Kopta Slough Riparian Habitat Restoration Plan

Sacramento River (RM 221.5)

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Protecting nature. Preserving life.™

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TABLE OF CONTENTS

RESTORATION PLAN SUMMARY **1**
EXECUTIVE SUMMARY **1**
I. INTRODUCTION **2**
A. Location 2
B. Property History 2
C. Significance of Restoration 2
D. Objectives 5
1. Short-term Objective 5
2. Long-term Ecological Objectives 5
3. Habitat Establishment Objectives 6
E. Permits and Environmental Documentation 6
1. CEQA 6
2. Floodplain Encroachment Permit 6
3. Pesticide Use Permits 6
II. SCHEDULE OF ACTIVITIES **7**
III. PLANNING **8**
A. Site Assessment 8
1. Soil Profile 8
2. Vegetation 8
3. Hydraulic Analysis 10
4. Geomorphology 10
5. Native Fish and Wildlife Usage 10
B. Cultivated Restoration Design 12
1. Restoration Communities 12
2. Planting Design 14
3. Plant Propagation 14
IV. RESTORATION IMPLEMENTATION **14**
A. Field Preparations 14
B. Irrigation Design and Installation 14
C. Planting 15
1. Phase 1 15
2. Phase 2 15
V. MAINTENANCE **15**
A. Restoration maintenance (spring Project Year 2 – December Project Year 4) 15
1. Irrigation 15
2. Weed Control 16
VI. MONITORING **16**
A. 30-Day Post-Planting Monitoring 16
B. Weekly Site Conditions Monitoring 17
C. End of Growing Season Monitoring 17
D. Annual Reports 17
E. Completion Report 17
VII. References **18**

Figures

Figure 1. Location of the Kopta Slough Property (DWR 2008) 3
Figure 2. Previous Kopta Slough Property restoration areas 4
Figure 3. Existing vegetation communities on the Kopta Slough Property (DWR 2008) 9
Figure 4. Historic Sacramento River channels in the vicinity of the Kopta Slough Property (DWR 2008) 11
Figure 5. Proposed Kopta Slough Property restoration communities. 13

Tables

Table 1. Timing of Restoration Activities 7

Appendices

Appendix 1: Soil Survey for Riparian Restoration at the Kopta Slough Preserve
Appendix 2: Kopta Slough Cultivated Restoration Plant Composition

RESTORATION PLAN SUMMARY

LOCATION	**Property Name**	Kopta Slough
	Street Address	Dale Road
	City	Corning
	County	Tehama
	APNs	075-070-02, 05, 03; 075-120-02,03,04,07,09,13; 075-220-02,03,08,10; 075-260-02,03,09,11
	River Mile	221.5
PLANTING SUMMARY	**Restoration site area**	176 acres
	Plant communities	Grassland: 46.6 acres Valley Oak Woodland: 44.7 acres Valley Oak Riparian Forest: 85 acres
	Planting density (spacing): emitters/acre	Valley Oak Woodland (11' x 60'): 66 Valley Oak Riparian Forest (11' x 45'): 88

EXECUTIVE SUMMARY

The Nature Conservancy (TNC) has designed a riparian habitat restoration plan for the remaining 176 acres to be restored on the Kopta Slough Property (the Property). The Riparian Restoration Plan for Kopta Slough details the restoration plan agreed upon by members of TNC's Sacramento River Project team and approved by the California Department of Water Resources' Northern Region Office. The restoration plan is based on implementation techniques developed and refined by TNC on prior restoration projects along the Sacramento River since 1989. This restoration plan describes a specific restoration design based on the environmental conditions and ecological goals at the Kopta Slough Property, and the procedures for implementation of site preparation, planting and seeding, maintenance, and monitoring.

I. INTRODUCTION

A. Location

The Property is located in Tehama County, north of South Avenue at the end of Dale Road, along the western bank of the Sacramento River at River Mile 221.5 (Figure 1) and is within the northern part of the Woodson Landing Sub-reach (RM 230-206).

B. Property History

Congress authorized the Chico Landing to Red Bluff Project in 1958 as an extension and modification of the Sacramento River Flood Control Project. It provided for 50 miles of bank protection along the Sacramento River between Chico Landing and Red Bluff. The purpose of the Chico Landing to Red Bluff Project was to reduce erosion and to stabilize the main river channel, protect urban, residential, riparian, and agricultural lands, and reduce sediment in the river. USACE installed bank protection along the Property's river bank in 1963.

Prior to 1988, the Property had been owned by the American Almond Company and was primarily farmed for almonds. In 1988, TNC signed a 25-year lease to manage the Property on behalf of the California State Controller's Environmental Trust. Since 1988, TNC has restored approximately 332 acres of the 658-acre Property (Figure 2). This restoration plan is for the remaining176-acre agricultural portion of the Property.

C. Significance of Restoration

The Sacramento River is a fundamental state water source that drains 24,000 square miles of the northern Central Valley and supplies 80% of freshwater flowing into the Bay-Delta (CA State Lands Commission 1993). Historically, the river was lined by approximately 800,000 acres of riparian forest (Katibah 1984). Over 95% of this habitat has been lost, however, to selective logging, agriculture, urban development, and flood control and power generation projects. Cumulatively, these changes have greatly stressed the Sacramento River and associated species. The loss and degradation of riparian habitat has greatly diminished the river's ability to support viable wildlife populations and encouraged the invasion and proliferation of non-native invasive species. Two-thirds of the linear extent of the river's banks have been modified and confined by levees and rock revetment. Channelization, bank protection, and the construction of the Shasta Dam degraded riparian habitat along the Sacramento River by restricting the dynamic forces that promote natural habitat succession and regeneration.

Healthy riparian habitats contain a great number of flora and fauna due to the range of community types, overall structural diversity, availability of water and soil moisture, potential as corridors for migration, and critical breeding grounds (California State Lands Commission 1993, SRCAF 2000). Additionally, riparian corridors provide two primary functions essential to maintaining water quality: 1) moderating stream temperature and 2) reducing sediments and nutrients emanating from upland agriculture (Castelle et al. 1994). The loss of high-quality habitat and the decrease in water quality along the Sacramento River has caused some native species to be at risk of extinction or extirpation. Important at-risk species include the Sacramento splittail, green sturgeon, chinook salmon, steelhead trout, western yellow-billed cuckoo, Swainson's hawk, least Bell's vireo, and VELB (CALFED Bay-Delta Program 2000).

Figure 1 Location of the Kopta Slough Property

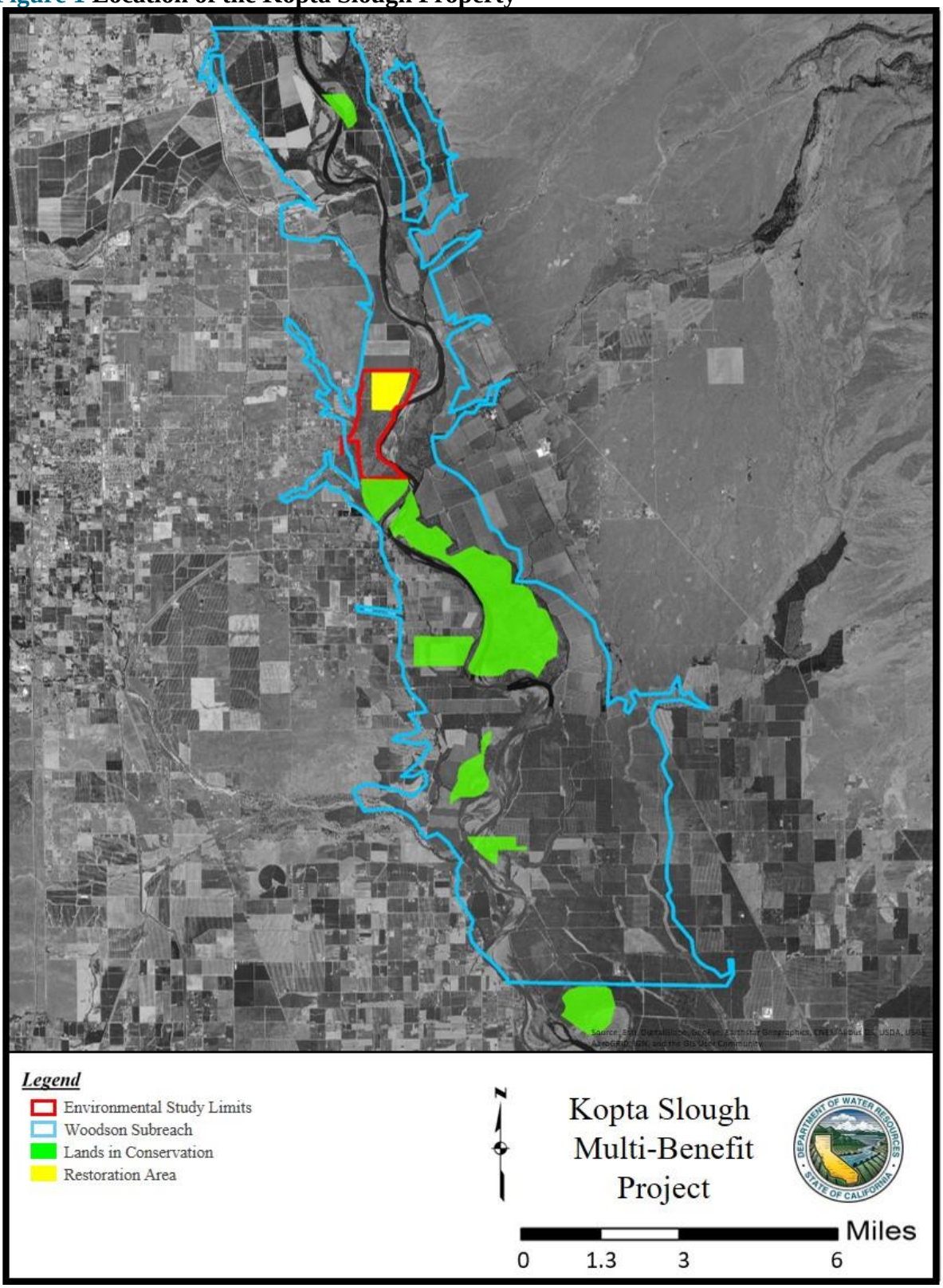
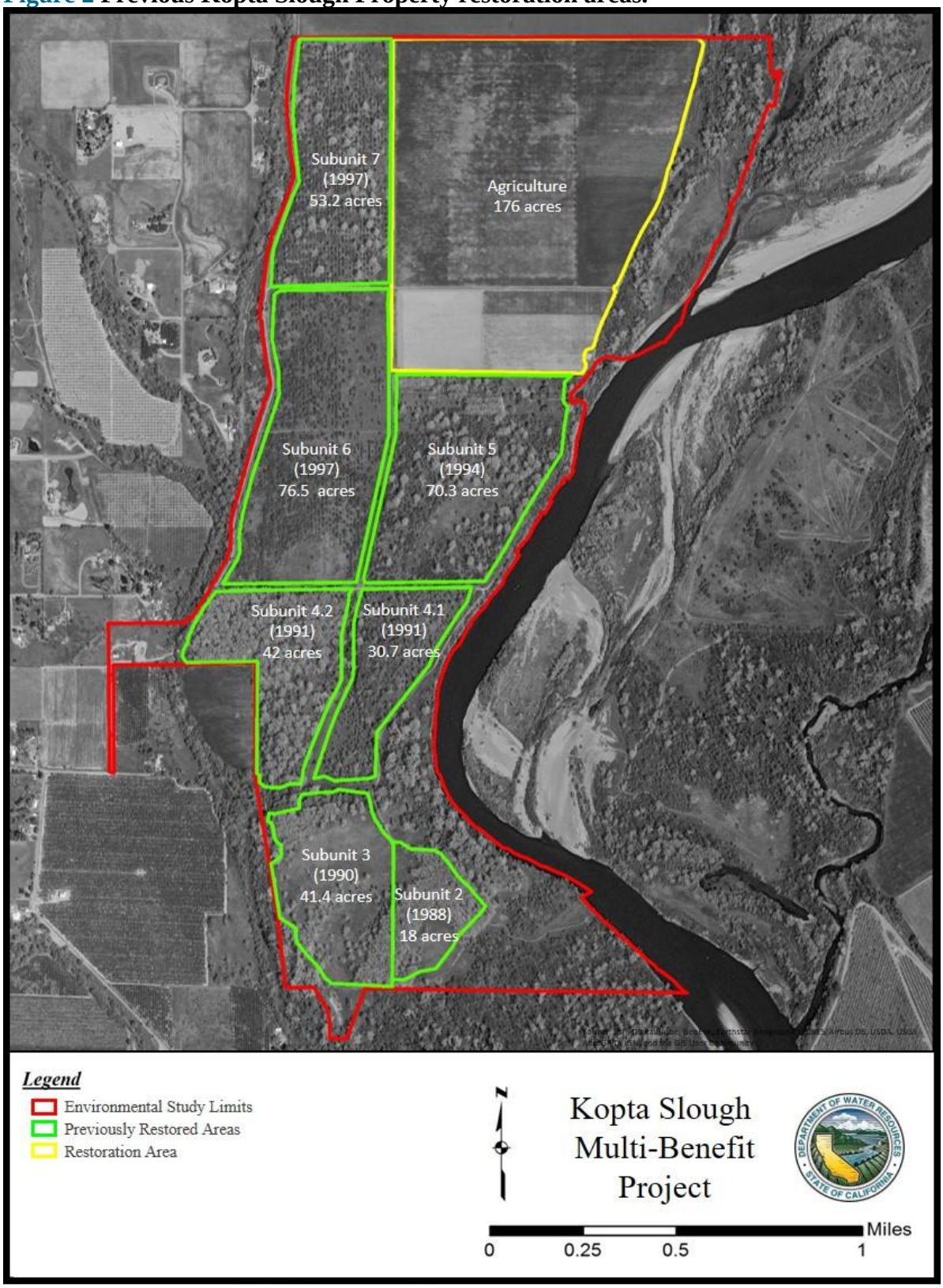


Figure 2 Previous Kopta Slough Property restoration areas.



Although severely degraded, the Sacramento River is still the most diverse and extensive river ecosystem in California (California State Lands Commission 1993). In an effort to improve ecosystem health in the region, federal, state, and local governments, as well as non-government organizations, have begun to implement a series of ecosystem restoration programs along the river. In 1986, the California State Legislature passed Senate Bill 1086, which mandated the development of a management plan for the Sacramento River and its tributaries to protect, restore, and enhance fisheries and riparian habitat (SRCAF 2000). The Sacramento River Conservation Area Forum (SRCAF) non-profit organization formed and set as its primary goal the preservation of remaining riparian habitat and reestablishment of a continuous riparian corridor along the Sacramento River from Red Bluff to Colusa.

The focus of this restoration plan is on riparian revegetation following an initial restorative action by the California Department of Water Resources. This DWR action involves removing approximately 5,600 linear feet of rock revetment along the Sacramento River's right bank at the Kopta Slough Property to create the dynamic hydrologic and geomorphic forces necessary for ecological restoration of the Sacramento River and its floodplain. It will also build on previous TNC restoration efforts, which since 1989 have restored 332 acres of the property (Fig. 2).

D. Objectives

1. Short-term Objective

After funding is secured and permits are obtained, the short-term goal for the Project is to plant a diverse mosaic of riparian communities on 176 acres in spring Project Year 2. Exotic weeds that inhibit seedling establishment of native riparian vegetation and a diminished flood disturbance regime limit natural establishment of floodplain riparian communities. Therefore, it is necessary to conduct active horticultural restoration such as planned for the restoration at the Property (Peterson 2002). Restoration on this site will facilitate the establishment of native riparian habitat that without active cultivated restoration would return to native vegetation at a very slow rate or not return at all.

2. Long-term Ecological Objectives

The long-term goal of the Project is to improve the ecological health and long-term viability of at-risk species and riparian communities along the Sacramento River by restoring riparian habitat and improving water quality through active horticultural restoration.

Based on the ecological conditions found in naturally occurring riparian forests along the Sacramento River from Red Bluff to Colusa, TNC's ecological objectives for the Property are to:

a. Establish early-successional stage and late-successional stage riparian communities which have been severely reduced in extent along the Sacramento River since 1850. The Project will add riparian habitat to an ecologically important floodplain area near the confluence of Deer Creek and the Sacramento River. Restoring complex riparian habitat in the area will improve habitat for fish and wildlife. Fish benefit from complex riparian areas, such as those to be restored at Kopta Slough, that become flooded at high flows, slow floodwaters down, and provide refugia for young and juvenile fish. Additionally, large woody debris, a

result of increased riparian habitat, provides food and cover for critical life stages of anadromous fish (Bryant 1983).

b. Provide habitat for neo-tropical migrant land birds.
Both aquatic and terrestrial at-risk riparian species, as well as common riparian species, will benefit from protection and restoration of large expanses of habitat along the mainstem and at the confluences of tributaries to the Sacramento River.

c. Improve water quality by decreasing sediment and pesticide runoff into the Sacramento River.
Replacing flood-prone agriculture with restored riparian habitat will decrease pesticide and herbicide applications on land adjacent to the river, thereby improving water and sediment quality. Additionally, restored riparian forests will buffer and filter toxic and organic matter that originate further away from the river, thereby further improving water and sediment quality.

d. Provide habitat for the federally threatened Valley Elderberry Longhorn Beetle.
This project will provide potential habitat for VELB by planting elderberry bushes.

3. Habitat Establishment Objectives
The habitat establishment objectives, which are implementation standards for achieving the ecological objectives, are outlined as follows:

a. Meet or exceed a survival rate of at least 80% for planted woody plants three years after planting (December of Project Year 4).

b. Meet or exceed an herbaceous layer density of 80% or greater by December of Project Year 4.

c. Ensure that the restoration site has a woody plant species diversity comparable to nearby remnant mixed riparian forest.

E. Permits and Environmental Documentation

1. CEQA
A CEQA analysis will need to be completed prior to restoration implementation.

2. Floodplain Encroachment Permit
A floodplain encroachment permit may be required from the Central Valley Flood Protection Board prior to restoration implementation.

3. Pesticide Use Permits
The restoration contractor will need to follow all Tehama County and State of California pesticide use laws when applying herbicides for weed control in the restoration area.

II. SCHEDULE OF ACTIVITIES

Table 1. Timing of Restoration Activities

Rehabilitation Action	Responsible Party	Pre-Project				Project Year 1				Project Year 2				Project Year 3				Project Year 4				Project Year 5			
		WI	SP	SU	FA	WI	SP	SU	FA	WI	SP	SU	FA	WI	SP	SU	FA	WI	SP	SU	FA	WI	SP	SU	FA
PLANNING																									
CEQA*	DWR																								
Restoration Plan*	TNC																								
PROPOGATION																									
Seed collection*	RC																								
Nursery production	RC																								
Cutting collection	RC																								
FIELDWORK																									
Field preparation	RC																								
Irrigation installation	RC																								
Layout	RC																								
Overstory planting	RC																								
Understory planting	RC																								
Understory seeding	RC																								
MAINTENANCE																									
Weed control	RC																								
Irrigation	RC																								
Irrigation line removal	RC																								
MONITORING																									
Post-planting	RC																								
Regular check-in	RC																								
End of Season	RC																								
REPORTING																									
Annual Report	RC																								
Completion Report	RC																								

Notes. * to be completed before on the ground project implementation; CEQA = California Environmental Quality Act. DWR = California Department of Water Resources. TNC = The Nature Conservancy. RC = Restoration Contractor. WI = Winter. SP = Spring. SU = Summer. FA = Fall.

III. PLANNING

A. Site Assessment

Information collected for the preparation of this restoration plan included several factors: vegetation on and nearby the site, native fish and wildlife usage, soil profile, depth to water table, regional hydrology, historic geomorphic patterns, and topography. This information was used to determine the most appropriate native species and communities for planting the site. The structure, or appearance, of a riparian forest is dictated by these factors. Some influences can be seen immediately on a restoration site and others may not be seen for many years or even decades. For example, gravel inclusions in the soil profile cause immediate mortality of planted trees due to lack of water, whereas the effects of hydrology on reproduction of specific species in a planting is not apparent for many years.

In 2008 DWR conducted biological surveys on the Property. Information gathered during the field surveys that informed the development of this restoration plan included the following:

1. Soil Profile

Soil type and water table depth are the two primary factors affecting what type of riparian community can be established at any given location. Detailed soil data is necessary to ensure the most appropriate community type is planned.

According to the 1967 USDA soil survey for Tehama County, the Property is located on the Columbia-Vina Association, which is some of the best soil found in California. However, the USDA soil surveys do not adequately capture the heterogeneity found in floodplain soils.

To address this shortcoming, a thorough soil survey was conducted in August 2003 by the California State University (CSU) Chico Biology Department with funding provided by the U.S. Army Corps of Engineers. Thirty soil cores were taken across the northern section of the Kopta Slough Property (Appendix 1). In August 2003 the water table was located between 8.3 and 17 feet in the northeast corner of the Property, with an average water table depth of 11 feet 10 inches. Of the 30 soil cores taken, 19 reached the water table, 10 reached gravel lenses, and one reached unconsolidated sand.

2. Vegetation

Unit-specific qualitative descriptions of dominant tree, shrub, and native understory species in adjacent riparian areas give valuable insight as to what species are appropriate for restoring a site. The valley oak woodland and valley oak riparian forest communities to be established on the Property are not very common in the surrounding area. Therefore, TNC relied on habitat composition descriptions from Holland (1986) and Vaghti (2003) to reconstruct these communities.

A vegetation map of the surrounding area was produced by CSU Chico's Geographic Information Center in 2008 (Figure 3). The remnant vegetation on the Kopta Slough Property is primarily found in lower lying areas than the proposed restoration area and is composed of willow stands, cottonwoods, and black walnut.

Figure 3 Existing Vegetation Communities at Kopta Slough

3. Hydraulic Analysis

Hydraulic modeling results prepared by Ayres Associates (2009) indicate that the planned habitat restoration planting would increase the water surface elevation up to 0.4 feet locally on the Kopta Slough Property and up to 0.1 feet across most or all of the floodplain width for approximately 0.75 to 0.8 miles upstream, all of which would not increase the extent of the 100-year flood inundation area.

The majority of the Property is within the designated floodway. The property has the potential for flooding in the winter, which dictates a spring planting schedule.

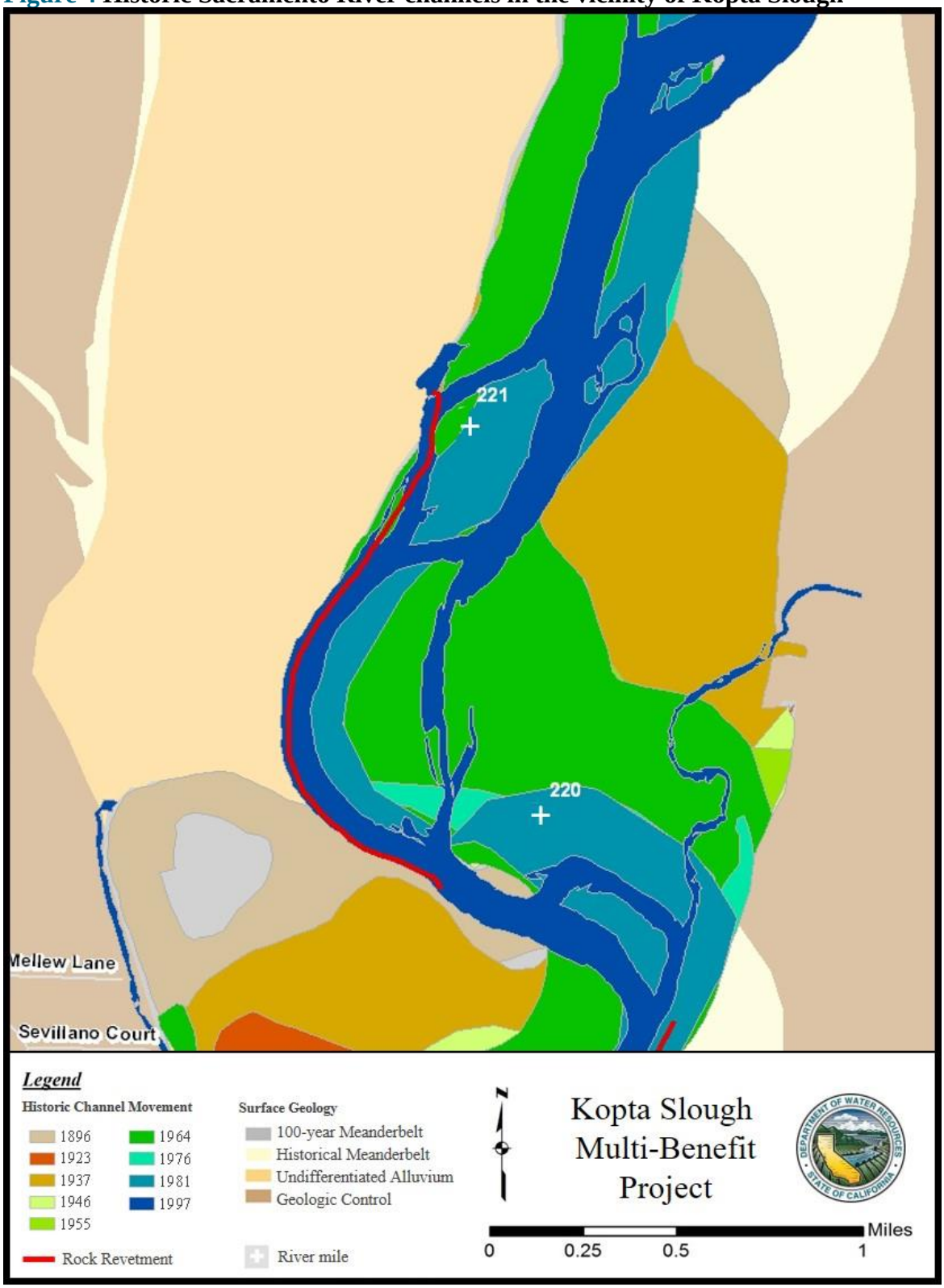
4. Geomorphology

The proposed restoration area is located within the Sacramento River's historic meander belt (Figure 4).

5. Native Fish and Wildlife Usage

Special-status wildlife species that may occur in the vicinity of the Kopta Slough Property and that may benefit from the Kopta Slough riparian habitat restoration are listed in Table 2.

Figure 4 Historic Sacramento River channels in the vicinity of Kopta Slough



B. Cultivated Restoration Design

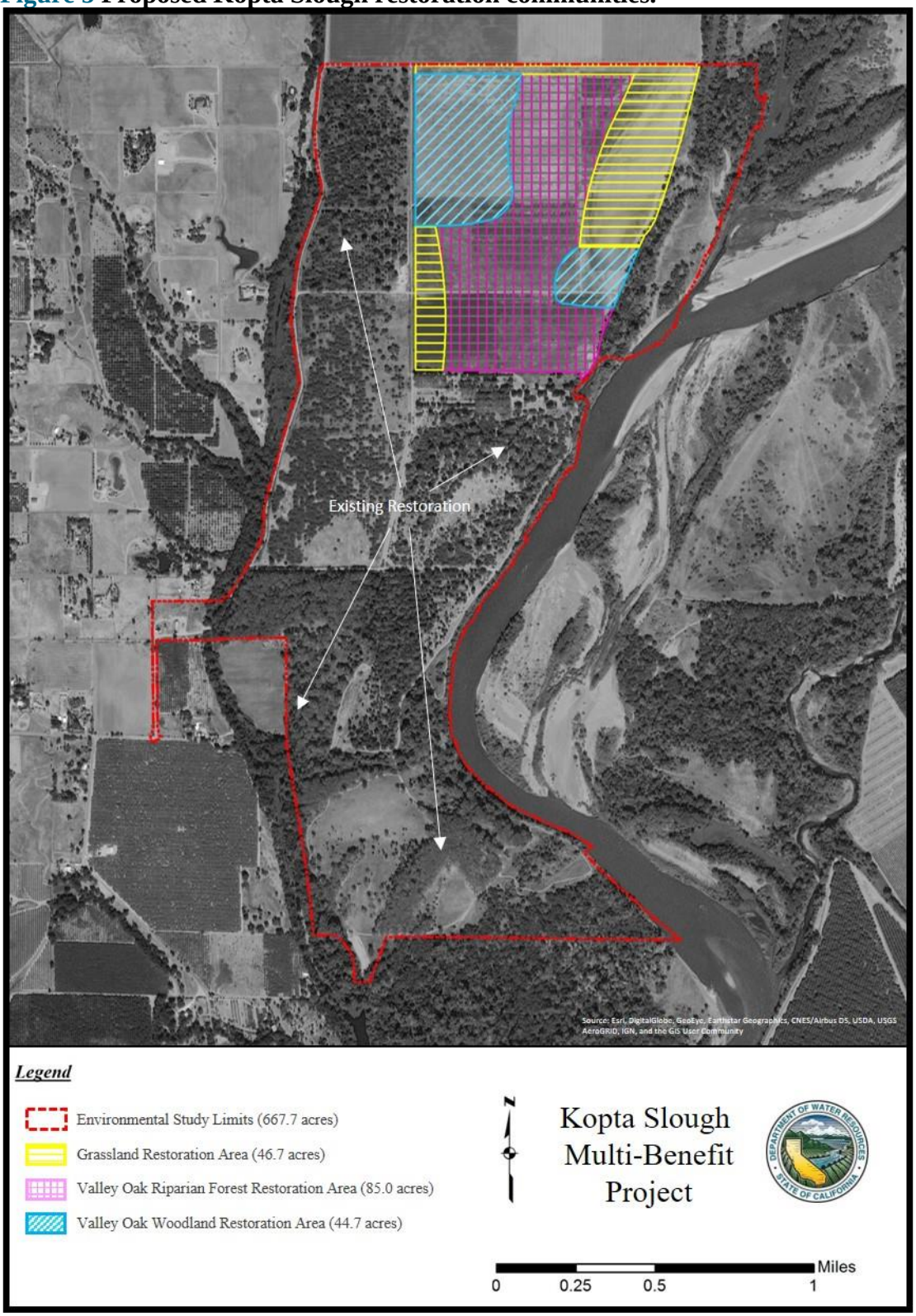
Communities planned for habitat restoration are based on site assessments (including soil profile, topography, flood frequency, depth to groundwater at base flows, weed community, and the existing adjacent riparian community) and historic aerial photography. Species composition is determined by the ecological objectives, existing native species at and around the Property, and available understory seed.

Point Blue (formally the Point Reyes Bird Observatory) monitors bird usage of habitats on the Sacramento River. Point Blue has provided TNC with recommendations for restoring appropriate breeding and foraging habitat for riparian obligate songbirds. Point Blue has recommended establishing communities with a diverse canopy structure both horizontally and vertically across any given restoration site. This will be accomplished at the Property by restoring a mosaic of habitat types across the Property. In addition, the restoration plantings will include areas where trees are clumped and interspersed with more open areas dominated by lower stature shrubs and forbs. This allows for usage of the site by a diverse array of wildlife species that require different habitat structure and composition types.

1. Restoration Communities

The Property will be planted with the following plant communities (Holland 1986): Valley Oak Riparian Forest (85 acres), Valley Oak Woodland (44.7 acres), and Grassland (46.6 acres) (Figure 5). The species composition for these communities is listed in Appendix 2.

Figure 5 Proposed Kopta Slough restoration communities.



2. Planting Design

The arrangement of plants across the site in any given 10 row by 10 plant area will be arranged to maximize structural and compositional diversity both vertically and horizontally across the field. At each location, spaced 11 feet along the planting strips, one or two plants will be planted according to the community-specific planting composition. The planting strips will be aligned with the contour of the river on the west side of the Property.

Planting strips in the valley oak riparian forest and valley oak woodland will be spaced 45 and 60 feet apart, respectively; an understory plant (shrub, forb, grass, or vine) will be planted either next to an overstory plant or clustered with other understory plants to allow for vertical and horizontal structural diversity. Refer to Appendix 2 for the planting composition of each community.

3. Plant Propagation

Appendix 1 lists the plant propagation method (container, cutting, plug, drilling) that will be used for each species. Container plants will be raised from seeds or cuttings collected from the Sacramento River floodplain and propagated by CSU Chico, Floral Native Nursery, and Hedgerow Farms for planting as seedlings at the Property. Willow and cottonwood cuttings, which are branches about 1" in diameter cut from mature cottonwood and willow trees, will be planted directly into the field. Cuttings will be taken no more than five days prior to planting and soaked for 24 hours before planting. Phase 1 overstory and understory plants will be hand planted in the spring of Project Year 2, while the Phase 2 understory grass seed will be directly seeded with a rangeland drill in December of Project Year 2.

The restoration contractor will be responsible for the plant propagation for all of the riparian plants. Planting crews will be hired and supervised by the restoration contractor.

IV. RESTORATION IMPLEMENTATION

A. Field Preparations

176 acres of alfalfa will be removed from the property in Project Year 1 and 2 prior to the restoration implementation in Project Year 2.

The restoration contractor will be responsible for field preparation prior to planting including clearing debris, disking, weed control (as necessary), and laying out the planting rows. Site layout is the preliminary stage of planting and will occur after field preparations have been completed. Site layout will organize the field according to the details outlined in the plant design (e.g. utilizing different colored flags to mark the planting space for an intended plant species) and is intended to facilitate planting efforts.

B. Irrigation Design and Installation

The restoration contractor will be responsible for modifying the existing irrigation system. A micro-drip, hard-hose irrigation system should be installed in the spring of Project Year 2. The system will be designed by an irrigation systems installation company based on the pump location, plant water needs, and plant distribution. The company will install the necessary underground main and sub-main lines with above ground hard hose drip irrigation lines. The drip irrigation lines will run most of the time in a north-south configuration, following the contour of

the river, with row spacing per habitat type as indicated in the plant communities table. Specific irrigation design will be determined at the time of installation. However, the irrigation system must be fully functional prior to planting because immediate irrigation may be needed to reduce transplant shock.

C. Planting

1. Phase 1

The first phase of the planting will be implemented as soon as the threat of flooding is over. The restoration contractor will plant all nursery-grown potted plants as well as all cottonwood and willow cuttings. Phase 1 planting for the site is scheduled for the spring of Project Year 2 (see Appendix 2).

2. Phase 2

The second phase will involve the planting of the understory. The herbaceous layer will be directly seeded in December of Project Year 2. Understory species used will be local ecotypes, preferably collected within 20 miles of the restoration site. Hedgerow Farms (Winters, CA) produces the appropriate ecotypes for seeding the Property. These ecotypes have been hand-picked by TNC staff and supplied to Hedgerow Farms for native grass restoration along the Sacramento River.

Protective milk cartons will be placed around nursery-grown plants and cuttings. The cartons will protect the plants from herbicide drift during weed control. Two small bamboo stakes will be used to anchor the cartons.

V. MAINTENANCE

Maintenance (including irrigation and weed control) is scheduled to follow directly after the Phase 1 planting and continue for 3 years. The Phase 2 understory direct seeding will be maintained during Project Years 3 and 4.

A. Restoration maintenance (spring Project Year 2 – December Project Year 4)

1. Irrigation

a. Method

Irrigation is the single most important factor in the success of riparian restoration projects in California. Adequate soil moisture allows plants to grow vigorously and compete effectively with weeds. If at any time it is determined that either irrigation scheduling or the irrigation system is inadequate and plants are not growing actively, TNC will remedy this problem immediately.

b. Standards

Standards are based on plant growth and survival assessed during weekly assessments by the restoration contractor. Adequate soil moisture and weed control must be maintained to ensure vigorous native plant growth. A watering regime will be determined each week according to weather, rate of growth, and site conditions.

2. Weed Control

a. Methods

The proposed restoration site contains annual brome grasses, starthistle, klamath weed, white top, Himalayan blackberry, morning glory, chick weed, and other problematic weeds that will inhibit native plant growth if unchecked. Control efforts for these noxious weeds will include herbicide application, mowing, and discing when and where appropriate. The restoration contractor will use adaptive management to determine best management practices for weed control.

Only state- and locally-approved herbicides will be used on the restoration site. The State of California and Tehama County regulate the use of all pesticides, and herbicide applications will be prescribed and applied by State-licensed applicators. Herbicide use will be reported to the Tehama County Agricultural Commissioner as required by state and county law. Weed control will be conducted year-round on an as-needed basis.

b. Standards

The height and vigor of weeds on restoration sites has a direct effect on the growth and survival of the cultivated riparian plants. TNC's objective is to optimize growth of the riparian species to a point where they can compete effectively with these exotic plants. It is envisioned that plantings will reach this point by December of Project Year 5. The larger the riparian species, the less they will be affected by weeds.

Standards for weed control for this project are as follows:

Project Year 2 growing season: No weed growth within the alleyways. Weed growth in the planting strips will be kept to less than 6". Weed stem density within the strips should be less than $3/ft^2$. Alleyways to be directly seeded will be kept completely clean, with no weed growth. All weeds growing inside each milk carton will be manually removed.

Project Year 3 growing season: No weed growth within the alleyways. Directly seeded native grass will dominate the alleyways and compete with the non-native weeds. Weed growth in the planting strips will be kept to less than 6". Weed stem density within the strips should be less than $3/ft^2$.

Project Year 4 growing season: No weed growth within the alleyways. Directly seeded native grass will dominate the alleyways and compete with non-native weeds. Weed growth in the planting strips will be kept to less than 6". Weed stem density within the strips should be less than $3/ft^2$.

VI. MONITORING

A. 30-Day Post-Planting Monitoring

The restoration contractor will conduct a post-planting assessment to determine the composition and survival of planted nursery stock and cuttings 30 days after all plants are planted (Project Year 2). This will provide baseline information for comparison at the end of each growing season (Project Year 2, 3, and 4) and for the Completion Report.

B. Weekly Site Conditions Monitoring
Post planting, the restoration contractor will check in weekly to ensure the site is being managed according to guidelines set forth in this document.

C. End of Growing Season Monitoring
This monitoring will be completed in November (Project Years 2, 3, and 4) before plants go dormant for the winter. End of Growing Season Monitoring is an interim assessment of the planting Unit to determine success at the end of each planting season and document progress on meeting Habitat Establishment Objectives. This information is summarized in the Annual Reports, which will be prepared by the restoration contractor and provided to DWR.

D. Annual Reports
Annual reports will be prepared by the restoration contractor summarizing restoration activity for that year. The survivorship and height for each planted species will be detailed and included in the report in tabular format. In addition, there will be a summary discussion of the previous year's work activities and the results of the survivorship and height data. Annual reports will be submitted by January 31 in Project Years 3, 4, and 5.

If the Annual Reports completed by January 31st of Project Year 3 and 4 indicate less than 80% overall survival for a community, the restoration contractor will replant where necessary to ensure a minimum 80% survival rate for each community by the overstory restoration project completion date (December 31 of Project Year 4).

E. Completion Report
A completion report will be prepared at the end of the 3-year maintenance phase (January 31 of Project Year 5) to report the final survivorship and height of the restoration planting. Data on survivorship and height of the planted species will be provided in tabular format accompanied by text that will explain all activities during the 3-year maintenance phase and a summary discussion of the survivorship and height data of the restoration planting.

VII. References

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Appendix 1.

Soil Survey

for

Riparian Restoration

at the

Kopta Slough Preserve

SOIL SURVEY

FOR

RIPARIAN RESTORATION

AT THE

KOPTA SLOUGH PRESERVE

FOR

THE U.S. ARMY CORPS OF ENGINEERS

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August 2003

Introduction

The Kopta Slough Preserve is located on the west side of the Sacramento River between river miles 220-222 approximately 1-mile upstream from Woodson Bridge State Park. The Preserve is 4.5 miles east of the town of Corning, in Tehama County, California. The survey area is bound to the east by the Sacramento River and associated riparian habitat and to the west by riparian habitat associated with Kopta Slough (Figure 1). The survey area is bound to the north by row crops and to the south by a restored riparian forest planted more than 10 years ago. The survey area itself is currently in alfalfa production. The west side of the area has some riparian restoration plantings with alfalfa grown between the rows of riparian plantings.

Methods

Soil data were gathered from thirty auger holes that were sampled across the existing alfalfa fields on August 4th-7th, 2003 (Figure 1). Eighteen holes were located 270 meters apart on a grid across the survey area (samples 1-18, Figure 1). An additional twelve holes were augered where needed in order to examine apparent soil discontinuities (samples 19-30, Figure 1). Soil texture was estimated at one-foot increments following the Natural Resources Conservation Service's texture-by-feel method using the soil texture triangle (Figure 2; Schoeneberger et al. 2002). In addition, depth to refusal (gravel, saturation, or unconsolidated sand) was noted for each sample core along with any unique characteristics.

Soil Data Summary

The soils of the Kopta Slough survey area are mapped mostly as Columbia Silt Loam in the Tehama Soil Survey (Gowans 1967; Figure 3). Table 1 gives auger hole data, and Table 2 lists comments (if any) for each hole. Surface textures across the soil survey area varied, ranging from clay loam to sand (Table 1).

The water table (saturation) was reached at 19 of the 30 auger holes at an average depth of 12.5 feet +/- .5 feet (mean +/- standard deviation). The maximum and minimum depths for saturation were 17 feet and 8.3 feet at auger holes 13 and 16, respectively. At 10 locations, gravel refusal occurred at an average depth of 7.6 feet +/- 1.1 feet. The maximum and minimum depths for gravel refusal were 14 feet and 1 foot at auger holes 7 and 28, respectively. Unconsolidated sand was encountered at 4.2 feet at auger hole 24.

Reduced oxygen characteristics (redox features), most notably reduced iron and manganese, were encountered at 9 locations (Table 2). Redox features generally occurred between 7 and 16 feet. Redox features represent soil horizons influenced by saturated conditions for extended periods of time throughout the year. Gleyed layers occurred in 5 of the locations with redox features at depths from 7 to 15 feet. This reduced or "gleyed" layer is the extreme example of redox features where no oxygen is present in the soil resulting in the minerals remaining in a reduced form. These locations have periods of inundation longer than those just showing redox features.

Figure 1. Sampling locations of hand auger data collected at Kopta Slough Preserve in August 2003. Points 1-18 were systematically sampled on a grid at 270-meter intervals. Samples 19-30 were sampled in areas showing poor plant growth and topographical variation to increase the resolution of the survey.

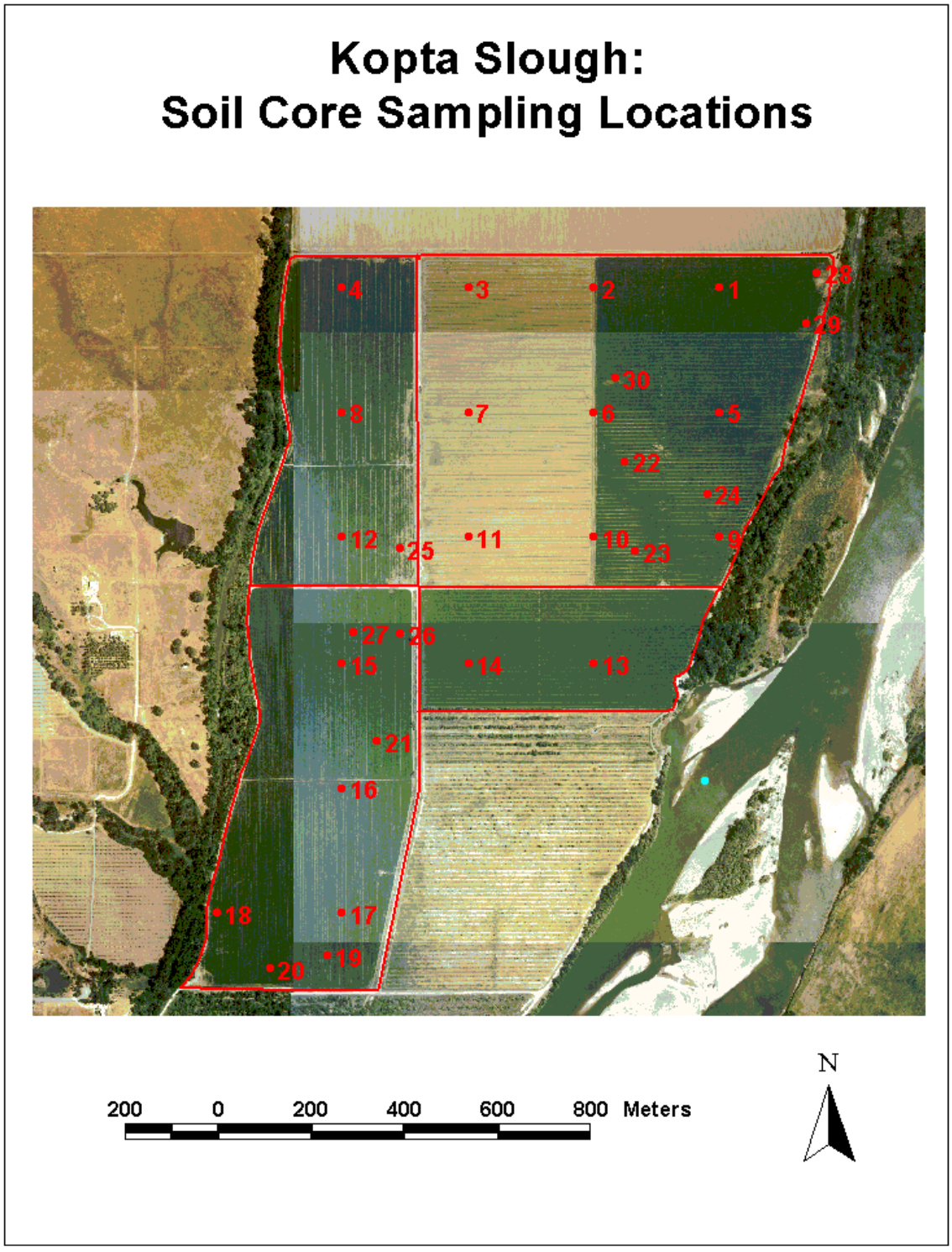

Figure 2. Soil texture classification triangle (Schoeneberger et al. 2002). The three vertices of the triangle depict clay, sand, or silt. The interior of the triangle shows various soil textures based on their proportion of clay, sand, or silt.

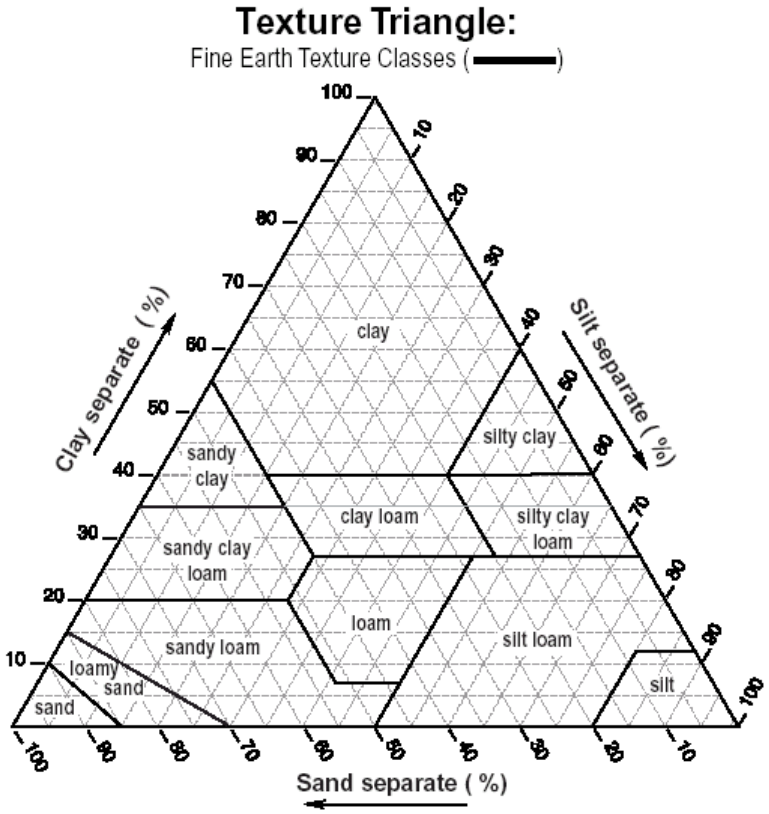

Figure 3. Aerial photo (ca. 1967) showing approximate boundary of Kopta Slough soil survey area in red (from Gowans, 1967). Soil types within the soil survey area include Columbia complex, channeled (Cu); Columbia fine sandy loam, 10-30% slopes (CmA); and Columbia silt loam, 0-3% slopes (CsA).

Kopta Slough: Tehama County Soil Survey Aerial Photograph (ca. 1967)

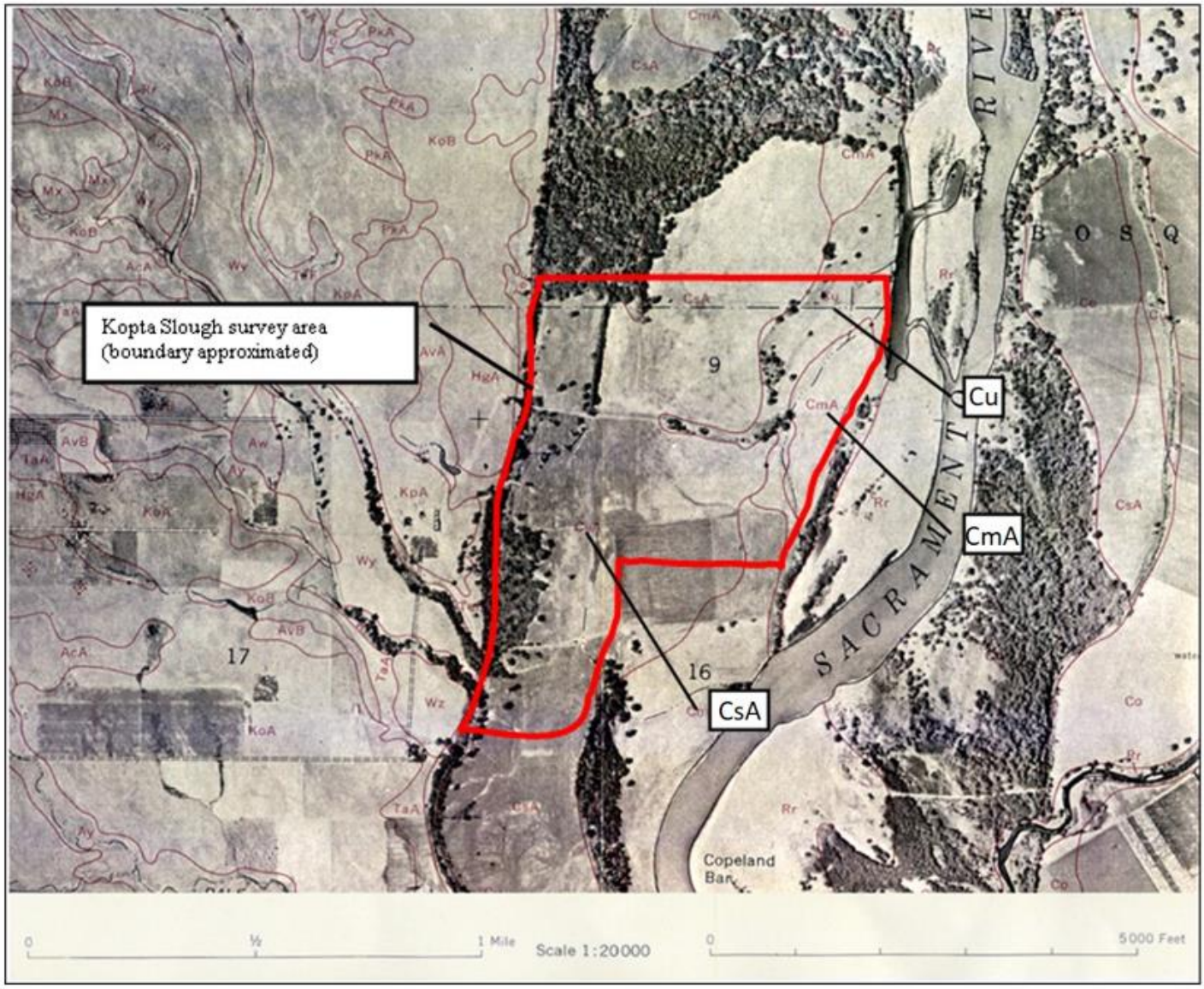

Table 1. Soil texture by depth from auger holes across the Kopta Slough soil survey area (sample locations 1 through 6). For comments, see Table 2.

Depth	Soil Texture at Location 1	Soil Texture at Location 2	Soil Texture at Location 3	Soil Texture at Location 4	Soil Texture at Location 5	Soil Texture at Location 6
Surface	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Clay Loam	Sandy Clay Loam	Clay Loam
1 ft	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Clay Loam	Clay Loam	Sandy Clay Loam
2 ft	Clay Loam	Sandy Clay Loam	Sand	Silty Clay Loam	Loamy sand	Sandy Clay Loam
3 ft	Silty Clay Loam	Sandy Clay Loam	Sand	Silty Clay Loam	Silty Clay Loam	Sandy Clay Loam
4 ft	Silty Clay Loam	Sandy Clay Loam	Sand	Silty Clay Loam	Silty Clay Loam	Sandy Clay Loam
5 ft	Silty Clay Loam	Sandy Clay Loam	Clay Loam	Silty Clay Loam	Loamy Sand	Silty Clay Loam
6 ft	Silty Clay Loam	Sandy Clay Loam	Sand	Loamy Sand	Loamy Sand	Sandy Clay Loam
7 ft	Silty Clay Loam	Sandy Clay Loam	Sand	Sand	Loamy Sand	Sandy Clay Loam
8 ft	Silty Clay Loam	Silty Clay Loam	Clay Loam	Sand	NA	Sandy Loam
9 ft	Silty Clay Loam	Loamy sand	Loamy Sand	Sand	NA	Loamy Sand
10 ft	Clay Loam	Loamy sand	Silty Clay Loam	Sand	NA	Silty Clay Loam
11 ft	Sandy Clay Loam	Loamy sand	Clay Loam	Sand	NA	Sand
12 ft	Sand	Loamy sand	Sandy Clay	Sand	NA	Sand
13 ft	NA	Loamy sand	Sandy Clay	NA	NA	Sand
14 ft	NA	Sand	NA	NA	NA	Sand
15 ft	NA	NA	NA	NA	NA	Loamy Sand
16 ft	NA	NA	NA	NA	NA	Loamy Sand
17 ft	NA	NA	NA	NA	NA	NA
18 ft	NA	NA	NA	NA	NA	NA
19 ft	NA	NA	NA	NA	NA	NA
20 ft	NA	NA	NA	NA	NA	NA
Refusal (depth [feet])	Gravel (12.5)	Saturation (14)	Saturation (13)	Saturation (12)	Gravel (7)	Saturation (16.3)

Table 1 continued. Soil texture by depth from auger holes across the Kopta Slough soil survey area (sample locations 7 through 12).

Depth	Soil Texture at Location 7	Soil Texture at Location 8	Soil Texture at Location 9	Soil Texture at Location 10	Soil Texture at Location 11	Soil Texture at Location 12
Surface	Sandy Clay Loam	Loam	Sandy Loam	Loam	Sandy Clay Loam	Silty Loam
1 ft	Sandy Clay Loam	Silt Loam	Sand	Loam	Sandy Clay Loam	Silty Clay Loam
2 ft	Sandy Clay Loam	Clay Loam	Clay Loam	Sandy Loam	Sandy Clay Loam	Silty Clay Loam
3 ft	Sandy Clay Loam	Sandy Clay Loam	Loam	Sandy Loam	Sandy Clay Loam	Silty Clay Loam
4 ft	Sandy Clay Loam	Loamy Sand	Sand	Sandy Loam	Sandy Clay Loam	Sandy Clay Loam
5 ft	Clay Loam	Sandy Loam	Sand	Sandy Loam	Sandy Loam	Sandy Clay
6 ft	Clay Loam	Clay Loam	Sand	Sandy Loam	Sandy Loam	Loamy Sand
7 ft	Clay Loam	Clay Loam	Sand	Sandy Loam	Loamy Sand	Sandy Clay Loam
8 ft	Clay Loam	Silty Clay Loam	Sandy Loam	Loamy Sand	Clay Loam	Sandy Clay Loam
9 ft	Clay Loam	Silty Clay Loam	Sand	Sandy Loam	Sandy Loam	Silty Clay
10 ft	Clay Loam	Silty Clay Loam	Sand	Loamy Sand	Clay Loam	Sand
11 ft	Loamy Sand	Sandy Loam	NA	Sand	Clay Loam	NA
12 ft	Loamy Sand	NA	NA	Sand	Silty Clay Loam	NA
13 ft	Loamy Sand	NA	NA	NA	Clay Loam	NA
14 ft	Loamy Sand	NA	NA	NA	Sandy Clay Loam	NA
15 ft	NA	NA	NA	NA	NA	NA
16 ft	NA	NA	NA	NA	NA	NA
17 ft	NA	NA	NA	NA	NA	NA
18 ft	NA	NA	NA	NA	NA	NA
19 ft	NA	NA	NA	NA	NA	NA
20 ft	NA	NA	NA	NA	NA	NA
Refusal (depth [feet])	Gravel/saturation (14)	Saturation (11)	Gravel (10.2)	Saturation (12.5)	Saturation (14)	Saturation (10)

Table 1 continued. Soil texture by depth from auger holes across the Kopta Slough soil survey area (sample locations 13 through 18).

Depth	Soil Texture at Location 13	Soil Texture at Location 14	Soil Texture at Location 15	Soil Texture at Location 16	Soil Texture at Location 17	Soil Texture at Location 18
Surface	Sandy Loam	Sandy Clay Loam	Sandy Loam	Sandy Clay Loam	Silty Clay Loam	Silty Clay Loam
1 ft	Sandy Loam	Clay Loam	Sandy Loam	Sandy Clay Loam	Clay Loam	Silty Clay Loam
2 ft	Sandy Loam	Sandy Loam	Silty Clay Loam	Sandy Clay Loam	Silty Clay Loam	Silty Clay Loam
3 ft	Sandy Loam	Sandy Clay Loam	Silty Clay Loam	Silt Loam	Silty Clay Loam	Silty Clay Loam
4 ft	Sandy Loam	Sandy Clay Loam	Sandy Loam	Sandy Loam	Sandy Clay Loam	Silty Clay Loam
5 ft	Sandy Loam	Clay Loam	Silty Clay Loam	Sandy Loam	Loamy Sand	Silty Clay Loam
6 ft	Sandy Loam	Sand	Sandy Clay Loam	Loamy Sand	Loam	Silty Clay Loam
7 ft	Loamy Sand	Loamy Sand	Sandy Clay Loam	Sandy Loam	Sandy Clay Loam	Silt Loam
8 ft	Loamy Sand	Clay Loam	Sandy Clay Loam	Loamy Sand	Loam	Sandy Loam
9 ft	Sand	Sandy Clay Loam	Silty Clay Loam	NA	Silty Clay Loam	Sandy Clay Loam
10 ft	Clay Loam	Loamy Sand	Sandy Clay Loam	NA	Loam	Clay Loam
11 ft	Sandy Clay Loam	Sandy Loam	NA	NA	Sand	Sandy Clay Loam
12 ft	Sandy Loam	Silty Clay Loam	NA	NA	Sand	Sandy Clay
13 ft	Loamy Sand	Sandy Clay Loam	NA	NA	NA	NA
14 ft	Clay Loam	NA	NA	NA	NA	NA
15 ft	Sandy Clay Loam	NA	NA	NA	NA	NA
16 ft	Sandy Clay	NA	NA	NA	NA	NA
17 ft	Sandy Clay Loam	NA	NA	NA	NA	NA
18 ft	NA	NA	NA	NA	NA	NA
19 ft	NA	NA	NA	NA	NA	NA
20 ft	NA	NA	NA	NA	NA	NA
Refusal (depth [feet])	Saturation (17)	Saturation (13.5)	Saturation (10.3)	Saturation (8.3)	Gravel (12)	Saturation (12)

Table 1 continued. Soil texture by depth from auger holes across the Kopta Slough soil survey area (sample locations 19 through 24).

Depth	Soil Texture at Location 19	Soil Texture at Location 20	Soil Texture at Location 21	Soil Texture at Location 22	Soil Texture at Location 23	Soil Texture at Location 24
Surface	Clay Loam	Silty Clay Loam	Silt Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Loam
1 ft	Sandy Loam	Clay Loam	Silty Clay Loam	Clay Loam	Loam	Loamy Sand
2 ft	Clay Loam	Clay Loam	Clay Loam	Sandy Clay Loam	Silt Loam	Sandy Loam
3 ft	Sandy Loam	Clay Loam	Sandy Clay Loam	Loamy Sand	Sand	Sandy Loam
4 ft	Sand	Silty Clay Loam	Sandy Loam	Loam	Sand	Sand
5 ft	Clay Loam	Sandy Loam	Silt Loam	Clay Loam	Sand	NA
6 ft	Clay Loam	NA	Sandy Clay Loam	Sandy Loam	Loamy Sand	NA
7 ft	Silty Clay Loam	NA	Clay Loam	Loamy Sand	Loamy Sand	NA
8 ft	Silty Clay Loam	NA	Sandy Loam	Sand	Loamy Sand	NA
9 ft	Loamy Sand	NA	Sand	Sandy Loam	Loamy Sand	NA
10 ft	NA	NA	NA	Sandy Loam	Silty Clay Loam	NA
11 ft	NA	NA	NA	Sandy Clay Loam	Clay Loam	NA
12 ft	NA	NA	NA	Loamy Sand	Clay Loam	NA
13 ft	NA	NA	NA	NA	Silty Clay Loam	NA
14 ft	NA	NA	NA	NA	Clay Loam	NA
15 ft	NA	NA	NA	NA	Sand	NA
16 ft	NA	NA	NA	NA	NA	NA
17 ft	NA	NA	NA	NA	NA	NA
18 ft	NA	NA	NA	NA	NA	NA
19 ft	NA	NA	NA	NA	NA	NA
20 ft	NA	NA	NA	NA	NA	NA
Refusal (depth [feet])	Gravel (9)	Gravel (5.5)	Saturation (9)	Saturation (12.2)	Saturation (15)	Unconsolidated Sand (4.2)

Table 1 continued. Soil texture by depth from auger holes across the Kopta Slough soil survey area (sample locations 25 through 30).

Depth	Soil Texture at Location 25	Soil Texture at Location 26	Soil Texture at Location 27	Soil Texture at Location 28	Soil Texture at Location 29	Soil Texture at Location 30
Surface	Clay Loam	Silt Loam	Sandy Loam	Sandy Clay Loam	Sandy Clay Loam	Clay Loam
1 ft	Silty Clay Loam	Silt Loam	Silty Clay Loam	NA	Sandy Clay Loam	Sandy Loam
2 ft	Sandy Loam	Silty Clay Loam	Silty Clay Loam	NA	Clay Loam	Sand
3 ft	Silty Clay Loam	Silty Clay Loam	Silty Clay Loam	NA	Sand	Sandy Clay Loam
4 ft	Sandy Loam	Sand	Silty Clay Loam	NA	Sand	Sandy Loam
5 ft	Loamy Sand	Sand	Clay Loam	NA	NA	Loam
6 ft	NA	NA	Loam	NA	NA	Loam
7 ft	NA	NA	Sandy Loam	NA	NA	Sandy Clay Loam
8 ft	NA	NA	Silty Clay Loam	NA	NA	Silt Loam
9 ft	NA	NA	Silty Clay Loam	NA	NA	Sandy Loam
10 ft	NA	NA	Silty Clay	NA	NA	Sand
11 ft	NA	NA	Sandy Clay Loam	NA	NA	Silty Clay
12 ft	NA	NA	NA	NA	NA	Sandy Clay
13 ft	NA	NA	NA	NA	NA	Loamy Sand
14 ft	NA	NA	NA	NA	NA	NA
15 ft	NA	NA	NA	NA	NA	NA
16 ft	NA	NA	NA	NA	NA	NA
17 ft	NA	NA	NA	NA	NA	NA
18 ft	NA	NA	NA	NA	NA	NA
19 ft	NA	NA	NA	NA	NA	NA
20 ft	NA	NA	NA	NA	NA	NA
Refusal (depth [feet])	Gravel (5.5)	Gravel (5.5)	Saturation (11)	Gravel (1)	Gravel (4.2)	Saturation (13)

Table 2. Soil auger hole comments for Kopta Slough restoration soil survey area.

Location	Sample Date	Comments
1	8/5/2003	Black sand was observed at 12 ft.
2	8/5/2003	No comment
3	8/5/2003	Redox features were found at 12 and 13 ft. Gleying was observed at 13 ft.
4	8/6/2003	Increased moisture at 9 ft. Vegetation growing poorly in surrounding environment.
5	8/6/2003	No comment
6	8/6/2003	No comment
7	8/5/2003	Refusal within first foot for first two attempts and then able to get auger through. Attempts are within 2 ft. of final auger hole. Gleying at 7 ft.
8	8/7/2003	At 4 and 6 ft soil moisture increased. Charcoal was observed at 8-9 ft. Redox features including gleying were found from 7-11 ft. (refusal).
9	8/7/2003	Increased soil moisture at 1ft. Coarse sand was mixed with gravel at refusal.
10	8/7/2003	Increased soil moisture at 9 ft.
11	8/5/2003	No comment
12	8/5/2003	Increased soil moisture at 5 ft.
13	8/5/2003	Increased soil moisture at 10 and 14 ft. Redox features were observed at 16 ft.
14	8/5/2003	No comment
15	8/4/2003	Gravels were present at point of saturation (refusal).
16	8/5/2003	No comment
17	8/5/2003	No comment
18	8/4/2003	Increased soil moisture at 6 ft. Grey soil at 7ft. Redox features were observed at 10 ft.
19	8/6/2003	Increased soil moisture at 8 ft. Refusal may have been due to a large rock as auger turned on what felt like a smooth surface.
20	8/6/2003	Angular gravel was encountered at 5 ft.
21	8/6/2003	Increased moisture, redox features including gleying, and charcoal were observed at 7 ft.
22	8/7/2003	Increased soil moisture at 9 ft. and 11ft.
23	8/7/2003	Redox features were observed at 12 and 14 ft. Gleying was observed at 10-14 ft.
24	8/7/2003	In location with poor alfalfa growth.
25	8/7/2003	Poor growth of woody restoration species. Small gravels at 4.5 ft.
26	8/7/2003	Redox features were observed at 2 ft. Sand and gravel were present at refusal.
27	8/7/2003	Redox features at 1 ft. Redox features including gleying were found at 11 ft.
28	8/7/2003	Poor alfalfa growth. Attempted three holes, all refused within 1 ft.
29	8/7/2003	Gravel was found at 1, 2, and 4 ft.
30	8/7/2003	Increased soil moisture at 4 ft. Redox features were found at 7 ft. Site was located in a low lying area with poor crop performance.

References

Gowans, K.D. 1967. Soil Survey, Tehama County, California. U.S. Soil Conservation Service, Washington D.C.

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

Appendix 2.
Kopta Slough Cultivated Restoration Plant Composition

Valley Oak Riparian Forest (VORF) Planting Design

Phase 1 - Manual Planting
Planting Spacings (plants x rows): 11' x 45'
Emitter Density per acre: 88
Acres: 85
Target Planting Date: Spring, Project Year 2
Total Locations: 7,480
Total Plants: 14,960

Canopy structure and species composition for the VORF community.

Canopy Structure	Species		Frequency	Total
Overstory	*Platanus racemosa*	Western sycamore	15%	1,122
Overstory	*Quercus lobata*	Valley oak	32%	2,244
Midstory	*Acer negundo*	Box elder	10%	748
Midstory	*Fraxinus latifolia*	Oregon ash	10%	748
Midstory	*Sambucus nigra ssp. caerulea*	Elderberry	10%	748
Understory	*Baccharus pilularis*	Coyote brush	3%	374
Understory	*Rosa californica*	California rose	10%	748
Understory	*Rubus ursinus*	California blackberry	5%	374
Understory	*Toxicodendron diversilobum*	Poison oak	5%	374
TOTAL			100%	7,480

Sedges, grasses, forbs, and vine composition for the VORF community.

Sedges	*Carex barbarae*	Santa Barbara sedge	20%	1,496
Sedges	*Carex gracilior*	Slender sedge	10%	748
Grasses	*Muhlenbergia rigens*	Deergrass	10%	748
Forbs	*Artemisia douglasiana*	Mugwort	10%	748
Forbs	*Euthamia ocidentalis*	California goldenrod	10%	748
Forbs	*Urtica dioecia*	Hoary nettle	10%	748
Forbs	*Oenothera hookeri*	Primrose	10%	748
Vines	*Aristolochia californica*	California pipevine	13%	972
Vines	*Clematis ligusticifolia*	Clematis	5%	374
Vines	*Vitis californica*	California grape	2%	150
TOTAL			100%	7,480

Phase 2 – Direct Understory Seeding
Acres: 85
Seeding rate (PLS lb/acre): 11
Target Planting Date: December, Project Year 3

Understory ecotype composition for the VORF community.

Grass Species	Ecotype	Seeding Rate
Elymus glaucus	Parrott	25%
Hordeum brachyantherum	Yolo Co.	15%
Elymus triticoides	Yolo Co.	25%
Stipa pulchra	Llano Seco	35%
TOTAL		100%

Valley Oak Woodland (VOW) Planting Design

Phase 1 - Manual Planting
Planting Spacings (plants x rows): 11' x 60'
Emitter Density per acre: 66
Acres: 44.7
Target Planting Date: Spring, Project Year 2
Total Locations: 2,950
Total Plants: 5,605

Canopy structure and species composition for the VOW community.

Canopy Structure	Species		Frequency	Total
Overstory	*Platanus racemosa*	Western sycamore	10%	295
Overstory	*Quercus lobata*	Valley oak	32%	944
Midstory	*Acer negundo*	Box elder	10%	295
Midstory	*Sambucus nigra* ssp. *caerulea*	Elderberry	10%	295
Understory	*Baccharus pilularis*	Coyote brush	3%	88
Understory	*Rosa californica*	California rose	15%	443
Understory	*Rubus ursinus*	California blackberry	10%	295
Understory	*Toxicodendron diversilobum*	Poison oak	10%	295
TOTAL			100%	2,950

Sedges, grasses, forbs, and vine composition for the VOW community.

Sedges	*Carex barbarae*	Santa Barbara sedge	10%	295
Grasses	*Muhlenbergia rigens*	Deergrass	10%	295
Forbs	*Artemisia douglasiana*	Mugwort	15%	443
Forbs	*Euthamia ocidentalis*	California goldenrod	20%	590
Forbs	*Urtica dioecia*	Hoary nettle	10%	295
Forbs	*Oenothera hookeri*	Primrose	10%	295
Vines	*Aristolochia californica*	California pipevine	16%	472
Vines	*Clematis ligusticifolia*	Clematis	7%	207
Vines	*Vitis californica*	California grape	2%	59
TOTAL			100%	2,950

Phase 2 - Direct Understory Seeding

Acres: 44.7
Seeding rate (PLS lb/acre): 11
Target Planting Date: December, Project Year 3

Understory ecotype composition for the VOW community.

Grass Species	Ecotype	Seeding Rate
Elymus glaucus	Parrott	20%
Hordeum brachyantherum	Yolo Co.	25%
Elymus triticoides	Yolo Co.	20%
Stipa pulchra	Llano Seco	35%
TOTAL		100%

Grassland Direct Seeding

Acres: 46.6
Seeding rate (PLS lb/acre): 13
Target Planting Date: December, Project Year 3

Grassland ecotype composition for the VOW community.

Grass Species	Ecotype	Seeding Rate
Elymus glaucus	Parrott	20%
Hordeum brachyantherum	Yolo Co.	25%
Elymus triticoides	Yolo Co.	20%
Stipa pulchra	Llano Seco	35%
TOTAL		100%