BASELINE ASSESSMENT

FOR

RIPARIAN RESTORATION

AT THE

COLUSA-NORTH RESTORATION AREA

Prepared by:

Jean G. Hubbell, M.S.
Catherine Little
Katie C. Price
John W. Hunt, M.S.
Dr. David M. Wood
Department of Biological Sciences
California State University, Chico

February 2007

Prepared for:

The Nature Conservancy
Sacramento River Project, Chico, California

TABLE OF CONTENTS

SECTION ONE

COLUSA-NORTH

RESTORATION PLANTING RECOMMENDATIONS

Prepared by:

Jean G. Hubbell, M.S.
Catherine Little
Katie C. Price
Dr. David M. Wood
Department of Biological Sciences
California State University, Chico

Introduction

The 136-acre Colusa-North tract is located about two miles north of Colusa in Colusa County on the west side of the Sacramento River at river mile 147. It is owned by the Wildlife Conservation Board and managed by the California Department of Fish and Game as the northerly subunit of the Colusa Unit of their Sacramento River Wildlife Area. The Colusa-North Restoration Area (hereafter "Restoration Area") comprises 5 acres of the tract inside the levees and is currently a fallow walnut orchard. The remainder of the tract surrounding the Restoration Area consists of riparian habitat.

Mixed riparian forest within the Colusa-North tract forms the Restoration Area's northeastern boundary (Figures 1 and 6). The remainder of the Restoration Area's boundary is cottonwood riparian forest within the Colusa-North tract. An herbland occurs in the center of the mixed riparian forest to the northeast of the Restoration Area. There is a band of willow scrub and a band of herbland with a patch of willow scrub all within the Colusa-North tract, extending east from the mixed and cottonwood riparian forests to the Sacramento River.

Within the Restoration Area there are four patches of remnant riparian vegetation as well as significant recruitment of riparian species (Figures 4 and 5). There are two patches of cottonwood riparian forest dominated by Fremont cottonwood (*Populus fremontii*) colonizing from the edges toward the middle. The eastern patch (1.2 acres) has scattered western poison oak (*Toxicodendron diversilobum*) throughout and mule fat (*Baccharis salicifolia*) on its edges. The western patch (0.3 acres) has a small clump of valley oak (*Quercus lobata*) and a blue elderberry (*Sambucus mexicana*) on its south side which is on the higher terrace, along with mule fat on its edges. There is a small patch of cottonwood riparian forest (0.1 acres) along the northeast border with virgin's bower (*Clematis ligusticifolia*), western poison oak, mugwort (*Artemisia douglasiana*) and California wild grape (*Vitis californica*) occurring on the edge with the Restoration Area. Box elder (*Acer negundo*), Fremont cottonwood and mule fat have significant natural recruitment along with a few valley oak and Oregon ash (*Fraxinus latifolia*) in the northern quarter of the Restoration Area near the patch of existing cottonwood riparian forest. On the western edge of the Restoration Area there is a very small patch (0.04 acres) of narrow-leaved willow (*Salix exigua*).

Field surveys of nearby remnant riparian vegetation, site soils and birds were conducted during June and August 2005, at the Restoration Area. Information on special status animals and non-native mammals for the site was also compiled during that time.

Vegetation sampling was done in the four natural communities nearby the Restoration Area, two of which are adjacent to the Restoration Area. The adjacent natural communities are: Great Valley cottonwood riparian forest and Great Valley mixed riparian forest. The two natural communities nearby the Restoration Area occur to the east: Great Valley willow scrub, and herbland (Figure 1). Qualitative community descriptions follow Holland (1986). With the exception of herbland, all of these communities in some form (i.e. nomenclature may differ) are on the list of California Terrestrial Natural Communities recognized by the California Natural Diversity Database (CA DFG 2003). Three of these communities (excluding herbland) comprise the estimated 104 acres of native riparian vegetation within the Colusa-North tract. A detailed discussion of nearby remnant riparian vegetation is in Section Two.

The restoration planting recommendations are presented below with supporting vegetation and soil surveys in Sections Two and Three. The special status animal, bird counts and non-native mammal information is in Section Four.

Adjacent Landcover

The Colusa-North tract is adjacent to three properties. To the north is the 79-acre Yerxa property with a mature walnut orchard in the northern portion. This property and the walnut orchard are approximately 60 m and 210 m, respectively, from the Restoration Area separated by existing remnant riparian forest (60 m on the Colusa-North tract and 150 m on the Yerxa property). The Sacramento River is the eastern boundary. To the south is the Colusa State Recreation Area owned by the California Department of Parks and Recreation. This property is approximately 750 m from the Restoration Area separated by existing remnant riparian forest. To the west is 87 acres of row crops and riparian forest owned by the Halseys. This property is approximately 150-250 m from the Restoration Area separated by existing remnant riparian forest.

Methods

The 5-acre Restoration Area was stratified into sections based on soils, topography and geomorphology. The sections were determined from aerial photographs and soil maps, and refined as needed upon site review. Potential plant communities were chosen for the Restoration Area utilizing the remnant riparian vegetation community descriptions and Restoration Area soil descriptions and estimated elevations (not shown), including the influence of historic channels and estimated flood frequency (Figures 1-5; Sections Two and Three). In the figures, the information on flood frequency comes from Department of Water Resources (DWR) 1997 data whereas the aerial photographs are from 1999. Thus on occasion the two do not coincide due to changes in landform and river location between the two time periods. This is especially evident at the Colusa-North tract where the line between the modeled 1-year floodplain and normal flow is offset to the west for unknown reasons (Figures 2, 4). Based on flooding patterns in recent years the Restoration Area was considered completely in the modeled 1 and 2-year floodplains. Furthermore the DWR estimated flood frequencies do not account for local topography and thus the estimated flood frequencies may not represent actual flooding patterns (CA DWR 2002, US ACE 1997). Potential plant community lines (polygons in Figures 4, 5) appear to be drawn within the existing forest to compensate for the oblique angle at which the 1999 aerial photographs were taken. The 2005 aerial photographs were used to assess any recent changes in vegetation, but not included in the document due to their blurriness.

Although only the flood frequencies are shown here, restoration recommendations take into account the topography data from the U.S. Army Corps of Engineers 1997 digital elevation model (DEM) with 2 foot contours as well as LIDAR data. Since the error on these data is +/- 2 feet, only differences greater than 4 feet are considered real. The potential plant communities are based on Holland's riparian communities (1986). Since biodiversity enhancement is an important restoration goal, species composition of the Holland community is adjusted to reflect nearby remnant riparian plant communities and local differences in that plant community (Hubbell and Efseaff 1998).

Recommended frequencies for woody species are based on species frequency in the remnant riparian vegetation, visual dominance and biodiversity concerns (Tables 1, 2; Peterson et al. 2003, Wood 2003). For communities where no nearby remnant vegetation data exist, data from other baseline assessments with that community were used (e.g. Hubbell et al. 1998, 1999a-d, 2003a-d) or estimates were made based on expected frequency of a species for that community. Remnant riparian woody species frequency was calculated in two ways to provide information on both species composition and distribution for recommended woody species. (1) Calculating remnant riparian woody species frequency across quadrants provides data on species composition and thus is referred to as composition frequency in this document. Within a remnant

riparian community type composition frequency was calculated as: number of quadrants a species occurred in divided by total number of quadrants sampled times 100 (Table 4). Since remnant riparian vegetation composition frequencies for woody species are by one of three physiognomic classes, and recommended composition frequencies are for all woody species lumped together, then recommended composition frequencies will be 1/3 of those found in the remnant vegetation and then possibly adjusted as noted above (Table 1). For species that occurred in multiple physiognomic classes the composition frequency was totaled and then divided by three. (2) Calculating remnant riparian woody species frequency across sampling points provides data on species distribution within the community (e.g. is it clumped or ubiquitous) and thus is called distribution frequency in this document (Table 2). These data can be utilized in the details of the planting design. Within a remnant riparian community type distribution frequency was calculated as: number of points a species occurred at divided by total number of points sampled times 100 (Table 4). For recommendations of species that occurred in multiple physiognomic classes, distribution frequency was calculated across these physiognomic classes. Thus remnant vegetation distribution frequencies are more similar to recommendations.

The species composition and abundance recommendations for herbaceous species are predominantly based on local visual dominance in remnant riparian areas, ecologically-based substitutions of natives for those non-natives common in remnant areas, and biodiversity enhancement (Table 3; Peterson et al. 2003, Wood 2003). Recommendations for herbaceous species are not as precise as are those for woody species due to low occurrence of native herbs in remnant riparian vegetation as well as to the paucity of information regarding composition and abundance of the natural herbaceous layer of riparian communities. Holl and Crone's (2004) study of herbaceous communities along a 150 km reach of the middle Sacramento River found no relationship between understory herbaceous communities and overstory dominance. Still, we were able to use Holl and Crone's data as a basis for some of the recommended herbaceous species. If there were data from both remnant riparian vegetation surveys and from Holl and Crone (2004) we used a mean of the two for the basis of our recommendations. Abundance of remnant riparian herbaceous species within a community type was calculated as mean percent cover: percent cover for a species summed over all points divided by the total number of sampling points (Table 5). Direct seeded grass species are listed without abundances. Only abundance for recommended herbaceous species composition is included here due to the limited data for distribution frequency of remnant riparian herbaceous species (Table 3).

For communities with *Salix* species (cottonwood riparian forest, mixed riparian forest, willow scrub, mule fat scrub, buttonbush scrub, blackberry scrub, rose/*Baccharis* scrub) the total recommended herbaceous species coverage is less than 100 % because this value was calculated as 100% minus the sum of mean percent cover for all the *Salix* species in that community.

Restoration Type Recommendations

A combination of natural process restoration and orchard tree removal with active weed control is recommended to derive the greatest habitat benefit for this Restoration Area. Direct loss of habitat is one of the primary reasons that many native species and communities of the Sacramento River ecosystem are in such critical condition. To improve the situation more habitat must be created in the short term. While restoration by natural processes provides one means of creating new terrestrial habitats, the approach has its limitations. Natural process restoration only works in a timely manner on the lowest lying areas of the floodplain where appropriate hydrogeomorphologic conditions exist. Although orchard tree removal with active weed control will likely damage some of the native recruits, many will resprout. For example valley oak

seedlings have been found to resprout after shoot damage (Hubbell 1997; Hubbell and Griggs unpublished data).

The lower terrace of this Restoration Area (the northwest portion), although lacking the erosional and depositional forces found on the channel edge or in low-lying areas, does appear to have sufficient flooding to permit natural process restoration to be successful. Native riparian vegetation comprises approximately 30% (1.6 acres) of the Restoration Area and there is significant colonization of native species. Furthermore, the Restoration Area is located within over 100 acres of native riparian vegetation. The Restoration Area occurs in the 1-2 year floodplain and is surrounded by sloughs that evidently flood regularly. The floodwaters clearly get as high as the Restoration Area as there appears to be a "channel" of flow from northeast to southwest along the edge between the lower and upper terraces (the north side of the two bands of cottonwood riparian forest in the center of the Restoration Area; see Figure 4). The lower terrace is similar in elevation (60-64'; U.S. ACE 1997) to some of the surrounding vegetation and has the most recruitment, further supporting the likelihood of consistent and/or long standing floodwaters. The upper terrace is higher in elevation than some of the surrounding vegetation, ranging from 64-65' and has less recruitment. However the reduced recruitment may also be a result of the soils (see below). Should active horticulture restoration be conducted, particularly on the upper terrace, the recommendations are described below.

Natural process restoration without any intervention (i.e. orchard removal and weed control) is not recommended as the Restoration Area will continue to be infested with non-native invasive species (e.g., yellow-starthistle, Johnson grass, Bermuda grass) that will inhibit the colonization and proliferation of desirable native vegetation for the foreseeable future, especially on the upper terrace (southern half of the Restoration Area). Although recruitment is occurring in the northern corner, elsewhere little change has occurred between 1999 and 2005. Previous research along the Sacramento River has shown even when sites are artificially flooded coincident with the dispersal of native propagules, exotic species will come to dominate (Peterson 2002). Thus semi-natural process restoration of this Restoration Area would be the most efficient method to create natural habitat relatively quickly.

Restoration Planting Recommendations

The potential plant communities are shown in Figure 4 whereas Figure 5 depicts the potential plant communities with estimated flood frequency and soil sampling locations. Composition and distribution frequencies for the recommended species within a potential plant community are in Tables 1-3. Communities are placed in arcuate bands as much as possible to simulate the natural vegetation pattern.

Mixed riparian forest is recommended for sections A and C to expand the existing mixed riparian forest adjacent to the Restoration Area in the north and reflect the pattern of recruitment toward mixed riparian forest from cottonwood riparian forest in the south. These sections have native species establishing, similar elevation as remnant vegetation, and are within the estimated 1-2-year floodplains. Typical species of mixed riparian forest such as box elder, Fremont cottonwood, valley oak and Oregon ash occur in Section A with valley oak, blue elderberry and mule fat along the edge of Section C. Section A is approximately at 60-64 feet, while section C has an essentially flat elevation of 64 feet. Mixed riparian forest generally occurs in the estimated 1-2-year floodplains from 56 to 66 feet in the sampled remnant riparian vegetation to the north of the Restoration Area (US ACE 1997). Section A has clay and silty clay loam over sandy loam soils. These generally finer-textured soils will be wetter and thus more likely to support a forest. This is evidenced by the better orchard growth and natural recruitment in section A on the 1999 aerial photo. Simultaneously these soils will be well-drained at depth due to the sandy loam and

thus the importance of the valley oak component here. In Section C the soils are loamy sand and thus better drained and drier than those of Section A. The species mix and percentages for section C are weighted toward mixed riparian forest species more tolerant of dry soils such as valley oak and blue elderberry, both of which occur adjacent to this section (Tables 1, 3).

Mule fat scrub and valley wildrye grassland are recommended for sections B and E due to mule fat recruitment, similar elevation as remnant vegetation, occurrence within the estimated 1-2-year floodplains, well-drained soils and for habitat diversity. Mule fat scrub is combined with valley wildrye grassland to reflect both the physical factors of the Restoration Area and the herbaceous composition of the mule fat scrub. Mule fat is recruiting extensively in section B as well as along the edge of section E. Section B has an elevation of 60-62 feet and section E is about 62-64 feet (US ACE 1997). Mule fat scrub was not found at the Colusa-North tract, but mule fat occurs in the estimated 1-2-year floodplains from 56-66 feet in the sampled mixed riparian forest (Table 4). Although valley wildrye grassland, dominated by blue wildrye (*Elymus glaucus* ssp. *glaucus*) was not found at the Colusa-North tract, it does occur adjacent to the Jensen tract (at 78-80 feet). Section B has sandy loam soils and Section E has sandy soils. Such coarse-textured soils are well-drained and thus less likely to support tree growth as evidenced by the lack of natural tree species invasion in these sections on the 1999 aerial photo further supporting shrub and grassland communities. Finally, the mule fat scrub and valley wildrye grassland communities would provide structural diversity for the Restoration Area and thus create different types of habitat.

Elderberry savannah and valley wildrye grassland are recommended for section D due to loamy sand soils, similar elevation as remnant vegetation, occurrence in the estimated 1-2-year floodplains and for habitat diversity. Elderberry savannah is combined with valley wildrye grassland to better reflect both the physical factors of the Restoration Area and the herbaceous composition of the elderberry savannah. Loamy sand soils are coarser-textured and thus are drier soils; this is evidenced by poor vegetative cover on the 1999 aerial photo in general in this section. Blue elderberry prefer sandier soils such as those found here, and do not tolerate longstanding floodwaters (Chirman 1994, Hubbell 1997, Waterman 1994). Section D has an elevation of 64-65 feet (US ACE 1997). Valley wildrye grassland, dominated by blue wildrye, is appropriate here due to the sandy soils and the sampled herbland elevation of 64-68 feet. Blue elderberry occurs in the estimated 1-2-year floodplains from 51-64 feet in the cottonwood riparian forest surrounding the Restoration Area, including nearby this section. Finally, the elderberry savannah and valley wildrye grassland communities would provide structural diversity for the Restoration Area and thus create different types of habitat.

Willow scrub and valley wildrye grassland are recommended for section F to expand the existing willow scrub in the Restoration Area. This section has sandy loam soils, similar elevation as remnant vegetation, and is in the estimated 1-2-year floodplains. Willow scrub is combined with valley wildrye grassland to reflect both the physical factors of the Restoration Area and the herbaceous composition of the willow scrub. Sandy loam soils are coarser-textured and thus are drier soils; this is evidenced by poor vegetative cover on the 1999 aerial photo. Section F has an elevation of about 58-62 feet (US ACE 1997). Willow scrub occurs in the estimated 1-2-year floodplains from 54-64 feet adjacent to the sampled herbland with an elevation of 64-68 feet. Valley wildrye grassland, dominated by blue wildrye, is appropriate here due to the sandy soils, even though this section is lower than the sampled herbland.

Colusa-North Restoration Area: Remnant Riparian Plant Communities

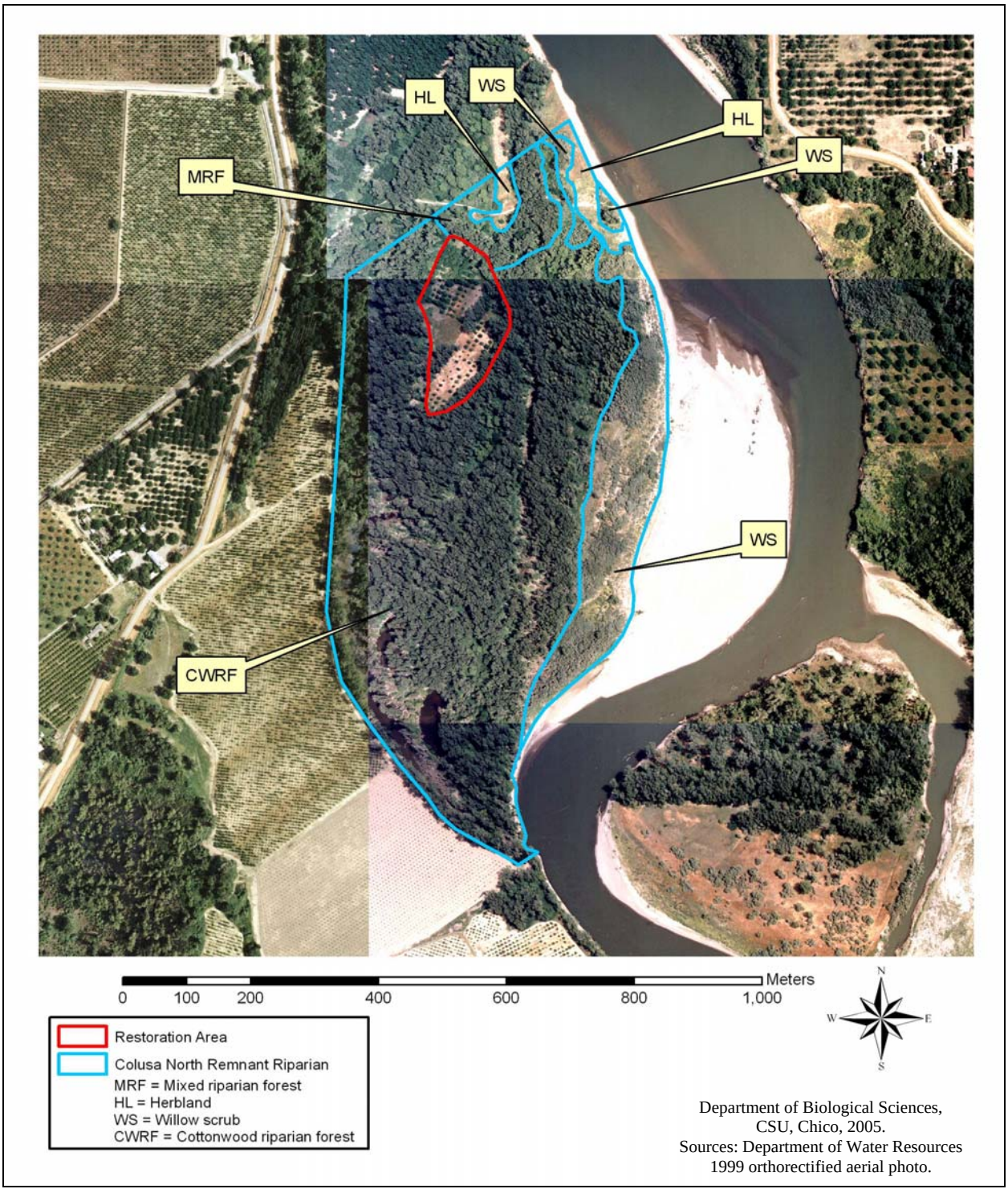


Figure 1. Remnant riparian plant communities surrounding the Colusa-North Restoration Area, Colusa County, California.

Colusa-North Restoration Area: Estimated Flood Frequency and Soil Sampling Locations

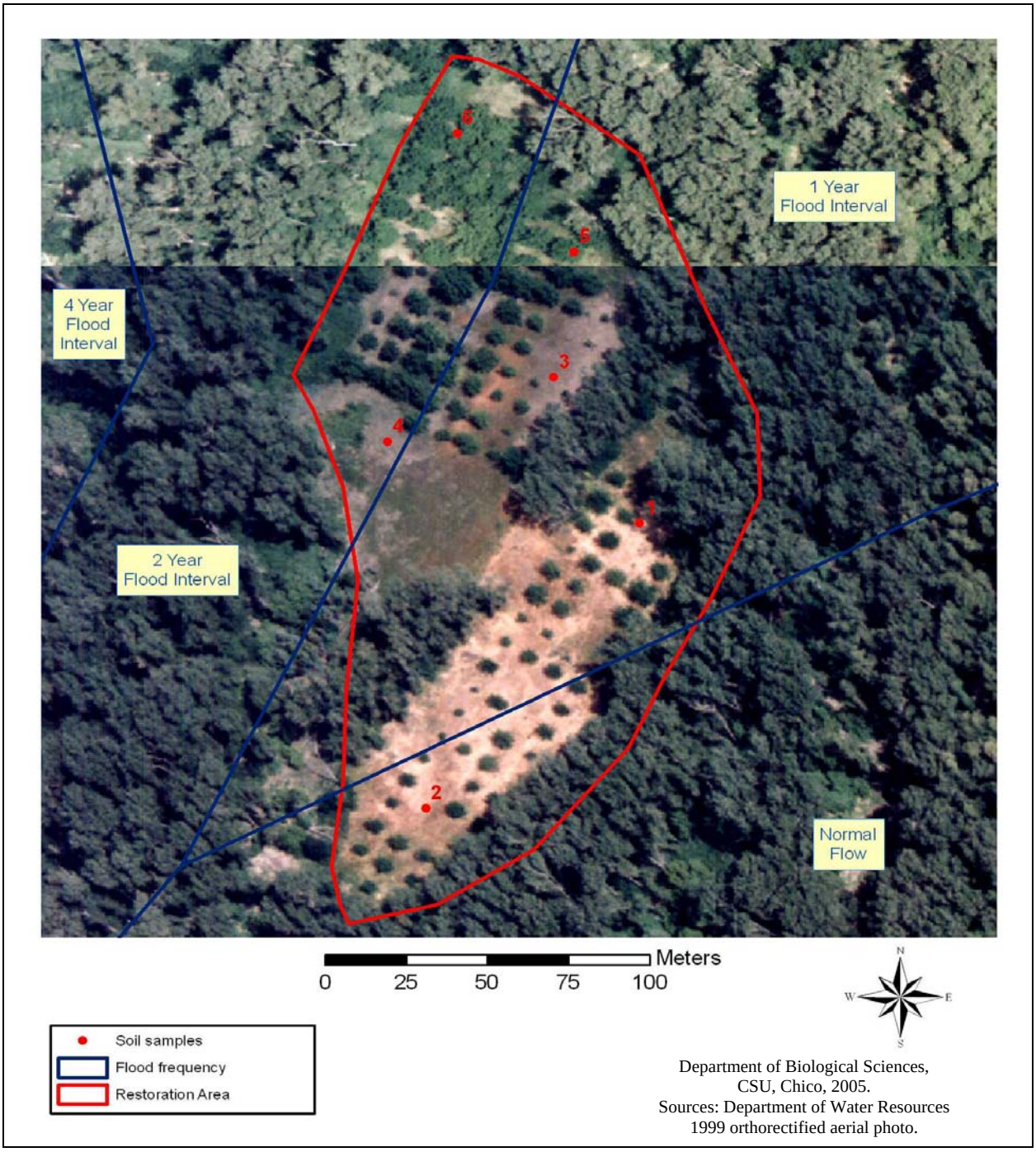


Figure 2. Estimated flood frequency and soil sampling locations at the Colusa-North Restoration Area, Colusa County, California. Flood frequencies are from Department of Water Resources 1997 data; air photo is from 1999. See text for discussion of discrepancy.

Colusa-North Restoration Area: Soil Sampling Locations and Historic River Channels

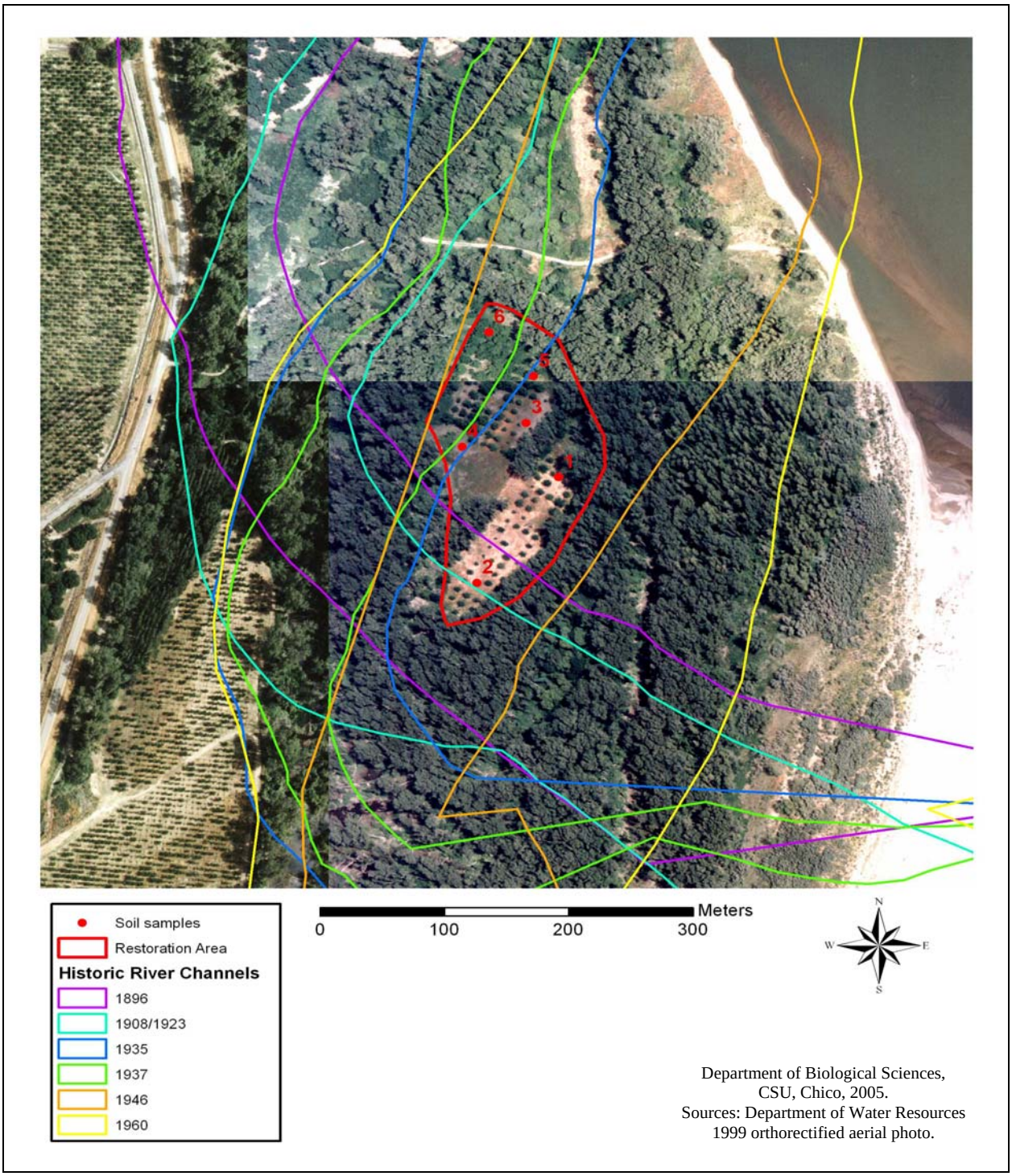


Figure 3. Historic river channels from 1896, 1908, 1923, 1935, 1937, 1946, and 1960 at the Colusa-North Restoration Area, Colusa County, California. For this stretch of the river, the 1923 river channel is the same as the 1908 river channel.

Colusa-North Restoration Area: Potential Plant Communities

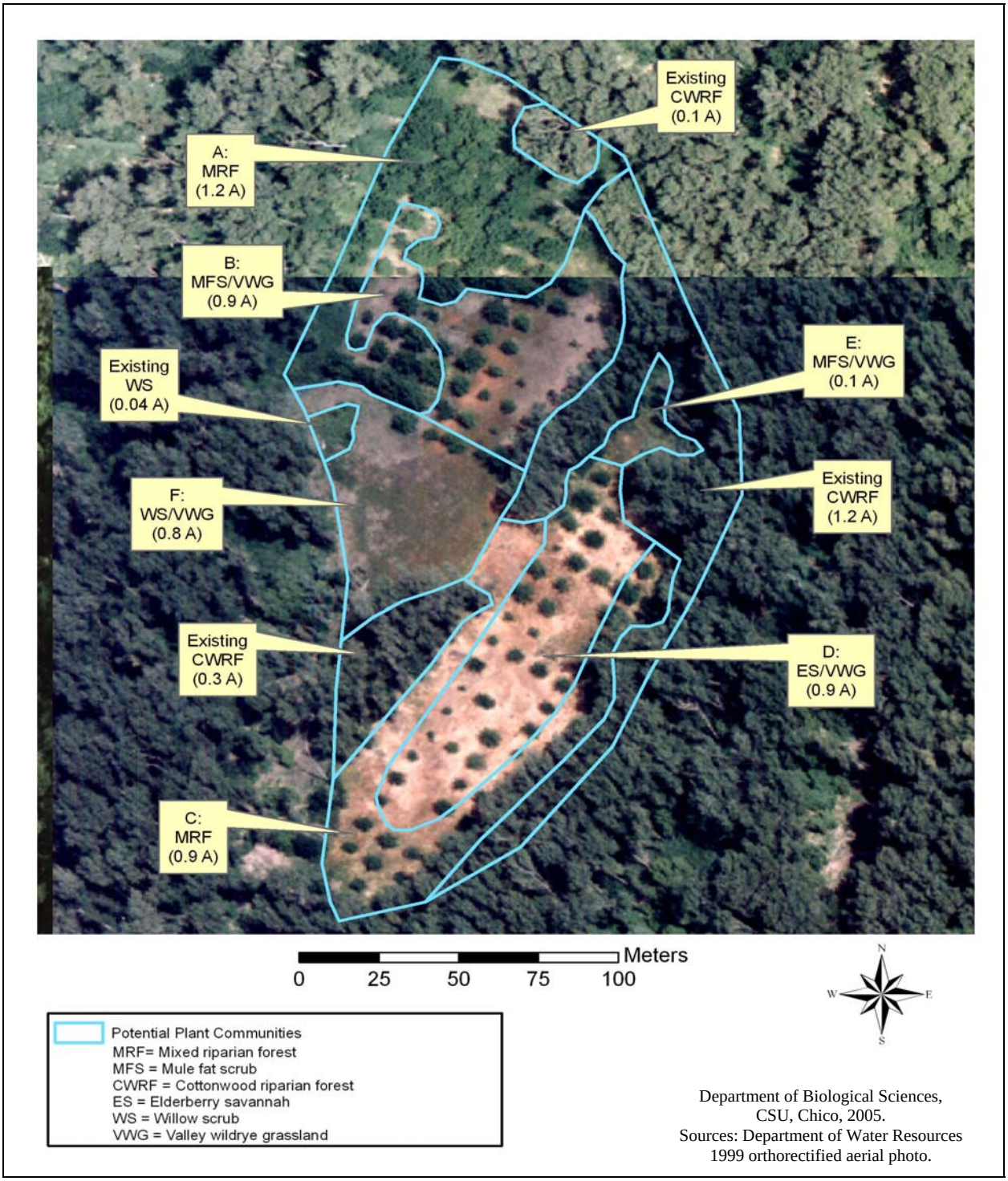


Figure 4. Potential plant communities for the Colusa-North Restoration Area, Colusa County, California. Note that polygons appear inside existing forest due to oblique angle of aerial photo.

Colusa-North Restoration Area: Estimated Flood Frequency, Soil Sampling Locations and Potential Plant Communities

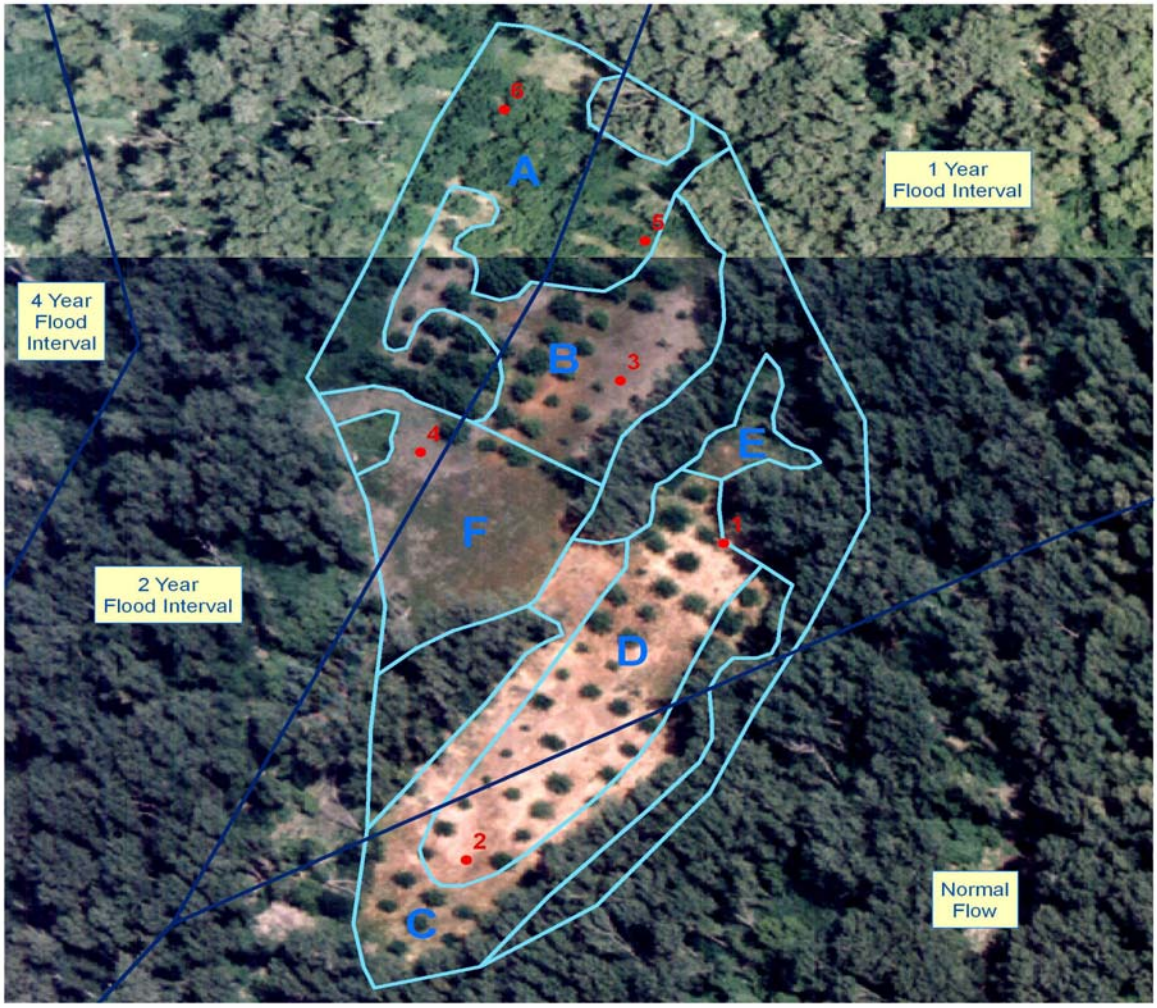


Figure 5. Estimated flood frequency, soil sampling locations, and potential plant communities at the Colusa-North Restoration Area, Colusa County, California. A and C are mixed riparian forest (1.2 and 0.9 A, respectively); B and E are mule fat scrub/valley wildrye grassland (0.9 and 0.1 A, respectively); D is elderberry savannah/valley wildrye grassland (0.9 A); F is willow scrub/ valley wildrye grassland (0.8 A). Flood frequencies are from Department of Water Resources 1997 data; air photo is from 1999. See text for discussion of discrepancy and polygon placement.

Table 1. Composition frequency by community type for potential woody overstory restoration species for the Colusa-North Restoration Area, Colusa County, California. Remnant vegetation frequency is given by community type for those species recorded during quantitative sampling. Abbreviations are: MRF=Mixed Riparian Forest with "-A" for section A and "-C" for section C; WS=Willow Scrub; ES=Elderberry Savannah; MFS=Mule Fat Scrub; VWG=Valley Wildrye Grassland. A "+" indicates observed but not sampled for that community; a blank indicates not observed. An "H" indicates a species added since listed by Holland. Nomenclature follows *The Jepson Manual* (Hickman 1993).

Common Name	Scientific Name	Composition Frequency (%)						
		Remnant Vegetation Colusa-North		Colusa-North Recommendations				
Woody Species		**MRF (n=8)**	**WS (n=8)**	**MRF-A**	**MRF-C**	**WS/VWG**	**ES/VWG**	**MFS/VWG**
box elder	*Acer negundo*	113		38	15			
western sycamore	*Platanus racemosa*	H		2	15			
Fremont cottonwood	*Populus fremontii*	25	13	12	5	10		
valley oak	*Quercus lobata*	+		2	15			
Oregon ash	*Fraxinus latifolia*	+		2	2			
Goodding's black willow	*Salix gooddingii*	H		2				
mule fat	*Baccharis salicifolia*	25		11	13			80
narrow-leaved willow	*Salix exigua*		100			45		10
arroyo willow	*Salix lasiolepis*	13	H	4	4	15		10
blue elderberry	*Sambucus mexicana*				5		90	
western poison oak	*Toxicodendron diversilobum*	13		4	4			
California button willow	*Cephalanthus occidentalis var. californicus*	H		2				
red willow	*Salix laevigata*	H		2				
shining willow	*Salix lucida ssp. lasiandra*	H	H	2		15		
California rose	*Rosa californica*		H			5		
California pipevine	*Aristolochia californica*		13			5		
virgin's bower	*Clematis ligusticifolia*	H		2	2			
California blackberry	*Rubus ursinus*	50		10	12			
California wild grape	*Vitis californica*	25	H	5	8	5	10	
Total Coverage				100	100	100	100	100

Table 2. Distribution frequency by community type for potential woody overstory restoration species for the Colusa-North Restoration Area, Colusa County, California. Frequency is given by community type for those species recorded during quantitative sampling. Abbreviations are: MRF=Mixed Riparian Forest with "-A" for section A and "-C" for section C; WS=Willow Scrub; ES=Elderberry Savannah; MFS=Mule Fat Scrub; VWG=Valley Wildrye Grassland. A blank indicates not observed. An "*" indicates estimated frequency for species that were recommended but not sampled within a remnant community. Nomenclature follows *The Jepson Manual* (Hickman 1993).

Common Name	Scientific Name	Colusa-North Recommendations				
		Distribution Frequency (%)				
Woody Species		**MRF-A**	**MRF-C**	**WS/VWG**	**ES/VWG**	**MFS/VWG**
box elder	*Acer negundo*	100	50*			
western sycamore	*Platanus racemosa*	10*	75*			
Fremont cottonwood	*Populus fremontii*	50	50	50		
valley oak	*Quercus lobata*	10*	75*			
Oregon ash	*Fraxinus latifolia*	10*	10*			
Goodding's black willow	*Salix gooddingii*	10*				
mule fat	*Baccharis salicifolia*	50	50			100*
narrow-leaved willow	*Salix exigua*			100		50*
arroyo willow	*Salix lasiolepis*	50	50	75*		50*
blue elderberry	*Sambucus mexicana*		10*		75*	
western poison oak	*Toxicodendron diversilobum*	50	50			
California button willow	*Cephalanthus occidentalis var. californicus*	10*				
red willow	*Salix laevigata*	10*				
shining willow	*Salix lucida ssp. lasiandra*	10*		75*		
California rose	*Rosa californica*			50*		
California pipevine	*Aristolochia californica*			50		
virgin's bower	*Clematis ligusticifolia*	10*	10*			
California blackberry	*Rubus ursinus*	100	100			
California wild grape	*Vitis californica*	50	50	50*	50*	

Table 3. Mean percent cover by community type for potential herbaceous understory restoration species at the Colusa-North Restoration Area, Colusa County, California. Abbreviations are: MRF=Mixed Riparian Forest with "-A" for section A and "-C" for section C; WS=Willow Scrub; HL=Herbland; VOW=Valley Oak Woodland; ES=Elderberry Savannah; MFS=Mule Fat Scrub; VWG=Valley Wildrye Grassland. Abundances in italics are from Holl and Crone (2004). A blank indicates not observed. "E" indicates species to be planted on the edge. An "H" indicates a species added since listed by Holland. "DS" indicates that these species will be direct seeded and thus not planted as plugs. Note that the herbaceous component is less than 100 % in communities with *Salix* species (see Methods). Nomenclature follows *The Jepson Manual* (Hickman 1993).

Common Name	Scientific Name	Mean Percent Cover								
		Remnant Vegetation				Colusa-North Recommendations				
		Colusa-North			Womble/Jensen					
Herbaceous Species		**MRF (n=2)**	**WS (n=2)**	**HL (n=2)**	**VWG/VOW (n=3)**	**MRF-A**	**MRF-C**	**WS/VWG**	**ES/VWG**	**MFS/VWG**
mugwort	*Artemisia douglasiana*	*4.36*	43.34	20.00	H	19	10	11	10	15
goose grass	*Galium aparine*	15.85	*16.67*		1.00	10	10		5	1
horseweed	*Conyza canadensis*	*0.05*				5				
fireweed	*Epilobium ciliatum*	*0.05*				5				
lotus	*Lotus purshianus*	*0.05*				5				
bugleweed	*Lycopus americanus*	*0.09*				5				
nettle	*Urtica dioica*	*1.76*			H	7	7	2	5	10
telegraph weed	*Heterotheca grandiflora*						10		5	
western goldenrod	*Euthamia occidentalis*					10	10	2	2	12
Fitch's spikeweed	*Hemizonia fitchii*						10		5	
Oregon golden aster	*Heterotheca oregona*						10		5	
California goldenrod	*Solidago californica*					10	10	2	2	12
hairy evening-primrose (E)	*Oenothera elata ssp hirsutissima*					2	7	2	1	
Santa Barbara sedge	*Carex barbarae*	*1.56*				7	7	2	10	10
clustered field sedge	*Carex praegracilis*					5		2	5	5
nodding needlegrass	*Nassella cernua*								15	
deergrass	*Muhlenbergia rigens*							2		15
California melic	*Melica californica*						5		15	
one-sided bluegrass	*Poa secunda* ssp. *secunda*								15	
blue wildrye	*Elymus glaucus*	*3.49*	*3.50*		33.00	DS	DS	DS	DS	DS

Table 3 continued.

Common Name	Scientific Name	Mean Percent Cover								
		Remnant Vegetation				Colusa-North Recommendations				
		Colusa-North			Womble/Jensen					
Herbaceous Species		**MRF (n=2)**	**WS (n=2)**	**HL (n=2)**	**VWG/VOW (n=3)**	**MRF-A**	**MRF-C**	**WS/VWG**	**ES/VWG**	**MFS/VWG**
creeping wildrye	*Leymus triticoides*				H	DS	DS	DS	DS	DS
meadow barley	*Hordeum brachyantherum*	TNC				DS	DS	DS		DS
purple needlegrass	*Nassella pulchra*					DS	DS		DS	
Total Coverage						90	96	25	100	80

References

California Department of Fish and Game. 2003. California Natural Diversity Database, List of California Terrestrial Natural Communities. Wildlife and Habitat Data Analysis Branch, Sacramento CA. Retrieved from: http://www.dfg.ca.gov/whdab/pdfs/natcomlist.pdf.

California, Department of Water Resources. 2002. GIS of the middle Sacramento River, California. Northern District, Red Bluff, California.

Chirman, D. B. 1994. Nutrient dynamics during establishment of understory woody species in California Central Valley riparian habitats. Master's thesis. University of California-Davis, Davis, California.

Hickman, J., Ed. 1993. The Jepson Manual: Higher Plants of California. University of California Press, Berkeley, California.

Holl, K. D. and E. L. Crone. 2004. Applicability of landscape and island biogeography theory to restoration of riparian understorey plants. Journal of Applied Ecology 41:922-933.

Holland, R. F. 1986. Preliminary Descriptions of the Terrestrial Natural Communities of California. California Department of Fish and Game, Non-game Heritage Program, Sacramento, California.

Hubbell, J. G. 1997. Competitive effects of intercropping alfalfa with valley oak and blue elderberry seedlings. Master's thesis. California State University-Chico, Chico, California.

Hubbell, J.G. and D.S. Efseaff. 1998. Vegetation Assessment of Five 1998/1999 Sacramento River Project Restoration Sites for The Nature Conservancy. Unpublished report to The Nature Conservancy (TNC).

Hubbell, J.G., D.L. Brown, J. Rotnem, J. Schwenkler, G. Magda, C. Wilder, and S. Ellberg. 1999a. Kaiser 1999 Site Assessment for The Nature Conservancy. Unpublished report to TNC.

----------. 1999b. River Vista 1999 Site Assessment for The Nature Conservancy. Unpublished report to TNC.

Hubbell, J.G., D.L. Brown, J. Rotnem, J. Schwenkler, G. Magda, and C. Wilder. 1999c. Ryan 1999 Site Assessment for The Nature Conservancy. Unpublished report to The Nature Conservancy.

----------. 1999d. Stone 1999 Site Assessment for The Nature Conservancy. Unpublished report to TNC.

Hubbell, J.G., J.W. Hunt, M. Quinn, and D.M. Wood. 2003a. Site Assessment for Riparian Restoration at the RX Ranch Unit. Unpublished report to TNC.

----------. 2003b. Site Assessment for Riparian Restoration at the Deadman's Reach Unit of U.S. Fish and Wildlife Service's Sacramento River National Wildlife Refuge. Unpublished report to TNC.

----------. 2003c. Site Assessment for 2003 Restoration at the Haleakala Unit of U.S. Fish and Wildlife Service's Sacramento River National Wildlife Refuge. Unpublished report to TNC.

----------. 2003d. Site Assessment for Riparian Restoration at the Sunset Ranch Unit. Unpublished report to TNC.

Keeler-Wolf, T. and M. Vaghti. 2000. Vegetation Mapping of Suisun Marsh, Solano County, California. California Department of Fish and Game, Wildlife and Habitat Data Analysis Branch.

The Nature Conservancy. 2005. Draft Colusa Subreach Background Report. Northern Central Valley Office, Chico, California.

Peterson, D.R. 2002. The development of an alternative restoration strategy for Sacramento River riparian forests. Master's Thesis, California State University, Chico.

Peterson D.R., G.H. Golet, R. Luster, M. Roberts, and D. Jukkola. 2003. Modeling plant community types as a function of physical site characteristics. Report to CALFED. Available at: http://www.sacramentoriverportal.org.

U.S. Army Corps of Engineers. 1997. Digital elevation model. Received from The Nature Conservancy.

U.S. Department of Agriculture, National Agriculture Imagery Program. 2005. Orthorectified aerial photos of Glenn and Colusa Counties, California.

Waterman, M. 1994. Play it again *Sambucus*. American Horticulturalist 73:35-37.

Wood, D.M. 2003. An analysis of vegetation on restoration sites. Report to The Nature Conservancy. Available at: http://www.sacramentoriverportal.org.

SECTION TWO

COLUSA-NORTH

REMNANT RIPARIAN VEGETATION SURVEY

Catherine Little
Jean G. Hubbell, M.S.
Gay Ann Silman
Katie C. Price
Dr. David M. Wood

Introduction

Remnant riparian vegetation surveys of nearby stands are used as a reference for potential vegetation communities and for determining planting recommendations in the Restoration Area.

Mixed riparian forest forms the Restoration Area's northeastern boundary. The remainder of the Restoration Area's boundary is cottonwood riparian forest. An herbland occurs in the center of the mixed riparian forest to the northeast of the Restoration Area. There is a band of willow scrub and a band of herbland with a patch of willow scrub extending east from the mixed and cottonwood riparian forests to the Sacramento River.

Remnant riparian vegetation surveyed occurs on the Colusa-North tract owned by the Wildlife Conservation Board and managed by California Department of Fish and Game as the northerly subunit of the Colusa Unit of their Sacramento River Wildlife Area and surrounds the Restoration Area as described above. Details of adjacent landcover can be found in Section One.

Four natural communities were found to occur nearby the Restoration Area: Great Valley cottonwood riparian forest, Great Valley mixed riparian forest, Great Valley willow scrub, and herbland (Figure 6). Qualitative community descriptions follow Holland (1986). With the exception of herbland, all of these communities in some form (i.e. nomenclature may differ) are on the list of California Terrestrial Natural Communities recognized by the California Natural Diversity Database (CA DFG 2003). Three of these communities (excluding herbland) comprise the estimated 104 acres of native riparian vegetation within the Colusa-North tract.

Methods

The vegetation survey maps community types and lists the most obvious plant species for nearby remnant riparian vegetation. Community typing here is qualitative and is based on visually dominant species, overall species list and frequency data rather than complete quantified sampling for community composition. Intergradations occur for most community types in the riparian vegetation. Listing of the visually common plant species was performed during point-quarter sampling and site reconnaissance. Nomenclature follows *The Jepson Manual* (Hickman 1993). If no common name is listed in *The Jepson Manual* then Oswald and Ahart's (1994) common name was used.

Vegetation sampling was conducted during June 2005 in the remnant riparian vegetation surrounding the Restoration Area (Figure 6). Point-quarter sampling was used to quantify frequency of woody species and abundance of herbaceous species (Barbour et al. 1999). Remnant vegetation was stratified into approximate community types using aerial photograph interpretation and GIS vegetation coverage (CA DWR 2002; not shown). Each community type was then sampled to provide enough data to confirm the community type, adjust boundaries, and describe species composition. The amount of sampling for each community is proportional to its area. In each community type within the remnant riparian vegetation at least two sampling points were established (if possible). Fourteen sampling points, each with four quadrants, were established along several transects running roughly perpendicular to the bands of vegetation. For frequency of woody species, each quadrant was sampled for three types of woody species: trees, shrubs and vines. For each type of woody species, the first species encountered within each quadrant of a sampling point was recorded. Since a number of riparian woody species occur as both trees and shrubs, physiognomic criteria were used (e.g. multiple stems for shrub and diameter at breast height greater than 8 cm for trees). Thus some woody species can be listed in two categories. For abundance of herbaceous species, the percent cover of the three most visually abundant species within a 3 m radius of each sampling point was recorded.

Within each remnant riparian community type and woody species category, frequency was calculated in two ways to provide information on both woody species composition and

distribution. (1) Calculating woody species frequency across quadrants provides data on species composition and thus is referred to as composition frequency in this document. Within a community type composition frequency was calculated as: number of quadrants a species occurred in divided by total number of quadrants sampled times 100 (Tables 4 and 6). These data are the basis for determining frequency of recommended species for restoration. (2) Calculating woody species frequency across sampling points provides data on species distribution within the community (e.g. is it clumped or ubiquitous) and thus is called distribution frequency in this document. These data can be utilized in the details of the planting design. Within a community type distribution frequency was calculated as: number of points a species occurred at divided by total number of points sampled times 100 (Tables 4 and 6). Abundance of herbaceous species within a community type was calculated as mean percent cover: percent cover for a species summed over all points divided by the total number of sampling points (Tables 5 and 7). Total percent herbaceous cover for a given point may sum to above or below 100% as a result of overlapping herb layers or patches of bare ground, respectively.

Species observed in the remnant riparian vegetation were divided into potential woody and herbaceous restoration species (Tables 4 and 5) and species not recommended for restoration (Tables 6 and 7). Composition and distribution frequency by community type are given for species that occurred at the sampling points. Species observed, but not quantitatively sampled, in a community type are noted by a "+" in the tables.

A search of the literature and the California Natural Diversity Database (CNDDB; CA DFG 2005) records was performed to determine potential and known occurrences of threatened and endangered plant species occurring within 1.0 mile of the Restoration Area. A separate CNDDB search was done by USGS quadrangles (7.5'series) to determine additional species with potential to occur on site. Four quadrangles were searched: Moulton Weir, Sanborn Slough, Colusa, and Meridian. An electronic copy of the CNDDB records is included on the Baseline Assessment CD.

River Channel History

The main channel of the Sacramento River scrolled across the remnant vegetation area from at least 1896 through 1976 (DWR 2002, Figures 3, 10-12). Between 1976 and 1981 the main channel migrated east of the present day forests, suggesting the age of forest bands ranges from 26 to 72 years old going east to west (away from the river). The inner approximate half of the 1999 point bar area was the main channel in 1981, suggesting the point bar began to develop about 26 years ago. The outer approximate half of the 1999 point bar area was the main channel in 1991, and thus is about 16 years old. Note that in the 2005 aerial photo (not shown) the sandy bands to the north and south of the 1999 point bar are completely vegetated. The northwestern quarter of the 1999 point bar is also vegetated.

Remnant Riparian Vegetation Community Descriptions

Qualitative community descriptions follow those of Holland (1986) with approximate acreage in parentheses. Remnant riparian plant communities sampled are mapped in Figure 6. Due to recent receding of floodwaters at the time of sampling the herbaceous layer was lacking at several sampling points in the cottonwood and mixed riparian forests. Thus the herbaceous layer sampled may be less species rich and have a lower percent cover than in other years. Broad-leaved pepper-grass (*Lepidium latifolium*) an aggressive invasive species composed 85% of the understory at one point in the cottonwood riparian forest. This point is located third from the river on the middle transect (see Figure 6).

The remnant riparian vegetation east, south, west and northwest of the Restoration Area consists of an extensive cottonwood riparian forest (75 acres). The forest is dominated primarily by Fremont cottonwood (*Populus fremontii*) and Goodding's black willow (*Salix gooddingii*) with a mixed subcanopy layer of box elder (*Acer negundo*), California black walnut (*Juglans californica*), edible fig (*Ficus carica*), willow (*Salix exigua*, *S. lasiolepis*), and pockets of blue elderberry (*Sambucus mexicana*). Valley oak (*Quercus lobata*) trees are interspersed on higher areas or the edges of the forest. Northeast of the Restoration Area there is a stand of mixed riparian forest (4.5 acres) that is dominated by box elder interspersed with occasional Fremont cottonwood trees. The box elder trees are larger in this forest community and are dominating the upper canopy as compared with the cottonwood riparian forest, where they are mostly a component of the subcanopy. The similarities of the mixed riparian forest canopy and cottonwood riparian forest sub-canopy suggest that the cottonwood riparian forest here is undergoing succession toward mixed riparian forest.

Closer to the river, there is a willow scrub community (16 acres, 0.5 acres) dominated by medium-sized narrow-leaved willow (*Salix exigua*) interspersed with patches of herbaceous species. There are two patches of herbland (0.9 acres, 1.5 acres) that are dominated by non-native herbaceous species and patches of native mugwort (*Artemisia douglasiana*). The herbland closer to the river had more species typical of wetter soils than the herbland located in the middle of the mixed riparian forest. Note that in the 2005 aerial photo (not shown) willows (*Salix* species) have colonized the northern and southern sandbars and the northwestern area of the large point bar to the east of the remnant vegetation since 1999 (4.4 acres). This additional riparian vegetation plus the approximate 1.6 acres within the Restoration Area make the estimated remnant vegetation 104 acres.

Colusa-North Restoration Area: Remnant Riparian Vegetation Sampling Locations

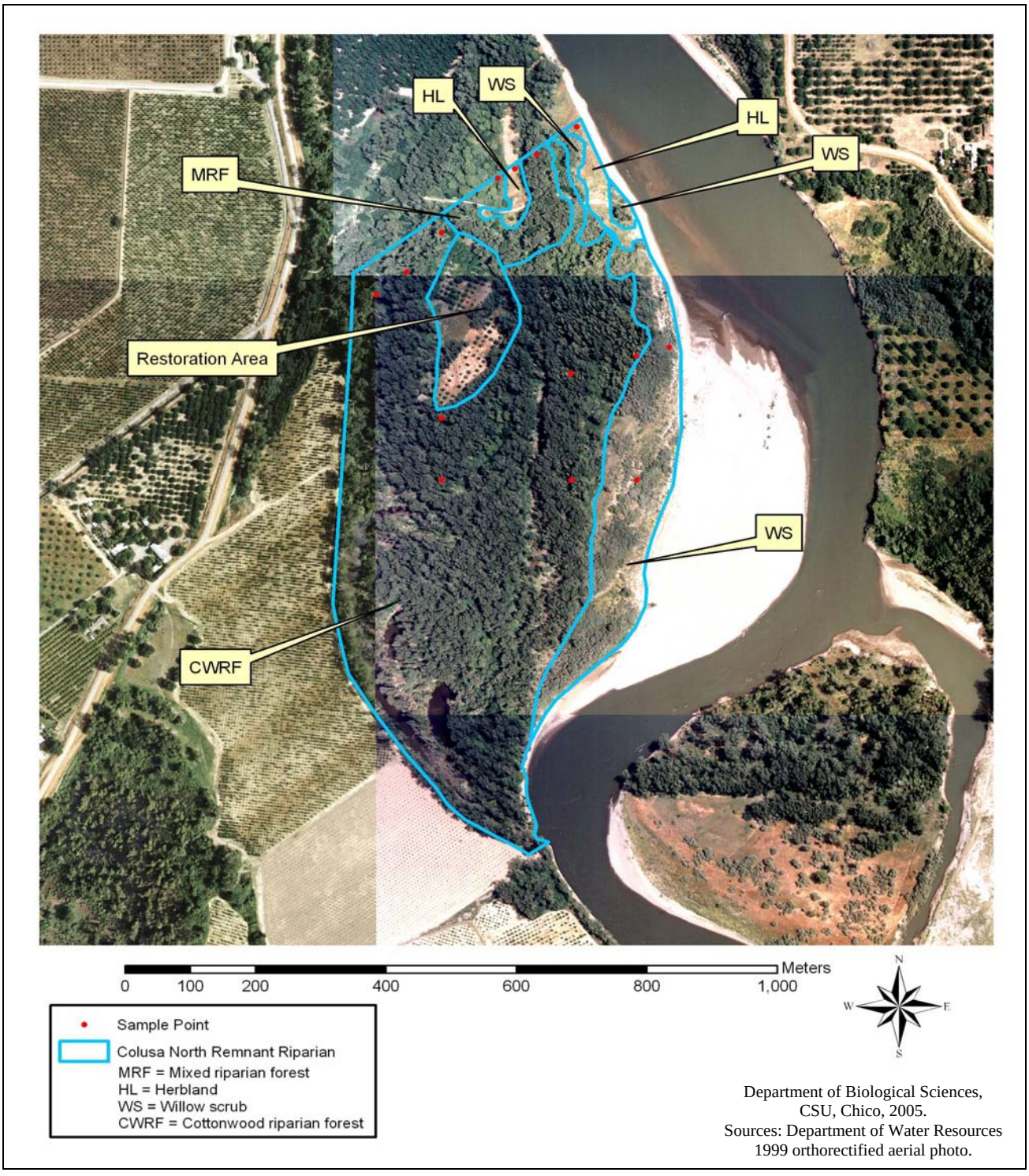


Figure 6. Remnant riparian plant communities and vegetation sampling locations within riparian plant communities surrounding the Colusa-North Restoration Area, Colusa County, California.

Table 4. Composition and distribution frequencies by community type for potential native woody restoration species found in remnant riparian vegetation close to the Colusa-North Restoration Area, Colusa County, California. Frequency is given by community type for those species recorded during quantitative sampling. The sample size (n) for composition frequency represents the number of quadrants sampled. The sample size (n) for distribution frequency represents the number of points sampled. Abbreviations are: CWRF=Cottonwood Riparian Forest; MRF=Mixed Riparian Forest; WS=Willow Scrub; HL=Herbland. A "+" indicates observed but not sampled for that community; a blank indicates not observed. Nomenclature follows *The Jepson Manual* (Hickman 1993).

Common Name	Scientific Name	Composition Frequency (%)				Distribution Frequency (%)			
Trees		**CWRF (n=32)**	**MRF (n=8)**	**WS (n=8)**	**HL (n=8)**	**CWRF (n=8)**	**MRF (n=2)**	**WS (n=2)**	**HL (n=2)**
box elder	*Acer negundo*	9	75			25	100		
western sycamore	*Platanus racemosa*	+							
Fremont cottonwood	*Populus fremontii*	44	25	13		75	50	50	
valley oak	*Quercus lobata*	6	+			25			
Goodding's black willow	*Salix gooddingii*	25				38			
Oregon ash	*Fraxinus latifolia*		+						
Shrubs									
box elder	*Acer negundo*	22	38			50	50		
mule fat	*Baccharis salicifolia*	+	25				50		
valley oak	*Quercus lobata*	3				13			
narrow-leaved willow	*Salix exigua*	3		100		13		100	
Goodding's black willow	*Salix gooddingii*	3				13			
arroyo willow	*Salix lasiolepis*		13				50		
blue elderberry	*Sambucus mexicana*	6				25			
western poison oak	*Toxicodendron diversilobum*	3	13			13	50		
Vines									
California pipevine	*Aristolochia californica*	+		13				50	
virgin's bower	*Clematis ligusticifolia*	3				13			
California blackberry	*Rubus ursinus*	50	50			75	100		
western poison oak	*Toxicodendron diversilobum*	6				13			
California wild grape	*Vitis californica*	28	25			63	50		

Table 5. Mean percent cover and distribution frequency by community type of potential native herbaceous restoration species found in remnant riparian vegetation close to the Colusa-North Restoration Area, Colusa County, California. The sample size (n) for mean percent cover and for distribution frequency is the same and represents the number of points sampled. Abbreviations are: CWRF=Cottonwood Riparian Forest; MRF=Mixed Riparian Forest; WS=Willow Scrub; HL=Herbland. A blank indicates not observed. Nomenclature follows *The Jepson Manua*l (Hickman 1993).

Common Name	Scientific Name	Mean Cover (%)				Distribution Frequency (%)			
Herbs		**CWRF (n=8)**	**MRF (n=2)**	**WS (n=2)**	**HL (n=2)**	**CWRF (n=8)**	**MRF (n=2)**	**WS (n=2)**	**HL (n=2)**
mugwort	*Artemisia douglasiana*	10		45	20	38		100	50
sedge	*Carex* sp.	4				13			
goose grass	*Galium aparine*	9	13			38	50		
nettle	*Urtica dioica*	1				13			

Table 6. Composition and distribution frequencies by community type for woody plant species not recommended, but found in remnant riparian vegetation close to the Colusa-North Restoration Area, Colusa County, California. Frequency is given by community type for those species recorded during quantitative sampling. The sample size (n) for composition frequency represents the number of quadrants sampled. The sample size (n) for distribution frequency represents the number of points sampled. Abbreviations are: CWRF=Cottonwood Riparian Forest; MRF=Mixed Riparian Forest; WS=Willow Scrub; HL=Herbland. A blank indicates not observed. Nomenclature follows *The Jepson Manua*l (Hickman 1993).

Common Name	Scientific Name	Composition Frequency (%)				Distribution Frequency (%)			
Trees		**CWRF (n=32)**	**MRF (n=8)**	**WS (n=8)**	**HL (n=8)**	**CWRF (n=8)**	**MRF (n=2)**	**WS (n=2)**	**HL (n=2)**
California black walnut	*Juglans californica*	3				13			
Shrubs									
edible fig	*Ficus carica*	31				63			
California black walnut	*Juglans californica*	28	13		25	63	50		50
Vines									
Himalayan blackberry	*Rubus discolor*		25				50		

Table 7. Mean percent cover and distribution frequency by community type for herbaceous plant species not recommended, but found in remnant riparian vegetation close to the Colusa-North Restoration Area, Colusa County, California. Frequency is given by community type for those species recorded during quantitative sampling. The sample size (n) for mean percent cover and for distribution frequency is the same and represents the number of points sampled. Abbreviations are: CWRF=Cottonwood Riparian Forest; MRF=Mixed Riparian Forest; WS=Willow Scrub; HL=Herbland. A blank indicates not observed. Nomenclature follows *The Jepson Manua*l (Hickman 1993).

Common Name	Scientific Name	Mean Cover (%)				Distribution Frequency (%)			
Herbs		CWRF (n=8)	MRF (n=2)	WS (n=2)	HL (n=2)	CWRF (n=8)	MRF (n=2)	WS (n=2)	HL (n=2)
wild oat	*Avena fatua*				18				50
ripgut grass	*Bromus diandrus*				15				50
black mustard	*Brassica nigra*				20				50
yelllow star-thistle	*Centaurea solstitialis*				13				50
grass	Grass sp.	3		60		13		100	
klamathweed	*Hypericum perforatum*			1				50	
prickly lettuce	*Lactuca serriola*			1				50	
broad-leaved pepper-grass	*Lepidium latifolium*	11				13			
Johnsongrass	*Sorghum halepense*				30				50
common hedge-parsley	*Torilis arvensis*	1				13			

Special-status Plant Species

Information about known and potential occurrences of special-status plant species was obtained from the California Natural Diversity Database (CNDDB; CA DFG 2005). Based on the quadrangle search of the CNDDB, five species were initially identified to potentially occur within 1 mile of the Restoration Area (Table 8). Based on distribution, elevation, and habitat requirements, one of these species was determined to be unlikely to occur. Of the four species with potential to occur, no known occurrences were found within 1.0 mile of the Restoration Area.

Table 8. Special-status plant species potentially occurring within 1.0 mile of the Colusa-North Restoration Area, Colusa County, California. FE=federally listed as endangered; FT=federally listed as threatened; CE=California state listed as endangered; CNPS=California Native Plant Society, 1B=rare, threatened or endangered in California and elsewhere, 2=rare in California but more common elsewhere, 3=need more information, 4=plants of limited distribution; a watch list. Habitat descriptions were adapted from CNPS (2004).

Scientific Name	Common Name	Habitat	Status	Potential to Occur
Astragalus tener var. *ferrisiae*	Ferris's milk-fetch	Meadows and seeps (vernally mesic), valley and foothill grassland (subalkaline flats); elevation 5-75 meters.	CNPS 1B	May occur. No known occurrences within 1 mile of the restoration area.
Atriplex depressa	brittlescale	Chenopod scrub, meadows and seeps, playas, valley and foothill grassland, vernal pools/alkaline, clay; elevation 1-320 meters.	CNPS 1B	May occur. No known occurrences within 1 mile of the restoration area.
Cordylanthus palmatus	palmate-bracted bird's-beak	Chenopod scrub, valley and foothill grassland (alkaline); elevation 5-155 meters.	FE, CE, CNPS 1B	May occur. No known occurrences within 1 mile of the restoration area. Known from only nine occurrences.
Hibiscus lasiocarpus	Rose-mallow	Marshes and swamps (freshwater); elevation 0-120 meters.	CNPS 2	May occur. No known occurrences within 1 mile of the restoration area.
Lasthenia glabrata ssp. *coulteri*	Coulter's goldfields	Marshes and swamps (coastal salt), playas, vernal pools; elevation 1-1220 meters.	CNPS 1B	Unlikely to occur due to the lack of suitable habitat. No known occurrences within 1 mile of the restoration area.

References

Barbour, M.G., J.H. Burk, W.D. Pitts, F.S. Gilliam and M.W. Schwartz. 1999. Terrestrial Plant Ecology 3rd Edition. Addison Wesley Longman, Menlo Park, CA.

California Department of Fish and Game. 2003. California Natural Diversity Database. List of California Terrestrial Natural Communities. Wildlife and Habitat Data Analysis Branch, Sacramento, CA. Retrieved from: http://www.dfg.ca.gov/whdab/pdfs/natcomlist.pdf

California Department of Fish and Game. 2005. California Natural Diversity Database. RareFind 3. Updated May 27, 2005. Wildlife and Habitat Data Analysis Branch, Sacramento, CA.

California Department of Water Resources. 2002. GIS of the middle Sacramento River, California. Northern District, Red Bluff, California.

California Native Plant Society (CNPS). 2004. Inventory of Rare and Endangered Vascular Plants of California (sixth edition). Rare Plant Scientific Advisory Committee, David P. Tibor, Convening Editor. California Native Plant Society. Sacramento, CA.

Hickman, J.C. 1993. The Jepson Manual. University of California Press, Berkeley, California.

Holland, R.F. 1986. Preliminary descriptions of the terrestrial natural communities of California. California Department of Fish and Game, Sacramento, California.

Oswald, V. H. 2002. Selected plants of northern California and adjacent Nevada. Studies From the Herbarium, Number 11. California State University, Chico, CA.

Oswald, V. and L. Ahart. 1994. Manual of the Vascular Plants of Butte County, California. CNPS Press, Sacramento, California.

The Nature Conservancy. 2005. Draft Colusa Subreach Background Report. Northern Central Valley Office, Chico, California.

SECTION THREE

COLUSA-NORTH

SOIL SURVEY

Jean G. Hubbell, M.S.
Catherine Little
Katie C. Price
Dr. David M. Wood

Introduction

A survey of Restoration Area soils is used to document existing conditions for plant growth and thus guide the restoration planting recommendations. Information on soil texture and depth to water table gathered from auger holes across the Restoration Area is used to match specific locations with appropriate plant community types.

The Colusa-North tract is located about 2 miles north of Colusa in Colusa County at river mile 147 and is owned by the Wildlife Conservation Board and managed by the California Department of Fish and Game as the northerly subunit of the Colusa Unit of their Sacramento River Wildlife Area. The Restoration Area is approximately 5 acres of the tract inside the levees on the west side of the Sacramento River. Currently the Restoration Area is a fallow walnut orchard.

Methods

Soil data were gathered from augering 6 auger holes by hand across the Restoration Area during June and August 2005. These 6 holes were located on a grid at approximately 50-150 m intervals across the fallow orchard (Figures 2, 3 and 9). Initially a grid with holes 200 m apart was laid out on the Restoration Area, resulting in 1 hole. Five additional holes were added to meet the minimum of 5 holes per/Restoration Area, or 1 hole/10 acres in order to give an accurate representation of soils across the Restoration Area. Textural analysis was done following the Natural Resource Conservation Service's (NRCS) texture-by-feel method at one-foot increments (Table 9; Schoeneberger et al. 2002). In addition, depth to refusal (gravel, water table or unconsolidated sand) was noted for each sample location along with any unique characteristics. Soil locations were classified into deep and shallow based on NRCS soil survey standards (Table 10; Schoeneberger et al. 2002).

Table 9. Natural Resource Conservation Service's soil texture classification.

Texture	% Sand
Silt	0-20
Silt loam	20-35
Sandy silt loam	35-50
Sandy loam	50-70
Loamy sand	70-85
Sand	85-100

Table 10. Natural Resource Conservation Service's soil depth classification.

Depth class	Depth (inches)
Very Shallow	0-10
Shallow	10-20
Moderately Deep	20-40
Deep	40-60
Very Deep	>60

Soils Description

The Restoration Area is dominated by sandy loam in the north and by loamy sand in the south. This is similar to the 1967 Colusa County historic survey, but differs from the historic Marysville area Soil Survey (1909) and the current 1998 soil survey (Figures 7-9). The Marysville area historic soil survey maps the Restoration Area as Sacramento silt loam whereas the auger hole data is mostly coarser sandy loam or loamy sand. In the 1967 Colusa County historic survey the Restoration Area soils are described as Columbia association with fine sandy loam textures (USDA 1967). The 1998 Colusa County soil survey describes the soils as Vina loam (USDA 1998). The auger hole soil textures support the sandy loam mapping of the 1967 survey but is generally coarser-textured sandy loam/loamy sand than the 1909 historic and current map designations. The Restoration Area is in the main channel of the Sacramento River for the 1948 soil survey (not shown, but see Figure 11). The small eastern edge that maybe on land would be Columbia fine sandy loam (USDA 1948) and would support the auger hole data. Table 11 gives the auger hole data and Table 12 lists comments (if any) for each hole. Surface textures across the site are primarily clay loams with clay occurring in the lower areas (holes 4 and 5; US ACE 1997). The auger hole profiles tended to be more homogeneous (e.g. hole 2) or well stratified (e.g. hole 6) than heterogeneous. Most of the Restoration Area has very deep soils with refusal from 8.5 to 20 feet.

The Restoration Area soils are more typical of alluvial soils further from the active channel since a uniform fining upward sequence was commonly found. Typical active floodplain soils have stratification from various flooding events quite evident but a uniform fining upward sequence (where coarser material is found at depth and finer textures make up the upper layers of the profile) has yet to occur (Andrew Conlin Pers. Comm., 2003). The soil auger holes either had a uniform fining upward sequence atypical of floodplain deposits (holes 2, 3, 5 and 6) or a series of fining upward sequences (holes 1 and 4) typical of floodplain deposits. The multiple fining upward sequences here suggest channel deposits. There has been extensive scrolling of the Sacramento River across the Restoration Area from 1896 to at least 1960 (Table 11; Figures 3, 10-12; DWR 2002). The 1896 main channel ran across the southern quarter of the Restoration Area encompassing sampling point 2. Then the main channel migrated slightly south, still running across the southern tip from at least 1908 through 1923. As the main channel migrated south it simultaneously scrolled to the east such that by 1935 the channel ran only across the northwestern quarter and not the southern tip of the Restoration Area. The channel continued to scroll east encompassing the entire Restoration Area no later than 1946. Finally, by 1964 the main channel had scrolled just to the east of the Restoration Area. The extensive loamy sand soils found at holes 1 and 2 and their location on a higher terrace by 2-4 feet suggest this area is an old sand/gravel bar or very large bank. The generally coarser-textured soils across the Restoration Area are testament to the scrolling channel described above since coarser material tends to stay in the main channel.

The Restoration Area has very deep soils with refusal at the water table at all sampling locations. The water table was reached between 8.5 and 11.5 feet on June 1 and 22, 2005 at points 1, 3, 4 and 5; and at 19 and 20 feet on August 2, 2005 at points 2 and 6. The differences seen in the pairs of holes done in June could be mainly due to elevation with the holes with greater depth being on higher ground (US ACE 1997). A particularly wet spring and early summer occurred in 2005 and thus the water table may have been more elevated than in a typical year.

Two of the sampling locations had gravel at depths ranging from 10 to 20 feet. Sampling point 2 had gravel from 10 feet down to saturation at 20 feet suggesting an old gravel bar or channel bank. This would be expected as this was the edge of the 1896 channel (Figure 10).

Sampling point 6 had gravel from 13 to 16 feet. This shallower gravel lens is likely a channel deposit from between approximately 1937 and 1960 during which time the Restoration Area was in the main channel of the Sacramento River (Figures 11 and 12).

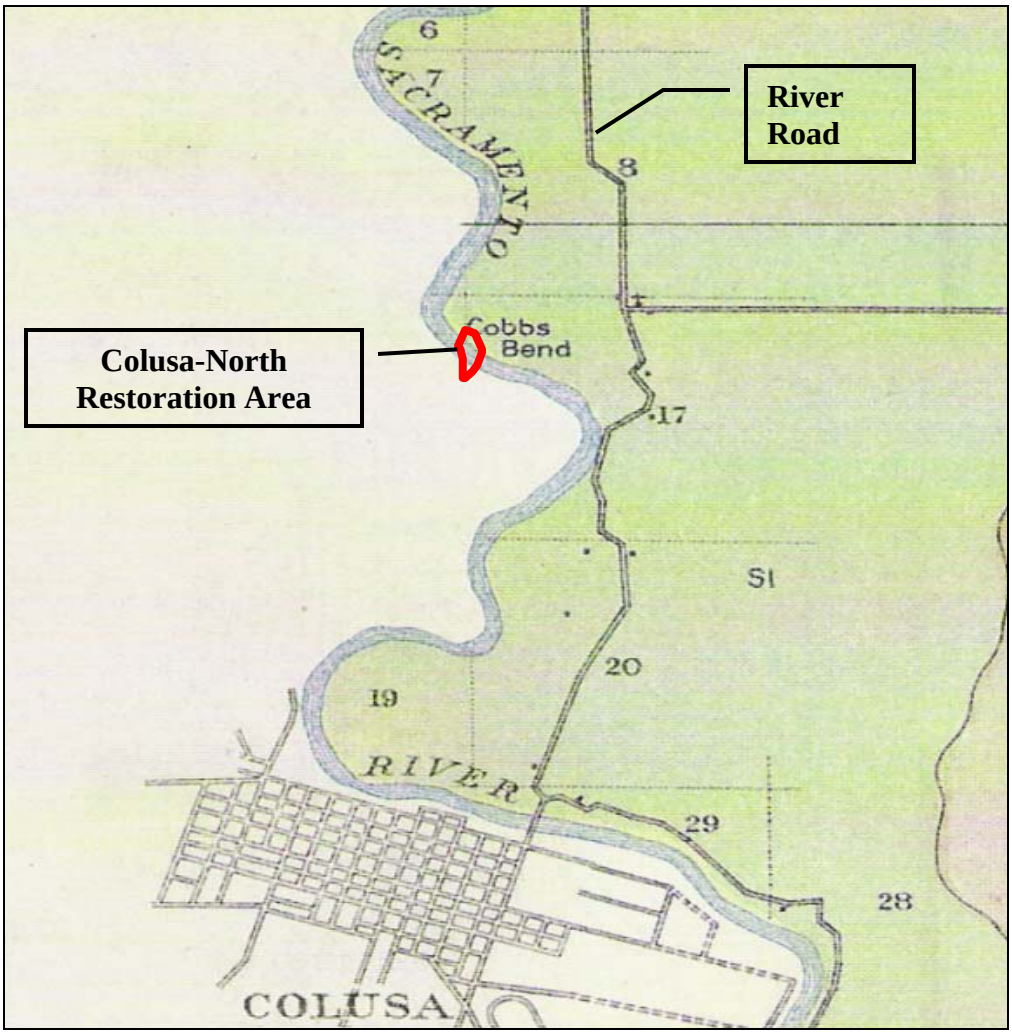
Table 11. Soil texture by depth from auger holes across the Colusa-North Restoration Area, Colusa County, California. For comments, see Table 12.

Date Sampled	6/1/2005	8/2/2005	6/1/2005	6/22/2005	6/22/2005	8/2/2005
Point	1	2	3	4	5	6
Surface	Sandy Clay Loam	Clay Loam	Clay Loam	Clay	Clay	Clay Loam
1 ft	Sandy Loam	Silt Loam/ Loam	Clay Loam	Clay	Clay	Silt Loam
2 ft	Loamy Sand	Silt Loam/ Loam	Silty Clay	Clay Loam	Clay	Silty Clay Loam
3 ft	Sandy Loam	Silt Loam	Sandy Loam	Sandy Loam	Sandy Loam	Silty Clay Loam
4 ft	Loamy Sand	Loamy Sand	Sandy Loam	Sandy Clay Loam	Sandy Loam	Silty Clay Loam
5 ft	Loamy Sand	Loamy Sand	Sandy Loam	Sandy Loam	Sandy Loam	Silty Clay Loam
6 ft	Loamy Sand	Loamy Sand	Sandy Loam	Sandy Loam	Sandy Loam	Loam
7 ft	Loamy Sand	Loamy Sand	Sandy Loam	Sandy Clay	Sandy Loam	Sandy Loam
8 ft	Loamy Sand	Loamy Sand	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
9 ft	Sandy Clay Loam	Loamy Sand		Sandy Loam	Sandy Loam	Sandy Loam
10 ft	Sand	Loamy Sand/Gravel		Loamy Sand		Loam/Sandy Loam
11 ft	Sand	Loamy Sand/Gravel				Loam/Sandy Loam
12 ft		Loamy Sand/Gravel				Loamy Sand
13 ft		Loamy Sand/Gravel				Loamy Sand
14 ft		Loamy Sand/Gravel				Loamy Sand
15 ft		Loamy Sand/Gravel				Loamy Sand
16 ft		Loamy Sand/Gravel				Loamy Sand
17 ft		Loamy Sand/Gravel				Loamy Sand
18 ft		Loamy Sand/Gravel				Loamy Sand
19 ft		Loamy Sand/Gravel				
20 ft						
Total	11 ft 6 in	20 ft	8 ft 6 in	10 ft 6 in	10 ft	19 ft
Refusal	Saturation	Saturation	Saturation	Saturation	Saturation	Saturation

Table 12. Soil auger hole comments for the Colusa-North Restoration Area, Colusa County, California. Reduced oxygen conditions are noted as mottling. Extreme anaerobic conditions are noted as gleying or gleyed layers.

Hole #1- No comments.
Hole #2- Moisture at 5 ft. Gravel present from 9.5 to 20 ft. Complete saturation at 20 ft.
Hole #3- No comments.
Hole #4- No comments.
Hole #5- No comments.
Hole #6- Gravel present from 13 to 16 ft. Increased moisture at 17-18 ft. Saturation at 19 ft.

Colusa-North Restoration Area: 1909 Soil Series

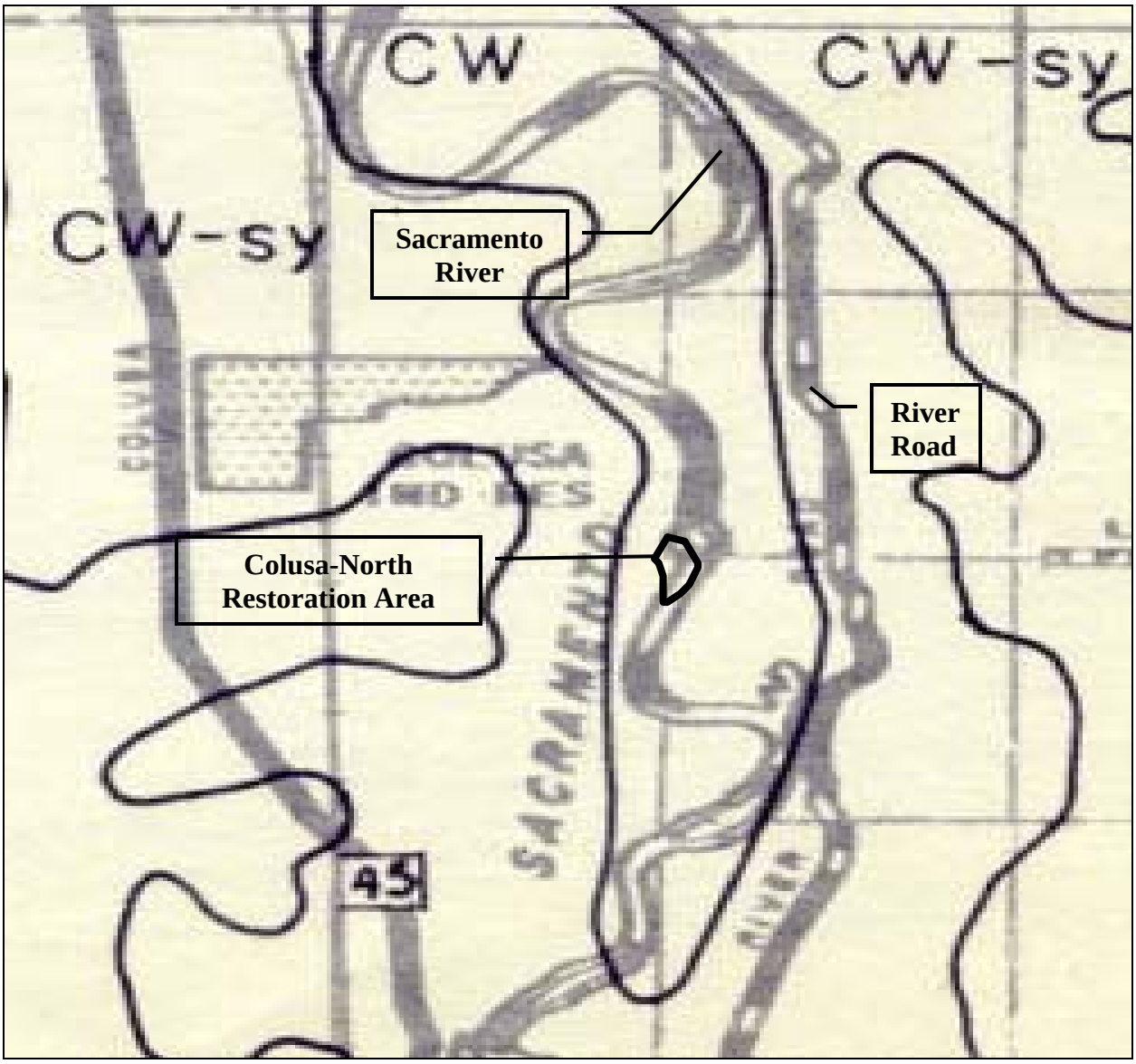


Sl= Sacramento silt loam

1 mile= approximately 1 ¼ inches

Figure 7. Approximate boundary and location of Colusa-North Restoration Area on the 1909 Soil Survey map, California, Marysville Sheet (USDA Bureau of Soils), Colusa County, California.

Colusa-North Restoration Area: 1967 Soil Series



Soil Series Contours
CW= Columbia association
CW-sy= Columbia-Sycamore association

1 mile= approximately 2 inches

Figure 8. Approximate boundary and location of the Colusa-North Restoration Area on the 1967 Soil Survey map, Colusa County, California (USDA Soil Conservation Service).

Colusa-North Restoration Area: 1998 Soil Series

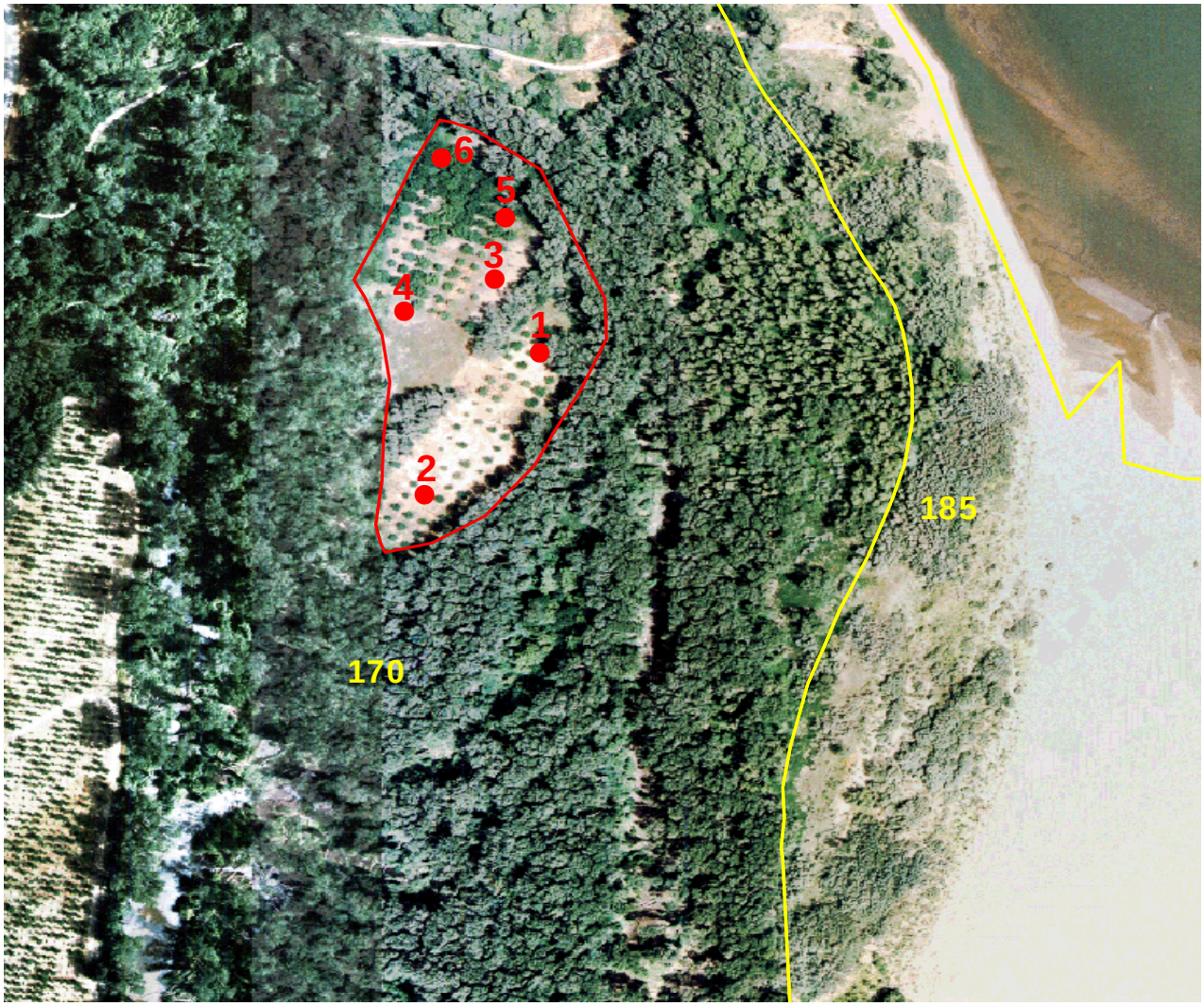


Figure 9. Soil series contours from the 1998 Colusa County Soil Survey at the Colusa-North Restoration Area, Colusa County, California (Natural Resources Conservation Service).

Colusa-North Restoration Area: Historic River Channels 1896-1923

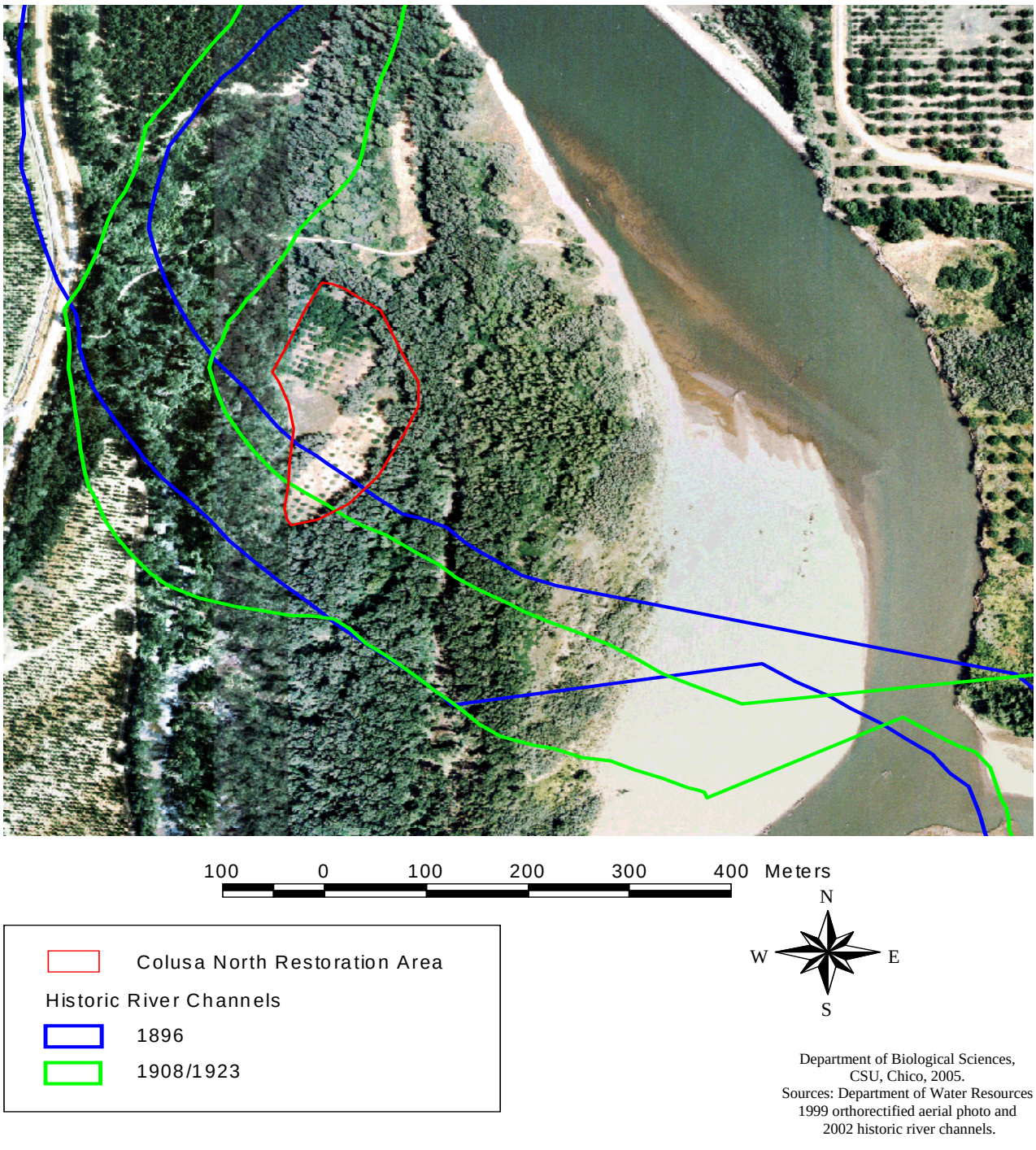


Figure 10. Historic river channels from 1896, 1908 and 1923 at the Colusa-North Restoration Area, Colusa County, California. The 1908 and 1923 channel is the same for this stretch of the river.

Colusa-North Restoration Area: Historic River Channels 1935-1946

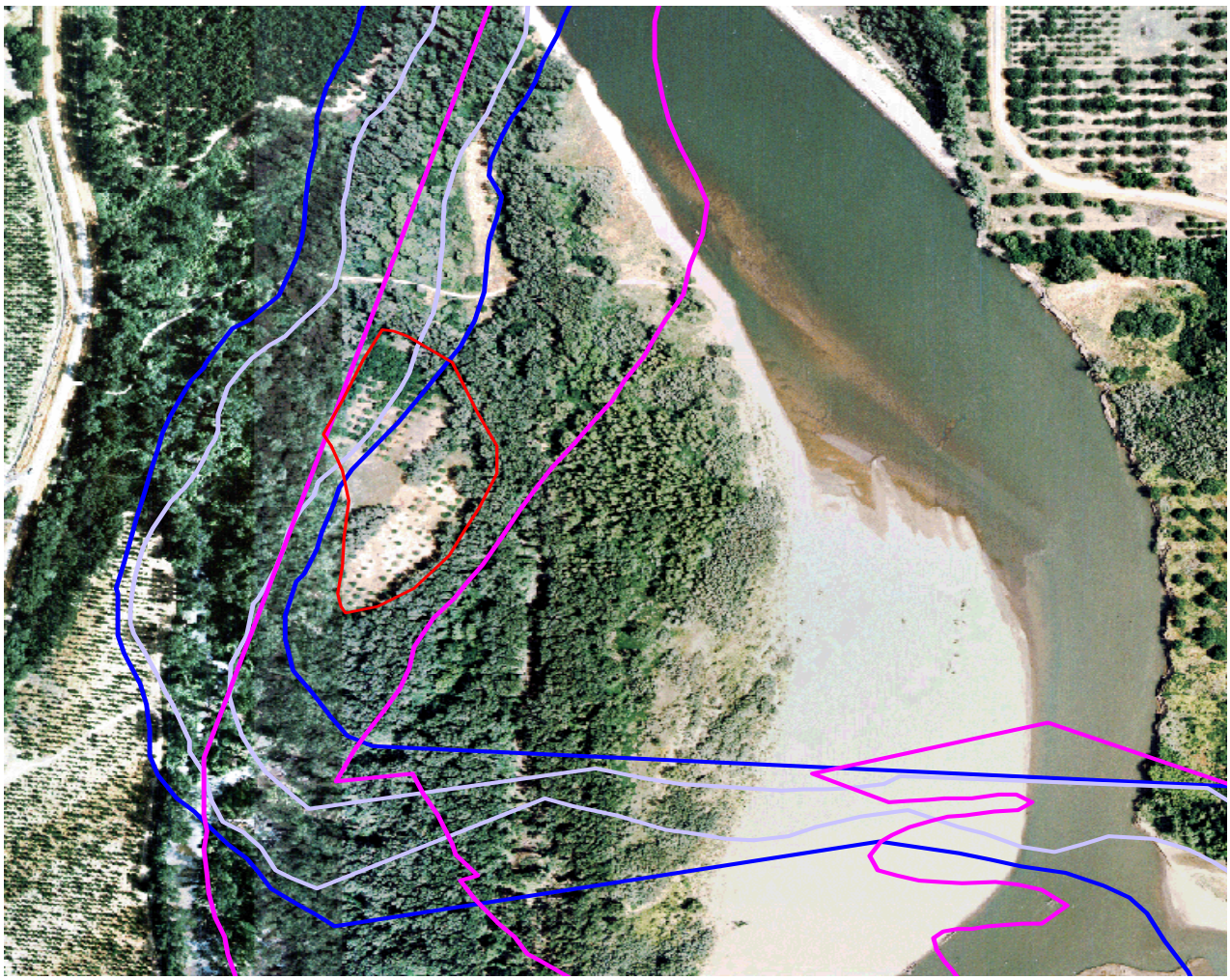


Figure 11. Historic river channels from 1935, 1937 and 1946 at the Colusa-North Restoration Area, Colusa County, California.

Colusa-North Restoration Area: Historic River Channels 1956-1991

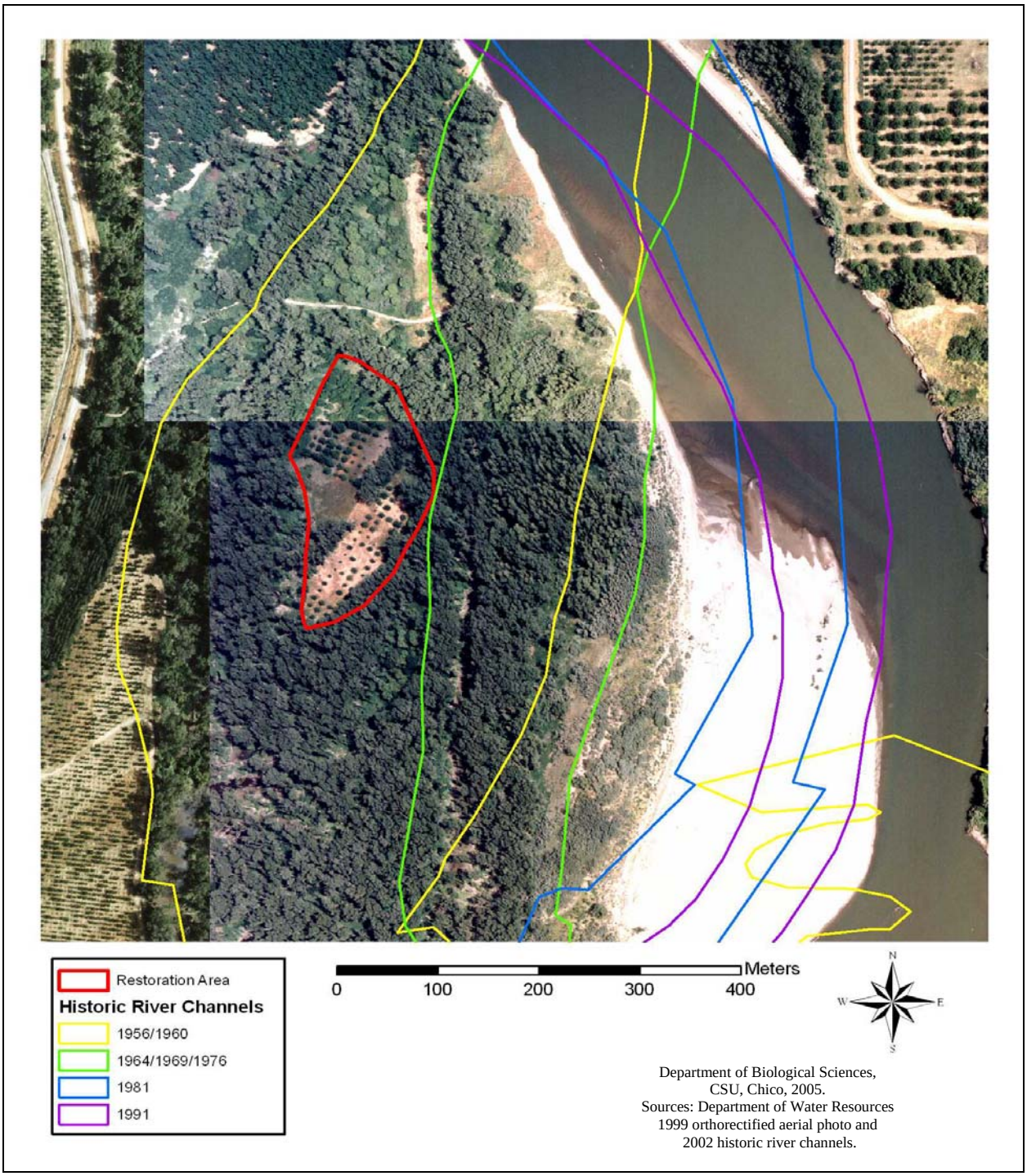


Figure 12. Historic river channels from 1956, 1960, 1964, 1969, 1976, 1981 and 1991 at the Colusa-North Restoration Area, Colusa County, California. The 1960 channel is the same for this stretch of the river as 1956 and the 1976 channel is the same for this stretch of the river as 1964 and 1969.

Acknowledgements

Thanks to our field assistants Gay Ann Silman, Aggie Morrow, Mark Lynch, Stacee Henderson, and Jason Glick for augering holes and data entry.

References

California Department of Water Resources. 2002. GIS of the middle Sacramento River, California. Northern District, Red Bluff, California.

Harradine, F. F. 1948. Soils of Colusa County, California. University of California Berkeley, College of Agriculture, Agricultural Experiment Station, Division of Soils. Berkeley, California.

Schoeneberger, P.J., D.A. Wysocki, E.C. Benham and W.D. Broderson, (editors). 2002. Field book for describing and sampling soils, Version 2.0. Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE.

The Nature Conservancy. 2005. Draft Colusa Subreach Background Report. Northern Central Valley Office, Chico, California.

U.S. Army Corps of Engineers. 1997. Digital elevation model. Received from The Nature Conservancy.

U.S. Department of Agriculture, Bureau of Soils. 1909. Soil map, California, Marysville Sheet.

U.S. Department of Agriculture, Soil Conservation Service. 1967. Report and general soil map, Colusa County, California.

U.S. Department of Agriculture, Natural Resources Conservation Service. 1998. Soil Survey of Colusa County, California.

SECTION FOUR

COLUSA-NORTH

SPECIAL STATUS ANIMAL SPECIES,

BIRD COUNTS, AND NON-NATIVE MAMMALS

John W. Hunt, M.S.
David Koenig
Dr. David M. Wood

Introduction

Animals such as wildlife and birds will benefit from the increased habitat created through natural process or active restoration. Information on wildlife and bird species present or known to occur near the Restoration Area can be used to better judge the value of restoration actions at a particular site. Non-native mammal species are important due to their probable negative impact on native wildlife species. Non-native mammal species can prey upon, directly compete with, and significantly disturb native wildlife.

Methods

A computer search for known occurrences of special status animal species (federal and state threatened and endangered species and species of special concern) occurring within 1.0 mile of the Restoration Area was conducted using the California Natural Diversity Database (CA DFG 2005). An assessment of potential non-native mammals and special status animal species occurring at or within 1.0 mile of the Restoration Area was performed in July 2005. This assessment was based on aerial photographs, field surveys of remnant riparian vegetation and associated nearby habitat, field experience of the authors and habitat characteristics of the species involved. During the bird point count survey (see below), any occurrences or signs of special status species or non-native mammals were noted. General habitat characteristics were gathered from vegetation surveys (Section Two). Information on species status was taken from California Wildlife Habitat Relations 8.0 (CA DFG 2002) and the California Natural Diversity Database (CA DFG 2005).

Bird species were surveyed on June 25, 2005, following an adaptation of the methods proposed by Ralph et al. (1993). Six point count stations set approximately 200 m apart were established in remnant riparian habitat adjacent to the Colusa-North tract (Figure 13). All birds observed (either seen or heard) within an eight-minute observation period were recorded. To reduce the possibility of individuals being recorded a second time at another station, only data on species encountered within 50 m of each station are presented here. To compute frequency of occurrence for a species, the total number of observations for that species was divided by the total number of observations for all species.

Special Status Animal Species

Table 13 lists California Natural Diversity Database special status species occurrences within 1.0 mile of the Restoration Area. More than one record indicates multiple sightings of a species in different years and/or locations. Table 14 is a list of special status wildlife species with potential or known to occur or reside within 1.0 mile of the Restoration Area.

Table 13. California Natural Diversity Database special status species occurrences occurring within 1.0 mile of the Colusa-North Restoration Area, Colusa County, California. FE/FT=federally endangered/federally threatened; FSC=Federal species of special concern; SE/ST=state endangered/state threatened; SSC=California species of special concern.

Common Name	Scientific Name	Status	# of known occurrences
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	FT	5
Swainson's hawk	*Buteo swainsonii*	ST	1
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	SE	4
Bank swallow	*Riparia riparia*	ST	2

Table 14. Special status animal species with potential or known to occur or reside within 1.0 mile of the Boeger Restoration Area, Colusa County, California. FE/FT=federally endangered/federally threatened; FSC=Federal species of special concern; SE/ST=state endangered/state threatened; SSC=California species of special concern; SSC1=species that face immediate extirpation of their entire California population or their California breeding population if current trends continue (these species may qualify as state endangered or threatened, but are not yet listed); SSC =species on the decline in a large portion of their range in California, which require management to prevent their becoming SSC1; SSC3=species not in any present danger of extirpation and their populations within most of their range do not appear to be declining seriously, however, due to their small populations in California they are vulnerable to extirpation should a threat materialize; ?=not enough information.

Common Name	Scientific Name	Status	Breeding
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	FT	probable
Sacramento splittail	*Pogonichthys macrolepidoptus*	SSC1	potential
Steelhead – Central Valley ESU	*Oncorhynchus mykiss*	FT	potential
Chinook salmon (fall run)	*Oncorhynchus tsawytscha (fall run)*	SSC	potential
Chinook salmon (spring run)	*Oncorhynchus tsawytscha (spring)*	FT/ST	potential
Chinook salmon (winter run)	*Oncorhynchus tsawytscha (winter)*	FE/SE	probable
Hardhead	*Mylopharodon conocephalus*	SSC3	
Western spadefoot toad	*Spea hammondii*	SSC	potential
Western pond turtle	*Clemmys marmorata*	SSC	probable
Giant garter snake**	*Thamnophis gigas*	FT/ST	potential
American white pelican*	*Pelecanus erythrorhynchos*	SSC	
Double-crested cormorant*	*Phalacrocorax auritus*	SSC2	potential
White-faced ibis	*Plegadis chihi*	SSC	
Osprey*	*Pandion haliaetus*	SSC2	potential
Bald eagle	*Haliaeetus leucocephalus*	FT/SE	
Northern harrier*	*Circus cyaneus*	SSC2	probable
Sharp-shinned hawk	*Accipiter striatus*	SSC3	probable
Cooper's hawk *	*Accipiter cooperii*	SSC3	probable
Swainson's hawk*	*Buteo swainsoni*	ST	known
Ferruginous hawk	*Buteo regalis*	SSC	
Golden eagle	*Aquila chrysaetos*	SSC3	
Peregrine falcon	*Falco peregrinus*	SE	
Prairie falcon	*Falco mexicanus*	SSC3	
California gull	*Larus californicus*	SSC3	
Burrowing owl	*Athene cunicularia*	SSC2	potential
Short-eared owl	*Asio flammeus*	SSC2	potential
Long-eared owl	*Asio otus*	SSC	
Greater sandhill crane	*Grus canadensis tabida*	ST	
Long-billed curlew	*Numenius americanus*	SSC	
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	FSC/SE	known
Willow flycatcher	*Empidonax traillii*	SE	?
Loggerhead shrike	*Lanius ludovicianus*	CSC	probable
Purple martin	*Progne subis*	SSC2	
Bank swallow	*Riparia riparia*	ST	known
Yellow warbler	*Dendroica petechia*	SSC2	potential
Yellow-breasted chat	*Icteria virens*	SSC2	probable
California horned lark	*Eremophila alpestris actia*	SSC	potential
Tricolored blackbird	*Agelaius tricolor*	SSC	potential

Table 14 continued.

Common Name	Scientific Name	Status	Breeding
Townsend's big-eared bat**	*Corynorhinus townsendii*	SSC2	?
Pallid bat**	*Antrozous pallidus*	SSC	?
Western mastiff bat	*Eumops perotis*	SSC2	?

***Species observed within 1.0 miles of the Restoration Area by the authors.**
**** Species not known or with low probability of occurrence within area of consideration.**

Threatened and Endangered Wildlife Species

Seven threatened or endangered wildlife species are of particular interest in the vicinity of the Restoration Area. Following is a brief discussion of their status and any observations noted during fieldwork.

1. Valley elderberry longhorn beetle (*Desmocerus californicus dimorphicus*)

Valley elderberry longhorn beetle (VELB) is a federally threatened species. Potential VELB habitat occurs throughout the adjacent remnant vegetation wherever blue elderberry (*Sambucus mexicana*) is present. This species is recorded in the CNDDB as occurring within 1.0 mile of the Restoration Area and adjacent remnant riparian habitat.

2. Steelhead (*Oncorhynchus mykiss*) – Central Valley Evolutionarily Significant Unit (ESU)

The Central Valley steelhead ESU is a federally threatened population. Steelhead is an anadromous fish species spawning in tributaries of the Sacramento River.

3. Chinook salmon (*Oncorhynchus tsawytscha*) – spring run

The spring run Chinook salmon is a federal and state threatened species. Spring run Chinook salmon is an anadromous species of fish that spawns in tributaries of the Sacramento River. Mill, Deer, and Butte Creek are the principal spawning grounds of this species.

4. Chinook salmon (*Oncorhynchus tsawytscha*) – winter run

Winter run Chinook salmon is a federal and state endangered species. Winter run Chinook salmon is known to spawn in cold gravels of the Sacramento River. This species is recorded as occurring throughout the lower Sacramento River below Keswick Dam.

5. Swainson's hawk *(Buteo swainsonii)*

Swainson's hawk is a state threatened species. Swainson's hawks were observed foraging within 1.0 mile of the Restoration Area by the authors. A pair of Swainson's hawks was also observed performing courtship displays over remnant riparian habitat adjacent to the Restoration Area by the authors. It is expected that this pair has a nest location within riparian habitat adjacent to either the Ward or Colusa-North tracts. This species is recorded in the CNDDB as occurring within 1.0 mile of the Restoration Area.

6. Bank Swallow (*Riparia riparia*)

Bank swallows are a state threatened species. This species is known to nest in colonies in undercut banks along the Sacramento River. This species is recorded in the CNDDB as nesting within 1.0 mile of the Restoration Area.

7. Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*)

Western yellow-billed cuckoo is a state endangered species known to nest in riparian forests along the Sacramento River. This species is recorded in the CNDDB as occurring within 1.0 mile of the Restoration Area.

Non-native Mammal Species

Table 15 lists the non-native mammal species known to occur or potentially occurring within 1.0 mile of the Restoration Area, and an estimate (where possible) of abundance. Due to the lack of available field data, information on non-native mammals presented here is highly qualitative and should be taken as such.

Domestic dogs were not observed on or near the Restoration Area. Because of the proximity of residences, domestic dogs potentially occur on the Restoration Area periodically. Feral cats were not observed at the Restoration Area, but this species is expected to occur periodically due to the fact that feral cats have been observed repeatedly at other restoration areas. Feral cats can cause significant depredation on small vertebrates as well as serving as a potential vector for disease to other mammals (e.g. feline distemper, feline leukemia, feline immune deficiency disease, and toxoplasmosus; Coleman et. al. 1997).

House mice (observed), roof rats, and Norway rats all have potential to occur within 1.0 mile of the Restoration Area. These animals are relatively widespread in lower elevations in California, especially in association with residences and agriculture (Whitaker 1991) and have been documented in riparian areas. Roof rats have been shown to be important nest predators in remnant riparian and riparian restoration sites at Cosumnes River Preserve (Whisson and Engilis Jr. 2005). According to Whisson (unpublished), because of its arboreal habits, mixed riparian forests can provide an ideal habitat for roof rats. Norway rats are also a widespread invasive mammal species with a high potential of occurrence, but they lack the arboreal tendencies of roof rats.

Nutria were not observed on or near the Restoration Area. Potential effects of nutria on native wildlife are not well documented. Tracks of Virginia opossum were observed on and around the Restoration Area.

Domestic/feral dogs, feral cats, roof rats, Norway rats and Virginia opossum are all known predators of small mammals, birds, reptiles and amphibians. All non-native mammals listed below are likely to have a widespread occurrence within riparian habitat along the Sacramento River. Information is currently being gathered on the relative abundance of non-native rodent species, but more information on the presence/absence and relative abundance of other non-native mammals (such as feral cats) needs to be collected in order to determine the relative importance of these species.

Table 15. Non-native mammal species known or potentially occurring within 1.0 miles of the Colusa-North Restoration Area, Colusa County, California. Estimated abundances are based upon the experience of the authors and field observations at the Restoration Area and similar sites. A “common” indicates that the species was observed in abundance either during visual surveys or during small mammal trapping. An “unknown” indicates that either the species was never observed or that the site itself was not sampled.

Common Name	Scientific Name	Observed	Abundance
Domestic dog	*Canis domesticus*	No	Unknown
Feral Cat	*Felis catus*	Yes	Unknown
House Mouse	Mus musculus	No	Unknown
Roof Rat	Rattus rattus	No	Unknown
Norway Rat	*Rattus norvegicus*	No	Unknown

Table 15 (continued).

Common Name	Scientific Name	Observed	Abundance
Nutria	*Myocastor coypu*	No	Unknown
Virginia Opossum	*Didelphus virginianis*	Sign (tracks)	Unknown

Bird Counts

Figure 13 shows sampling locations and Table 16 lists all bird species observed on the June 25, 2005 point counts. Figure 14 shows the frequency of occurrence for species observed more than once. Twenty-nine species were encountered during the survey. Species composition was fairly typical of riparian habitats along the Sacramento River. Black-headed grosbeak was the species most frequently observed (11.2%), followed by spotted towhee (8.8%), brown-headed cowbird (7.2%), American goldfinch, American robin, bushtits and tree swallows were the fourth most abundant species observed (all at 6.4%).

Table 16. Bird species observed within and adjacent to remnant riparian habitat nearby the Colusa-North Restoration Area, Colusa County, California (see Table 14 for definition of status).

Common Name	Scientific Name	Status
American crow	*Corvus brachyrhynchos*	
American goldfinch	*Cardeulis tristas*	
American pelican	*Pelecanus erythrorhynchos*	SSC
American robin	*Turdus migratorius*	
Ash-throated flycatcher	*Myiarchus cinerascens*	
Bewick's wren	*Thryomanes bewickii*	
Black-headed grosbeak	*Pheucticus melanocephalus*	
Brewer's blackbird	*Euphagus cyanocephalus*	
Brown-headed cowbird	*Molothrus ater*	nonnative
Bullock's oriole	*Icterus bullocki*	
Bushtit	*Psaltriparus minimus*	
California towhee	*Pipilo crissalis*	
Downy woodpecker	*Picoides pubescens*	
European starling	*Sturnus vulgaris*	nonnative
House finch	*Carpodacus mexicanus*	
House wren	*Troglodytes aedon*	
Mourning dove	*Zenaida macroura*	
Northern flicker	*Colaptes auratus*	
Nutall's woodpecker	*Picoides nutalli*	
Oak titmouse	*Baeolophus inornatus*	
Red-tailed hawk	*Buteo jamaicensis*	
Spotted towhee	*Pipilo maculatus*	
Swainson's hawk	*Buteo swainsonii*	ST
Tree swallow	*Tachycineta bicolor*	
Turkey vulture	*Cathartes aura*	
Western bluebird	*Sialia mexicana*	
Western kingbird	*Tyrannus verticalis*	
Western scrubjay	*Aphelocoma californica*	
Western wood-pewee	*Contopus sordidulus*	
White-breasted nuthatch	*Sitta carolinensus*	

Colusa-North Restoration Area:
Bird Survey Locations

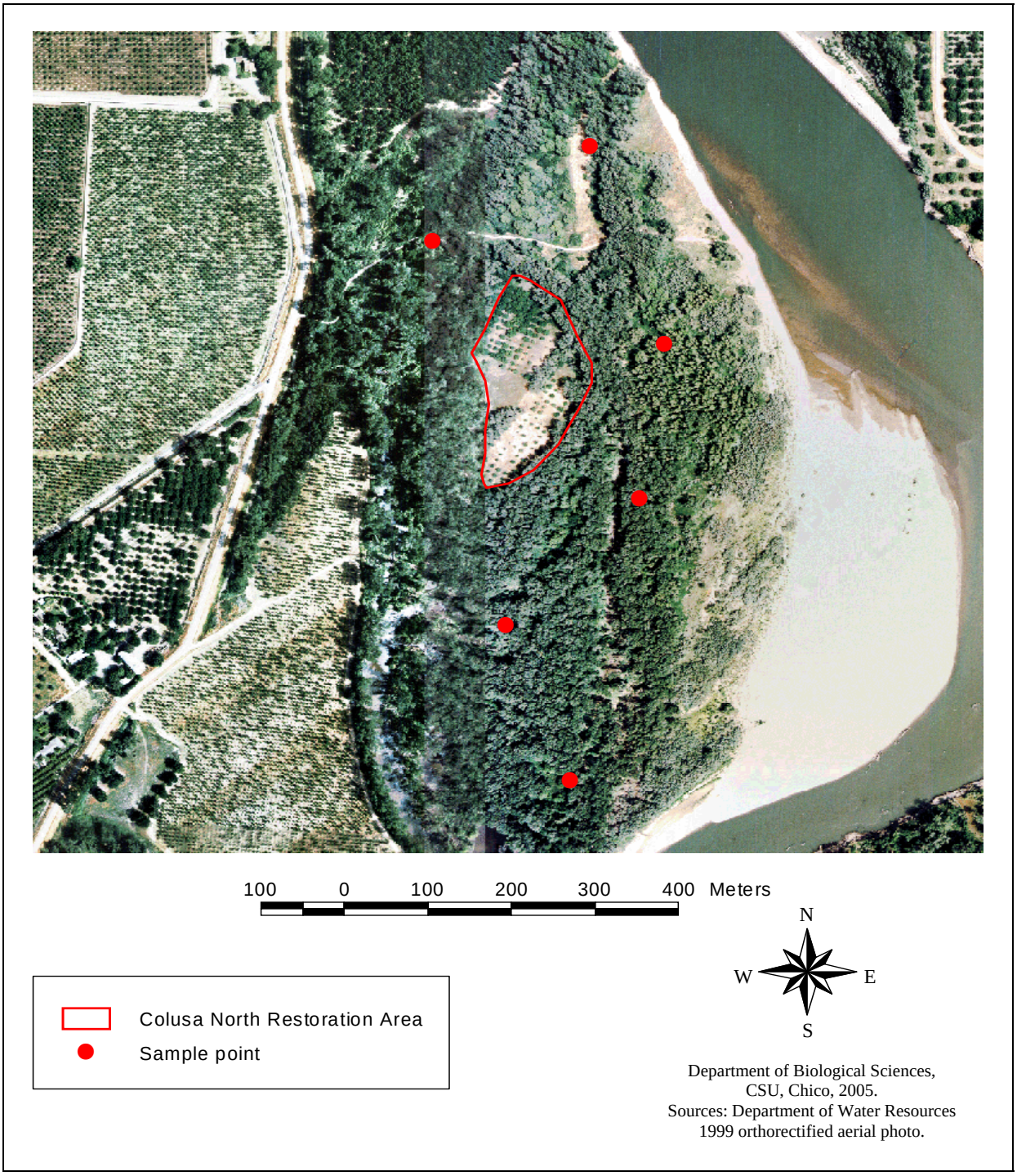


Figure 13. Bird survey station locations in riparian habitat nearby the Colusa-North Restoration Area, Colusa County, California.

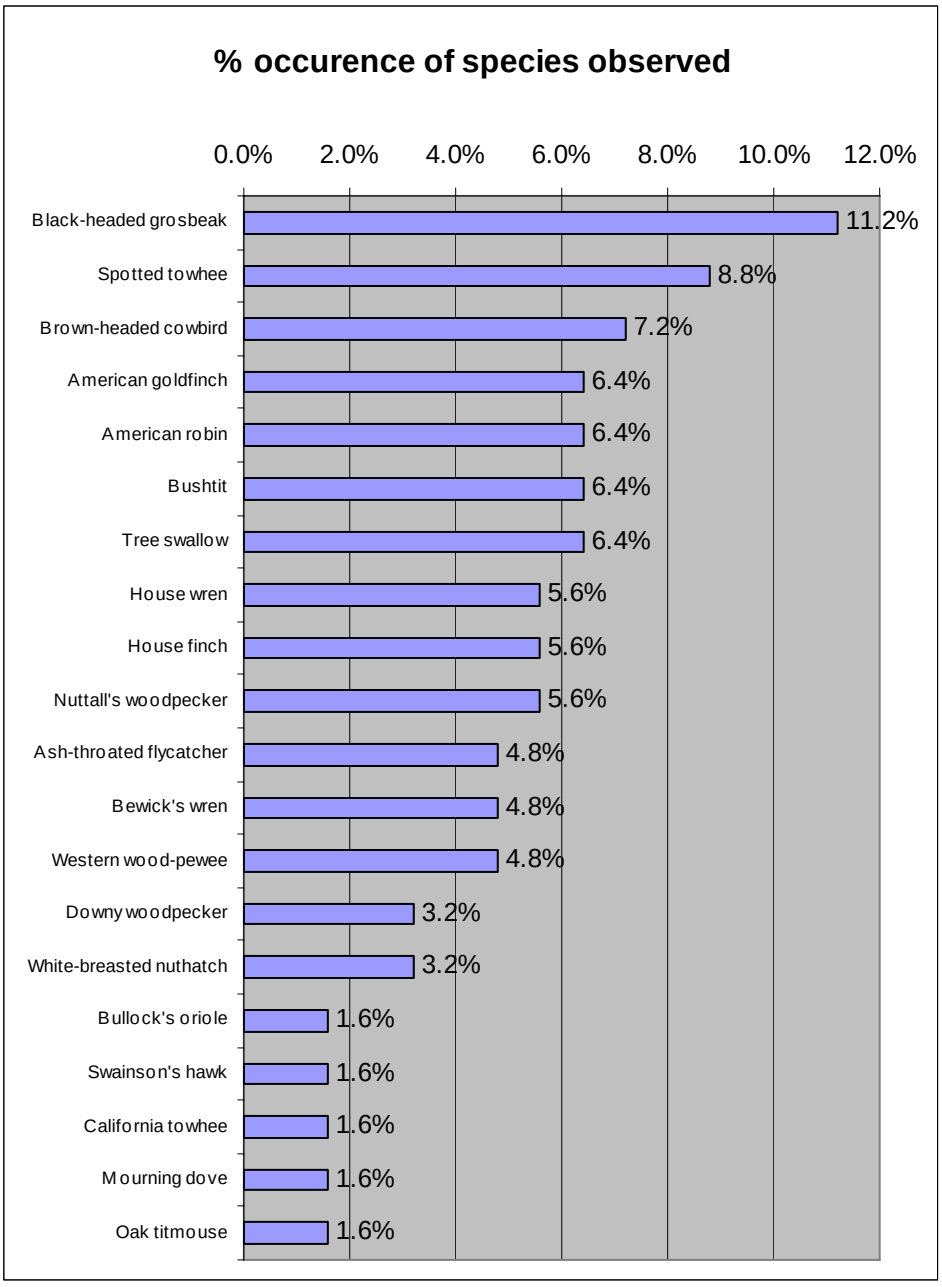


Figure 14. Frequency of bird species observed more than once within a 50 m radius of six 8-minute observation stations within remnant riparian habitat adjacent to the Colusa-North Restoration Area, Colusa County, California on June 25, 2005. Species observed only once are excluded for clarity.

References

Burt, W. H., and R. P. Grossenheider. 1976. A Field Guide to Mammals. Houghton Mifflin Co., Boston, MA.

California Department of Fish and Game. 2002. California Wildlife Habitat Relationships Systems 8.0. Wildlife and Habitat Data Analysis Branch, Sacramento, CA.

California Department of Fish and Game. 2005. California Natural Diversity Database. RareFind 3. Updated May 27, 2005. Wildlife and Habitat Data Analysis Branch, Sacramento, CA.

California Department of Fish and Game. 2005. California's Plants and Animals. Wildlife and Habitat Data Analysis Branch, Sacramento, CA. Retrieved from: http://www.dfg.ca.gov/hcpb/species/species.shtml.

California, Department of Water Resources. 2002. GIS of the middle Sacramento River, California. Northern District, Red Bluff, California.

Coleman, J.S., S.A. Temple, and S.R. Craven. 1997. Facts on cats and wildlife: a conservation dilemma. University of Wisconsin Extension, Madison, WI.

Ehrlich, P. R., D.S. Dobkin and D. Wheye. 1988. The Birder's Handbook. Simon and Schuster, Inc., New York, NY.

Ingles, L.G. 1965. Mammals of the Pacific States. Stanford University Press, Stanford, CA.

Moyle, P. 1976. Inland Fishes of California. University of California Press, Berkeley, CA.

National Geographic. 1999. Field Guide to the Birds of North America. National Geographic Society, Washington, D.C.

Ralph, C. J., G.R. Geupel, P. Pyle, T.E. Martin, and D.F. DeSante. 1993. Handbook of field methods for monitoring landbirds. Gen. Tech. Rep. PSW-GTR-144. Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture, Albany, CA.

Small, S. S., J. DeStaebler, G.R. Geupel, and A. King. 1999. Landbird response to riparian restoration on the Sacramento River system: preliminary results of the 1997 and 1998 field season. Submitted to The Nature Conservancy and U.S. Fish and Wildlife Service, October 1999, by Point Reyes Bird Observatory, Stinson Beach, CA.

Stebbins, R.C. 1985. A Field guide to Western Amphibians and Reptiles. Peterson Field Guide Series. Houghton Mifflin Company, Boston, MA.

Whitaker Jr., J.O. 1991. The Audubon Society Field Guide to North American Mammals. Alfred A. Knopf, Inc., New York, NY.

Whisson, D. and A. Engilis Jr.. 2005. Predation of songbirds in California riparian areas (ongoing research). Retrieved from**:**
http://wfcb.ucdavis.edu/www/Faculty/desley/research.htm
Department of Wildlife, Fish, and Conservation Biology, University of California, Davis, CA.