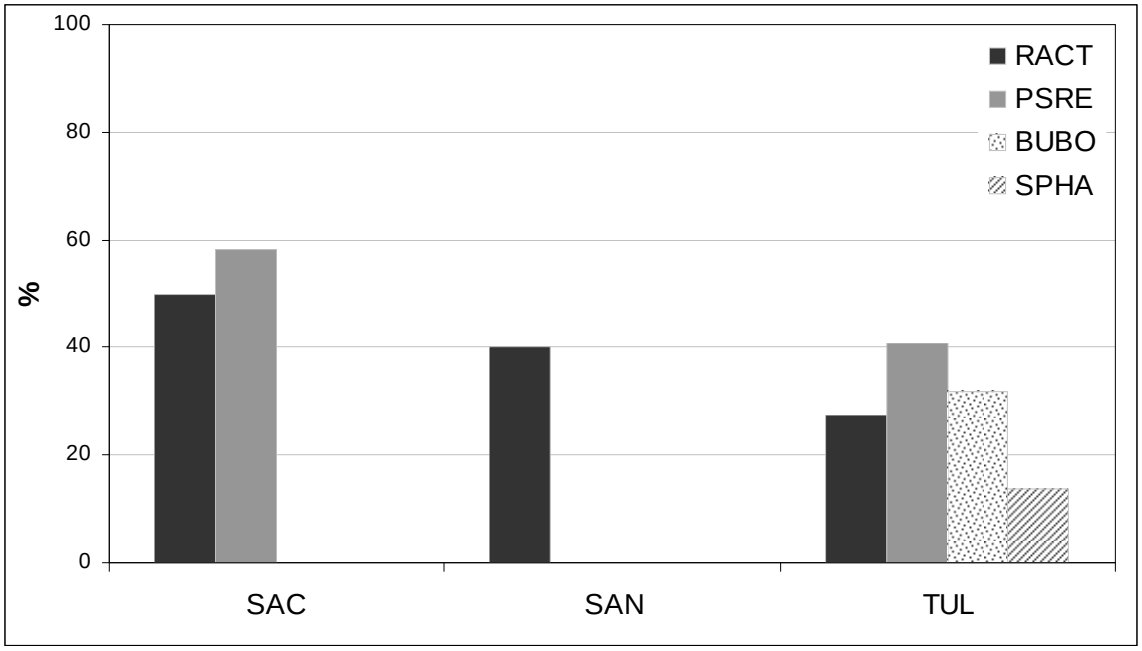


Figure 21. Percent occurrence of each amphibian species recorded on selected WRP easements in 2008 by sub-basin; SAC = Sacramento, SAN = San Joaquin and TUL = Tulare.

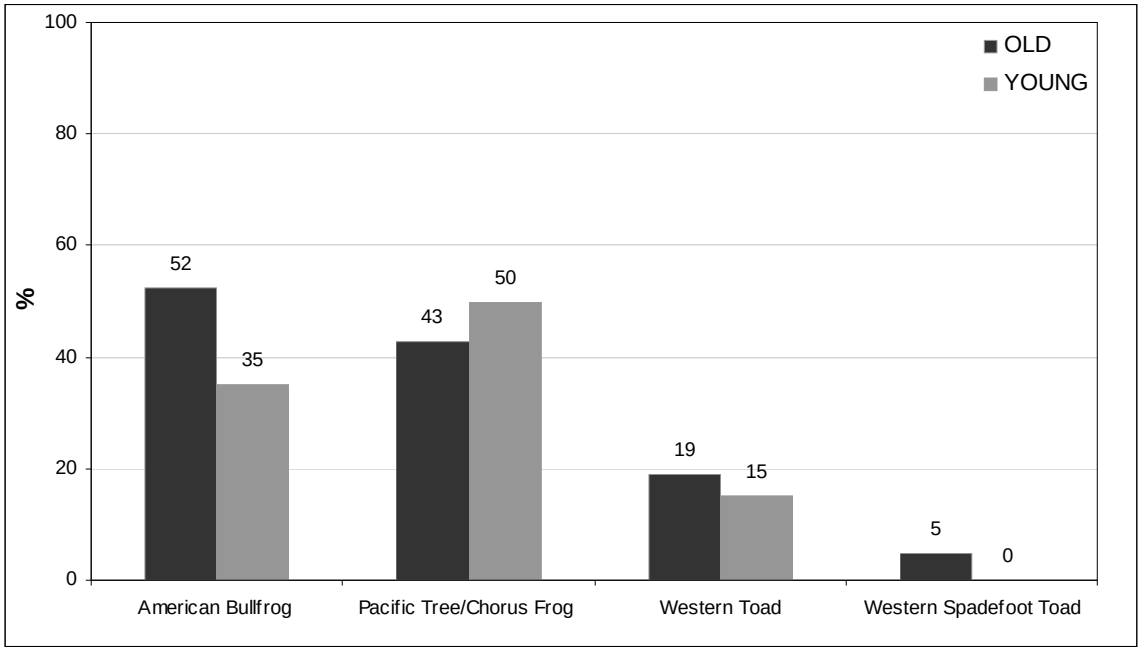


Figure 22. Percent occurrence of each amphibian species recorded on selected WRP easements in 2008 by restoration age.

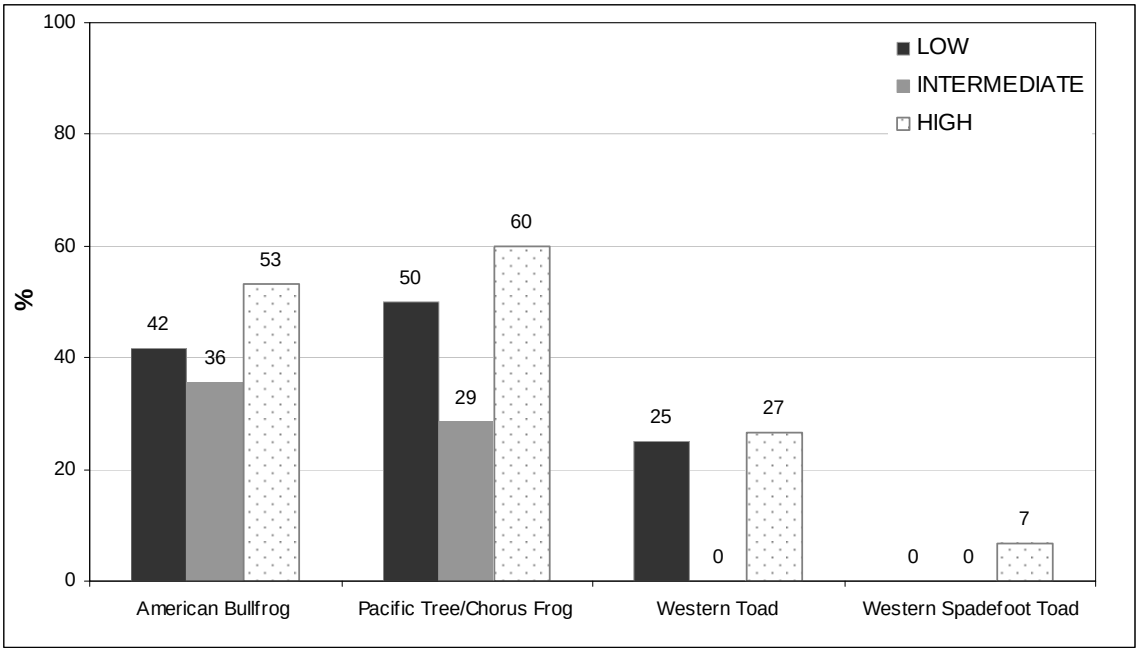


Figure 23. Percent occurrence of each amphibian species recorded on selected WRP easements in 2008 by management intensity.

***Birds***

A total of 63,934 individual adult birds were observed at WRP easements in the CCV during 2008 (Appendix A). Most abundant species included several species of resident waterfowl, shorebirds and passerine birds (Table 5). These abundant species all use wetland habitats for feeding, nesting and/or brood rearing.

A total of 182 bird taxa were observed at WRP easements in the CCV during 2008 (Appendix A). Most of the taxa were species, but a few were genera for which a species could not be assigned. Seven of the most frequently observed species were also among the most abundant (Table 6). However, several species such as black phoebe, great blue heron and ring necked pheasant were observed at a high proportion of WRP sites even though they were not abundant. Bird species richness was slightly higher in the Sacramento River Basin than in the Tulare Basin (Figure 24). Bird species richness declined with age of the WRP restoration in the Tulare Basin, but not in the Sacramento River Basin.

Table 4. Fifteen most abundant species of birds observed in WRP wetlands in the Central Valley of California during spring – summer 2008.

| Common name | Total Number |
|---|---|
| American Coot | 11879 |
| Red-winged Blackbird | 9525 |
| White-faced Ibis | 5562 |
| Tree Swallow | 3915 |
| Mallard | 3618 |
| Western Sandpiper | 2177 |
| White-crowned Sparrow | 1953 |
| Marsh Wren | 1877 |
| Cinnamon Teal | 1410 |
| Least Sandpiper | 1369 |
| Savannah Sparrow | 1363 |
| Gadwall | 1305 |
| Song Sparrow | 1047 |
| Yellow-headed Blackbird | 1016 |
| Cliff Swallow | 976 |

Table 5. Fifteen most frequently observed species of birds in WRP wetlands in the Central Valley of California during spring – summer 2008. Frequency is the number of sites, from a total of 316, at which the species was recorded.

| Common name | Frequency |
|---|---|
| Marsh Wren | 242 |
| Red-winged Blackbird | 235 |
| Song Sparrow | 231 |
| Western Meadowlark | 183 |
| Western Kingbird | 162 |
| Mallard | 160 |
| American Coot | 127 |
| Brown-headed Cowbird | 118 |
| Killdeer | 118 |
| Tree Swallow | 114 |
| Great Egret | 108 |
| Great Blue Heron | 108 |
| Black Phoebe | 102 |
| Cliff Swallow | 97 |
| Ring-necked Pheasant | 95 |

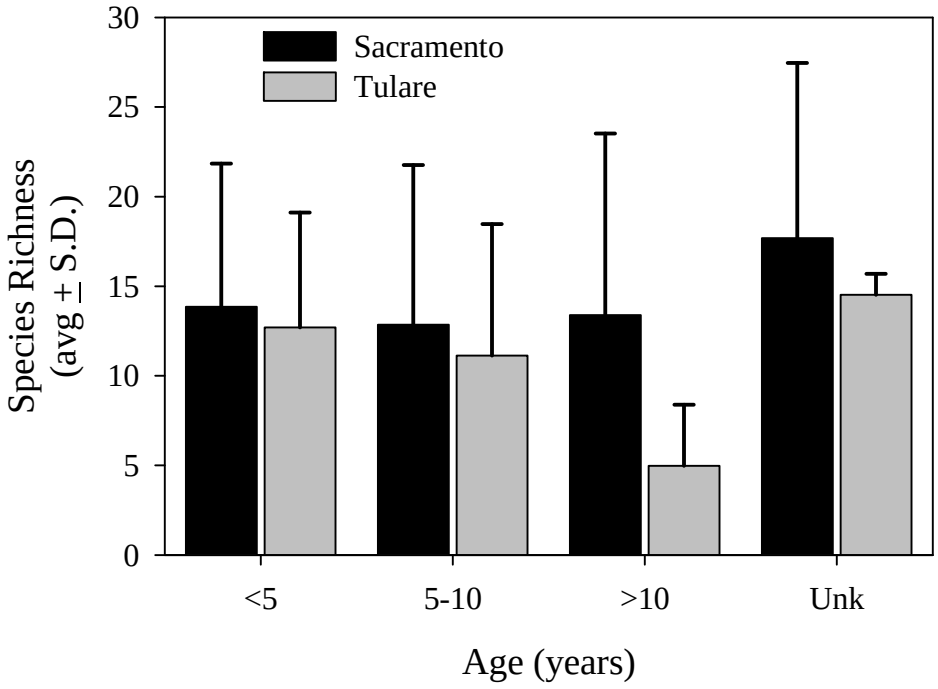


Figure 24. Average bird species richness (+ 1 S.D.) relative to age since restoration at 55 WRP wetland sites in the Sacramento River Basin and at 21 sites in the Tulare Basin.

***Continuing Data Collection***

The following data currently being collected include; 1) land-use history and current management intensity, 2) climate, 3) landscape features and wetland inventories, 4) wetland construction and elevation information, 4) soils and 5) fish. Sources include NRCS archival documents, NRCS-Web Soil Survey, California Department of Water Resources (DWR), the National Oceanic and Atmospheric Administration (NOAA), USGS gauging stations, USDA CRP and WRP land units, National Land Cover Database (NLCD, US-EPA) and the Central Valley Joint Venture (CVJV). NRCS digital soil survey maps will be used to determine WRP soil type.

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Appendix A. Bird species observed using WRP habitats in the Central Valley of California during summer 2008. Total is the total number of adult individuals observed, freq is the number of WRP site x sample period combinations at which the species was observed. Maximum frequency was 316.

| Common name | Genus | Species | Total | Freq |
|---|---|---|---|---|
| Acorn Woodpecker | Melanerpes | formicivorus | 1 | 1 |
| Unidentified Clark or Western Grebe | Aechmorphus | | 1 | 1 |
| Green-winged Teal | Anas | crecca | 157 | 20 |
| American Avocet | Recurvirostra | americana | 334 | 40 |
| American Bittern | Botaurus | lentiginosus | 54 | 24 |
| American Coot | Fulica | americana | 11879 | 127 |
| American Crow | Corvus | brachyrhynchos | 3 | 2 |
| American Goldfinch | Carduelis | tristis | 349 | 77 |
| American Kestrel | Falco | sparverius | 5 | 4 |
| American Pipit | Anthus | rubescens | 152 | 19 |
| American Robin | Turdus | migratorius | 131 | 46 |
| American Wigeon | Anas | americana | 84 | 16 |
| Anna's Hummingbird | Calypte | anna | 12 | 7 |
| Ash-throated Flycatcher | Myiarchus | cinerascens | 115 | 50 |
| American White Pelican | Pelecanus | erythrorhynchos | 290 | 14 |
| Bald Eagle | Haliaeetus | leucocephalus | 2 | 2 |
| Bank Swallow | Riparia | riparia | 2 | 2 |
| Barn Owl | Tyto | alba | 2 | 2 |
| Barn Swallow | Hirundo | rustica | 79 | 25 |
| Black-bellied Plover | Pluvialis | squatarola | 100 | 4 |
| Black-chinned Hummingbird | Archilochus | alexandri | 8 | 6 |
| Black-crowned Night-Heron | Nycticorax | nycticorax | 215 | 44 |
| Belted Kingfisher | Ceryle | alcyon | 10 | 9 |
| Bewick's Wren | Thryomanes | bewickii | 112 | 29 |
| Brown-headed Cowbird | Molothrus | ater | 416 | 118 |
| Black-headed Grosbeak | Pheucticus | melanocephalus | 116 | 39 |
| Blue Grosbeak | Passerina | caerulea | 67 | 45 |
| Black Phoebe | Sayornis | nigricans | 168 | 102 |
| Black Tern | Chlidonias | niger | 1 | 1 |
| Barn Owl | Tyto | alba | 2 | 2 |
| Black-necked Stilt | Himantopus | mexicanus | 723 | 44 |
| Brewer's Blackbird | Euphagus | cyanocephalus | 251 | 47 |
| Bufflehead | Bucephala | albeola | 1 | 1 |
| Bullock's Oriole | Icterus | bullockii | 105 | 32 |
| Burrowing Owl | Athene | cunicularia | 17 | 6 |
| Bushtit | Psaltriparus | minimus | 205 | 39 |
| Blue-winged Teal | Anas | discors | 35 | 9 |
| Cattle Egret | Bubulcus | ibis | 205 | 19 |
| Canada Goose | Branta | canadensis | 72 | 12 |
| California Towhee | Pipilo | crissalis | 69 | 31 |
| Canvasback | Aythya | valisineria | 5 | 3 |
| California Quail | Callipepla | californica | 97 | 33 |

| | | | | |
|---|---|---|---|---|
| Caspian Tern | Sterna | caspia | 4 | 3 |
| Cedar Waxwing | Bombycilla | cedrorum | 42 | 2 |
| Chipping Sparrow | Spizella | passerina | 2 | 1 |
| Cinnamon Teal | Anas | cyanoptera | 1410 | 87 |
| Clark's Grebe | Aechmophorus | clarkii | 6 | 5 |
| Cliff Swallow | Petrochelidon | pyrrhonota | 976 | 97 |
| Cooper's Hawk | Accipiter | cooperii | 3 | 3 |
| Common Moorhen | Gallinula | chloropus | 119 | 33 |
| Common Raven | Corvus | corax | 12 | 5 |
| Common Yellowthroat | Geothlypis | trichas | 88 | 61 |
| Double-crested Cormorant | Phalacrocorax | auritus | 71 | 24 |
| Unidentified Dowitcher | Limnodromus | | 576 | 15 |
| Downy Woodpecker | Picoides | pubescens | 39 | 18 |
| Dusky Flycatcher | Empidonax | oberholseri | 1 | 1 |
| Dunlin | Calidris | alpina | 794 | 6 |
| Eared Grebe | Podiceps | nigricollis | 1 | 1 |
| European Starling | Sturnus | vulgaris | 37 | 16 |
| Forster's Tern | Sterna | forsteri | 89 | 8 |
| Gadwall | Anas | strepera | 1305 | 91 |
| Great Blue Heron | Ardea | herodias | 209 | 108 |
| Golden-crowned Sparrow | Zonotrichia | atricapilla | 4 | 3 |
| Great Horned Owl | Bubo | virginianus | 22 | 17 |
| Golden Eagle | Aquila | chrysaetos | 2 | 2 |
| Great Egret | Ardea | alba | 604 | 108 |
| Green Heron | Butorides | virescens | 6 | 4 |
| Greater Roadrunner | Geococcyx | californianus | 4 | 4 |
| Grasshopper Sparrow | Ammodramus | savannarum | 1 | 1 |
| Greater Yellowlegs | Tringa | melanoleuca | 146 | 22 |
| Great-tailed Grackle | Quiscalus | mexicanus | 61 | 22 |
| Greater White-fronted Goose | Anser | albifrons | 1 | 1 |
| Hermit Warbler | Dendoica | occidentalis | 1 | 1 |
| House Finch | Carpodacus | mexicanus | 280 | 77 |
| Horned Lark | Eremophila | alpestris | 24 | 8 |
| House Sparrow | Passer | domesticus | 6 | 6 |
| House Wren | Troglodytes | aedon | 82 | 21 |
| Killdeer | Charadrius | vociferus | 393 | 118 |
| Lark Sparrow | Chondestes | grammacus | 29 | 14 |
| Lazuli Bunting | Passerina | amoena | 31 | 13 |
| Long-billed Curlew | Numenius | americanus | 272 | 7 |
| Long-billed Dowitcher | Limnodromus | scolopaceus | 68 | 6 |
| Lesser Goldfinch | Carduelis | psaltria | 71 | 27 |
| Lesser Nighthawk | Chordeiles | acutipennis | 1 | 1 |
| Least Sandpiper | Calidris | minutilla | 1369 | 25 |
| Lesser Scaup | Aythya | affinis | 14 | 5 |
| Lesser Yellowlegs | Tringa | flavipes | 19 | 3 |
| Lincoln's Sparrow | Melospiza | lincolnii | 33 | 15 |
| Loggerhead Shrike | Lanius | ludovicianus | 160 | 94 |

| | | | | |
|---|---|---|---|---|
| Mallard | Anas | platyrhynchos | 3618 | 160 |
| Marsh Wren | Cistothorus | palustris | 1877 | 242 |
| Merlin | Falco | columbarius | 2 | 2 |
| Mourning Dove | Zenaida | macroura | 275 | 87 |
| Northern Flicker | Colaptes | auratus | 4 | 3 |
| Northern Harrier | Circus | cyaneus | 107 | 79 |
| Northern Mockingbird | Mimus | polyglottos | 37 | 29 |
| Northern Pintail | Anas | acuta | 258 | 25 |
| Northern Rough-winged Swallow | Stelgidopteryx | serripennis | 11 | 7 |
| Northern Shoveler | Anas | clypeata | 468 | 45 |
| Nuttall's Woodpecker | Picoides | nuttallii | 83 | 33 |
| Oak Titmouse | Baeolophus | inornatus | 31 | 15 |
| Orange-crowned Warbler | Vermivora | celata | 14 | 4 |
| Olive-sided Flycatcher | Contopus | cooperi | 1 | 1 |
| Osprey | Pandion | haliaetus | 3 | 3 |
| Pied-billed Grebe | Podilymbus | podiceps | 468 | 92 |
| Peregrine Falcon | Falco | peregrinus | 1 | 1 |
| Prairie Falcon | Falco | mexicanus | 2 | 2 |
| Pacific-slope Flycatcher | Empidonax | difficilis | 3 | 1 |
| Ruby-crowned Kinglet | Regulus | calendula | 2 | 2 |
| Redhead | Aythya | americana | 23 | 5 |
| Ring-necked Duck | Aythya | collaris | 28 | 8 |
| Red-necked Phalarope | Phalaropus | lobatus | 13 | 4 |
| Ross' Goose | Chen | rossii | 1 | 1 |
| Ring-necked Pheasant | Phasianus | colchicus | 166 | 95 |
| Red-shouldered Hawk | Buteo | lineatus | 4 | 4 |
| Red-tailed Hawk | Buteo | jamaicensis | 81 | 53 |
| Ruddy Duck | Oxyura | jamaicensis | 98 | 24 |
| Red-winged Blackbird | Agelaius | phoeniceus | 9525 | 235 |
| Sandhill Crane | Grus | canadensis | 170 | 1 |
| Sanderling | Calidris | alba | 1 | 1 |
| Say's Phoebe | Sayornis | saya | 3 | 3 |
| Savannah Sparrow | Passerculus | sandwichensis | 1363 | 78 |
| Semipalmated Plover | Charadrius | semipalmatus | 106 | 7 |
| Snowy Egret | Egretta | thula | 331 | 51 |
| Snow Goose | Chen | caerulescens | 1 | 1 |
| Sora | Porzana | carolina | 24 | 5 |
| Solitary Sandpiper | Tringa | solitaria | 3 | 1 |
| Song Sparrow | Melospiza | melodia | 1047 | 231 |
| Spotted Sandpiper | Actitus | macularia | 10 | 8 |
| Spotted Towhee | Pipilo | maculatus | 219 | 33 |
| Sharp-shinned Hawk | Accipiter | striatus | 2 | 2 |
| Swainson's Hawk | Buteo | swainsoni | 12 | 9 |
| Swainson's Thrush | Calathrus | ustulatus | 2 | 1 |
| Townsend's Warbler | Dendroica | townsendi | 2 | 2 |
| Tricolored Blackbird | Agelaius | tricolor | 9 | 2 |
| Tree Swallow | Tachycineta | bicolor | 3915 | 114 |

| | | | | |
|---|---|---|---|---|
| Turkey Vulture | Cathartes | aura | 259 | 49 |
| Unidentified Blackbird | Icteridae | | 51 | 11 |
| Unidentified Duck | Anatidae | | 8 | 5 |
| Unidentified Swallow | Hirundinidae | | 107 | 7 |
| Vaux's Swift | Chaetura | vauxi | 4 | 2 |
| Violet-green Swallow | Tachycineta | thalassina | 1 | 1 |
| Virginia Rail | Rallus | limicola | 27 | 16 |
| Unknown Waterbird (duck or grebe) | | | 0 | 1 |
| Warbling Vireo | Vireo | gilvus | 9 | 4 |
| White-breasted Nuthatch | Sitta | carolinensis | 5 | 4 |
| White-crowned Sparrow | Zonotrichia | leucophrys | 1953 | 49 |
| Western Bluebird | Sialia | mexicana | 11 | 7 |
| Western Grebe | Aechmophorus | occidentalis | 3 | 3 |
| Western Kingbird | Tyrannus | verticalis | 625 | 162 |
| Western Meadowlark | Sturnella | neglecta | 584 | 183 |
| Western Sandpiper | Calidris | mauri | 2177 | 12 |
| Western Scrubjay | Aphelocoma | californica | 46 | 26 |
| Western Tanager | Piranga | ludoviciana | 8 | 6 |
| Western Wood-Pewee | Contopus | sordidulus | 80 | 25 |
| White-faced Ibis | Plegadis | chihi | 5562 | 51 |
| Whimbrel | Numenius | phaeopus | 80 | 4 |
| Wilson's Phalarope | Phalaropus | tricolor | 8 | 3 |
| Wilson's Snipe | Gallinago | delicata | 10 | 5 |
| Wild Turkey | Meleagris | gallopavo | 7 | 5 |
| Wilson's Warbler | Wilsonia | pusilla | 20 | 8 |
| Westerin/Least Sandpiper | Calidris | | 31 | 1 |
| Wood Duck | Aix | sponsa | 140 | 35 |
| Wrentit | Chamaea | fasciata | 6 | 5 |
| White-tailed Kite | Elanus | leucurus | 36 | 23 |
| White-throated Swift | Aeronautes | saxatalis | 1 | 1 |
| unknown dabbling duck | Anas | | 15 | 2 |
| unknown peep (western or least) | Calidris | manuri/minutilla | 189 | 3 |
| Unknown Anas species | Anas | sp | 5 | 1 |
| Empidonax unknown species | Empidonax | | 1 | 1 |
| Unknown goldfinch | Carduelis | | 2 | 1 |
| Unidentified Hummingbird | Trochilidae | | 18 | 9 |
| Unidentified Sandpiper | Scolopacidae | | 102 | 3 |
| Unidentified Scaup | Aythya | | 3 | 1 |
| Unknown warbler | Parulidae | | 1 | 1 |
| Unknown woodpecker | Picidae | | 3 | 1 |
| Unidentified Bird | Aves | | 0 | 1 |
| Yellow-breasted Chat | Icteria | virens | 1 | 1 |
| Yellow-billed Cuckoo | Coccyzus | americanus | 3 | 1 |
| Yellow-billed Magpie | Pica | nuttalli | 3 | 2 |
| Yellow-headed Blackbird | Xanthocephalus | xanthocephalus | 1016 | 19 |
| Yellow-rumped Warbler | Dendroica | coronata | 138 | 20 |
| Yellow Warbler | Dendroica | petechia | 11 | 7 |