The 2020 Distribution, Abundance, and Habitat Associations of the Swainson's Hawk (*Buteo swainsoni*) in Yolo County, California

September 2020

Prepared for:

Yolo Habitat Conservancy

Prepared by:

ESTEP Environmental Consulting

The 2020 Distribution, Abundance, and Habitat Associations of the Swainson's Hawk (*Buteo swainsoni*) in Yolo County, California

Prepared for:

Yolo Habitat Conservancy
292 West Beamer Street
Woodland, CA 95695
Contact: Alexander Tengolics
530.666.8068

Prepared by:

Estep Environmental Consulting
3202 Spinning Rod Way
Sacramento, CA 95833
Contact: Jim Estep
916.921.2515

September 2020

Table of Contents

List of Figures

List of Color Plates

List of Tables

Executive Summary

In compliance with monitoring provisions in Section 6.5.6.3.6 of the Yolo County Habitat Conservation Plan/Natural Communities Conservation Plan (HCP/NCCP), a county-wide census was conducted for the state-threatened Swainson's hawk during the 2020 breeding season. A total of 381 occupied nesting territories were located, exceeding the threshold population number of 270 that would trigger remedial conservation actions. Due to diminished survey effort in several areas and the likelihood of undetected occupied territories, the total number of occupied nesting territories within the survey area likely exceeds 400.

Land cover within the survey area, which included approximately 75% of the total HCP/NCCP area, was also mapped and acreages calculated to determine the extent of suitable foraging habitat available to Swainson's hawks in the HCP/NCCP area. A total of 280,842 acres of suitable foraging habitat, including 25,000 acres of high value habitat, were calculated. These totals exceed the threshold habitat acres specified in Section 7.7.1.2.8 of the HCP/NCCP of 267,750 acres of suitable habitat and 24,584 acres of high value habitat that could also trigger remedial conservation actions. However, this also indicates a decline of suitable foraging habitat of 45,828 acres since the 2007 baseline survey. This reduction is correlated with an increase in orchards of 48,090 acres since 2007. A rapidly expanding agricultural land cover since 2004, orchards currently comprise 24% of the total cultivated landscape in the survey area.

Although the nesting population increased by approximately 24% along with an increase in the proportion of successful nests since the 2007 baseline survey, which informed the development of the conservation strategy for Swainson's hawk in the HCP/NCCP, reproductive output decreased, as indicated by the number of fledged young per the number of occupied territories monitored for reproduction (1.15), and the number of fledged young per successful nest (1.21). Although the survey area supported a greater number of nesting territories and a higher rate of successful nests, the majority of successful nests produced just one fledgling. This is consistent with recent monitoring in Sacramento County and elsewhere in the species' range and is speculatively related to available food resources in cultivated habitats.

Information is also presented on Swainson's hawk nesting habitat and nest tree selection. Data on other nesting raptors was also collected during the survey, including red-tailed hawk, red-shouldered hawk, white-tailed kite, and great-horned owl. Because of their similar nesting habitat use and conspicuousness, data on red-tailed hawk were considered sufficient to make general comparisons with Swainson's hawk with regard to distribution and abundance, reproduction, and nesting habitat. Data collection on other species was considered incidental.

Introduction

In 2018 the Yolo Habitat Conservancy completed the Yolo County Habitat Conservation Plan/Natural Communities Conservation Plan (HCP/NCCP). Implementation of the county-wide plan began with receipt of state and federal permits on January 11, 2019. Providing Endangered Species Act permits and associated mitigation for infrastructure and development activities for 50 years, the HCP/NCCP covers 12 species, among them the state-threatened Swainson's hawk (*Buteo swainsoni*).

The conservation strategy for the Swainson's hawk was based, in part, on the results of the plan-area-wide survey conducted in 2007 (Estep 2008), which provided information on the baseline population and distribution of the species in the plan area. Using this information, a conceptual conservation strategy was developed (Estep 2015), including establishing thresholds for maintaining the nesting population and available habitat for the species throughout the permit period. Using this information, requirements for monitoring and establishing specific thresholds for population and habitat along with remedial measures, were established. Monitoring and threshold requirements, and remedial actions for the Swainson's hawk are found in Sections 6.5.6.3.6 and 7.7.1.2.8 of the HCP/NCCP, which state:

6.5.6.3.6 Swainson's Hawk Document and Monitor Species Status

The Conservancy will monitor the nesting population within the Plan Area at five-year intervals. Every five years, the Conservancy will evaluate the breeding population using a sampling methodology developed by a Swainson's hawk expert and approved by the wildlife agencies. The census will include identifying active nest sites, associated land uses, reproductive output, and possible threats. Trends in the nesting population will reveal the extent to which the Conservancy is meeting the goal to provide for the conservation of Swainson's hawk in the Plan Area. If the nesting population declines by more than 10 percent below the baseline number (300 pairs), this will initiate a meet and confer process with the wildlife agencies, as described in Section 7.7.1.2.8, Regional Loss of Swainson's Hawk Habitat. The Conservancy and the wildlife agencies will examine causes for population declines as needed to assess the extent to which the decline could be related to land use/habitat changes or other activities within the Plan Area or other range-wide causes. In association with nesting population monitoring, the Conservancy will monitor land uses/crop patterns and the extent of nesting habitat within the Plan Area at five-year intervals. Using up-to-date aerial photos, the Conservancy will map the extent and type of each land use/crop type and suitable nest trees/habitat using GIS. The Conservancy will tally totals of each type and examine the data with regard to the extent of suitable foraging and nesting habitat for the Swainson's hawk. The Conservancy will conduct ground-truthing as needed. Trends in the extent of nesting and foraging habitat will reveal the extent to which habitat goals are being met in the Plan Area.

7.7.1.2.8 Regional Loss of Swainson's Hawk Habitat

The analysis in the conceptual conservation strategy suggests that, to maintain the current population of Swainson's hawk in the Plan Area (estimated at 300 nesting pairs), the amount of foraging habitat in the Plan Area should consistently exceed 267,750 acres, and the amount of high-value foraging habitat should be at least 24,584 acres.

Because it had been 13 years since the baseline survey was conducted, the Yolo Habitat Conservancy scheduled the initial county-wide monitoring survey in compliance with Section 6.5.6.3.6 for Year 2 (2020) of the HCP/NCCP implementation. This report provides the results of that survey effort.

Goal

Conduct a survey to establish a current nesting population (i.e., number of occupied nesting territories) and identify available habitat for the Swainson's hawk in the plan area in order to determine the extent to which current conditions meet the requirements of Sections 6.5.6.3.6 and 7.7.1.2.8 of the HCP/NCCP.

Objectives

1. Conduct a complete census of nesting Swainson's hawks within the plan area.
2. Focus on determining territory occupancy, and to the extent possible determine nesting status.
3. Determine reproductive output of the nesting population
4. Determine the acres of suitable and high value foraging habitat in the plan area.
5. Estimate the extent of suitable nesting habitat in the plan area.

Description of the Survey Area

Yolo County is a relatively large county (661,760 acres [267,805 ha]) on the west side of the Central Valley (Figure 1). As a whole the county is biological and topographically diverse extending westward into the chaparral and woodland communities of the inner Coast Ranges, the agricultural lands of the Central Valley west of the Sacramento River, and southward into the wetlands and pasturelands of the northern Sacramento-San Joaquin Delta (Figure 2).

The survey area, initially established for the 2007 survey (Estep 2008), was selected to incorporate all portions of Yolo County that could potentially support nesting Swainson's hawks based on vegetation and topographical characteristics. It includes all lowland portions of the county, excluding only the chaparral and oak woodland-dominated areas on the western edge to approximately the 400-foot elevation contour. The survey area is thus defined by the Yolo County line on the east, north, and south, and by the western edge of the Central Valley (to approximately the 400-foot elevation contour) – and including Capay Valley – on the west (Figure 2). The survey area encompasses approximately 500,000 acres (202,000 ha), or approximately 75.5 percent of Yolo County.

The Sacramento River forms the eastern border of Yolo County and the survey area. The border extends along the Sacramento River northward to the Colusa County line just south of Howell's Landing where it continues westward along the Colusa County line to the western edge of the Central Valley. Southward along the Sacramento River, the border continues into the southern panhandle of Yolo County to Sutter Slough, then follows Sutter Slough for 2-3 miles to the southwest before turning westward along the Solano County border until it reaches County Road 104 (Levee Road) at Liberty Farms. At this point, the border turns northward along the county line formed by County Road 104 (Levee Road), which defines the western edge of the Yolo Basin. After crossing the south fork Putah Creek, the border turns westward along the north fork Putah Creek at the City of Davis. The border follows Putah Creek westward past the City of Winters to Highway 128 where it leaves the county line and turns north along the edge of the inner coast ranges. The western border incorporates all lands on the valley floor, grassland foothills, and several relatively broad lateral valleys, such as that formed by Chickahominy Slough, as it continues northward to Highway 16. Here the survey area boundary turns westward and northward to incorporate Capay Valley before continuing northward along the western edge of the Central Valley until it reaches the Colusa County border on the north (Figure 2).

Climate and Physiography

Yolo County's climate is characterized as Mediterranean with hot dry summers and temperate wet winters. During the summer months, a marine influence from the Sacramento-San Joaquin River Delta (Delta winds) moderates the hot summer temperatures. The average annual air temperature is from 60-62 degrees Fahrenheit. The average daily high temperature during the summer (June through August) is in the mid-90s, average daily low is in the mid-50s. During the winter months (December-February) average daily high is in the mid-50s and average daily

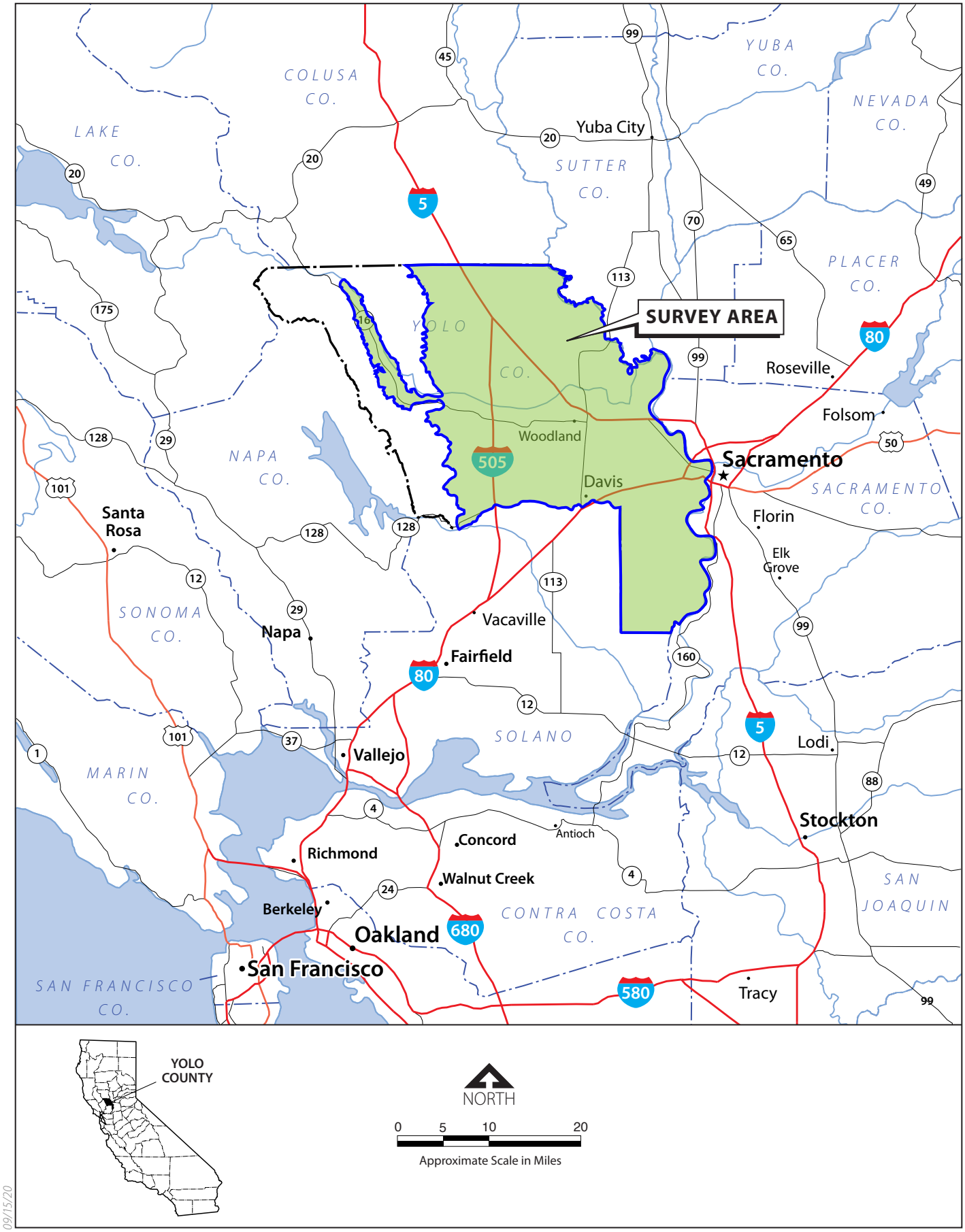


Figure 1
Regional Location Map

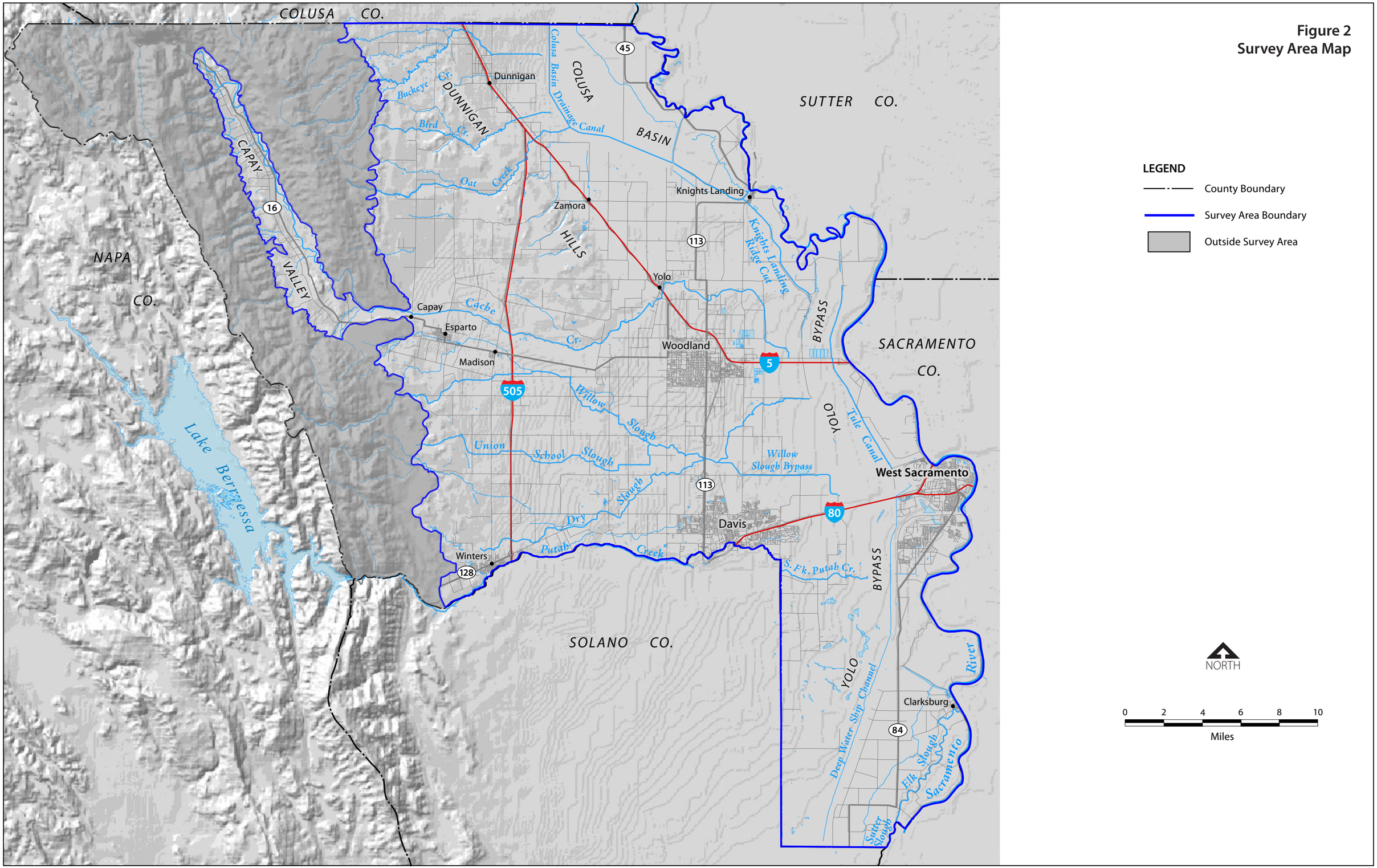


Figure 2
Survey Area Map
LEGEND
County Boundary
Survey Area Boundary
Outside Survey Area
NORTH
0 2 4 6 8 10
Miles
COLUSA CO.
SUTTER CO.
NAPA CO.
SACRAMENTO CO.
SOLANO CO.
YOLO
COLUSA BASIN
DUNNIGAN HILLS
CAPAY VALLEY
YOLO BYPASS
Colusa Basin Drainage Canal
Buckeye Cr.
Bird Cr.
Oat Creek
Cache Cr.
Knights Landing Ridge Cut
Willow Slough
Union School Slough
Willow Slough Bypass
Dry Slough
Putah Creek
S. Fk. Putah Cr.
Tule Canal
Deep Water Ship Channel
Elk Slough
Sutter Slough
Sacramento River
Lake Berryessa
Dunnigan
Zamora
Knights Landing
Yolo
Capay
Esparto
Madison
Woodland
West Sacramento
Davis
Winters
Clarksburg
45
16
113
5
505
80
128
84

09/15/20

low is from 38-40 degrees Fahrenheit. Average annual precipitation is lowest in areas near the Sacramento River (18 inches annually) and greatest in the Little Blue Ridge and Blue Ridge mountains (21 to 30 inches annually) (ICF 2018).

The survey area can be generally characterized as flat, open farmland with two major watercourses, Putah Creek and Cache Creek, flowing west to east through the survey area toward the Sacramento River. The survey area is composed of sediments from the Interior Coast Ranges deposited mainly by these creeks and from the Sierra Nevada deposited primarily by the Sacramento River. Soil associations are primarily associated with alluvial fans or basins, which have created particularly productive farmland in the county, and which are considered among the best irrigated soils in California. Over 270,000 acres of the agricultural land in the county (48%) is classified as Prime Agricultural Land (Yolo County 2009).

The elevation within the survey area ranges from approximately sea level in portions of the southern panhandle to approximately 400 feet above sea level along the western edge of the survey area in the foothills of the Interior Coast Ranges. Sloping imperceptibly from west to east toward the Sacramento River, the majority of the survey area is between 10 and 100 feet above sea level. As noted, the survey area is generally flat with few distinguishing topographical or geologic features. There are, however, four notable exceptions, the Yolo Bypass, the Colusa Basin, Dunnigan Hills, and Capay Valley.

Yolo Bypass

The Yolo Basin is a large natural basin within the flood plain of the Sacramento River extending from the Sacramento River at the Fremont Weir on the north to Cache Slough (south of the county border) on the south (Figure 2). Prior to agricultural and urban expansion in the region, the Yolo Basin consisted of a wide expanse of emergent wetlands and riparian habitats along the eastern border of Yolo County the southern portion of which is considered the northern extent of the Sacramento-San Joaquin Delta. Following initial agricultural expansion in the region, the natural basin was dramatically altered by constructing levees and flood control structures to contain flood waters within an artificially managed bypass (Yolo Bypass). Initially constructed to protect private agricultural lands in Yolo County, the Yolo Bypass is an essential part of regional flood protection by providing as-needed flood water storage capabilities (EDAW 2007).

Throughout its length, the Yolo Bypass is today the dominant feature on the landscape in eastern Yolo County while most of the surrounding Yolo Basin (outside of the Yolo Bypass) is now indistinguishable due to agricultural conversion and urbanization. The Bypass is currently defined on the east by levees along the Tule Canal, generally from Interstate 80 north to the Fremont Weir, and the Deep Water Ship Channel, generally from Interstate 80 south to Cache Slough (Figure 2). The western boundary is a system of levees extending from the Knight's Landing Ridge Cut on the north to the Liberty Island ranch on the south.

Most of the Yolo Bypass from the Fremont Weir south to South Fork Putah Creek is cultivated farmland, with rice as the dominant crop type. However, there are two state wildlife areas in the bypass, the Fremont Weir Wildlife Area, a 1,500 acre natural area at the far northern end of the Yolo Bypass and consisting of valley oak and cottonwood-dominated woodlands and grasslands;

and the 16,600-acre Yolo Bypass Wildlife Area, which extends from just north of Interstate 80 southward into the lower Yolo Bypass and consists of integrated seasonal wetlands, marshes, irrigated pastures, and rice farming. The Yolo Basin south of the Yolo Bypass Wildlife Area consists of irrigated pastures, farmland, managed marsh and seasonal wetlands.

Colusa Basin

The Colusa Basin is also a large natural basin in the floodplain of the Sacramento River (Figure 2). Like the Yolo Basin, the Colusa Basin was also significantly altered during agricultural conversion of the region through construction of levees and water control structures to manage water and agricultural development. The Colusa Basin extends from approximately Knights Landing on the south to Glen County on the north. Within the survey area, it is defined by the Colusa Canal on the south and west and the Sacramento River on the east.

Dunnigan Hills

The Dunnigan Hills is a prominent anticlinal (a fold in layered rocks in which the strata are inclined downward and away from the axis) structure resulting from uplift and folding of the interior Coast Ranges. This generally elongate and symmetrical feature extends from approximately the northwestern corner of the survey area west of Interstate 5 southeast to approximately Cache Creek (Figure 2). Reaching elevations of nearly 400 feet above sea level, this prominent feature has until recently been maintained as uncultivated grazed grassland, surrounded by and sloping toward intensively cultivated landscapes on the east and west. Over the last two decades, large portions of the Dunnigan Hills have undergone a conversion to vineyards and orchards.

Capay Valley

The Capay Valley is an approximately 20-mile long narrow (5-10 miles wide) valley extending from the town of Capay northward to Rumsey through the interior Coast Range. It is entirely within Yolo County and lies between the Blue Hills of the Vaca Mountains on the west and the Rumsey Hills on the east (Figure 2). The northern terminus, just north of Rumsey, is the entry into Cache Creek Canyon. Cache Creek flows along the east side of Capay Valley throughout its length. The floor of Capay Valley is almost entirely agricultural with a mix of orchards, vineyards, irrigated row and grain crops, and irrigated pastures.

Land Use

The survey area is comprised mainly of agricultural lands, but also includes some natural habitats and developed areas. Each of these is described below.

Agricultural Lands

The survey area includes all of the low elevation agricultural lands within Yolo County. Including all cultivated, pasture, and grazing lands, this area totals approximately 408,000 acres, or 82 percent of the survey area. Yolo County is a diverse matrix of agricultural types including

row and grain crops, hay crops, orchards and vineyards, and dryland and irrigated pasture. Table 1 indicates the combined acreages of the major crop types in Yolo County from 2018 as reported by the Yolo County Department of Agriculture (Yolo County 2019). (Note that the total in Table 1 does not represent the total cultivated land in Yolo County because the annual crop reports do not include fallowed lands or other non-reporting agricultural lands.) However, because the majority of the acreage occurs within the survey area (with the exception of orchard and vineyard types, each of which may extend westward into the Coast Range foothills beyond the survey area border), Table 1 illustrates the relative abundance of agricultural land cover (excluding grazing lands) and key crop types within the survey area.

Table 1. Relative abundance of agricultural crops in Yolo County in 2018.

Crop Type	2018	
	Acres	% Total
Alfalfa Hay	25,000	7.6
Other Hay[1]	15,900	4.9
Tomatoes	28,800	8.8
Wheat	26,500	8.1
Field Corn	7,550	2.3
Safflower	6,000	1.8
Sunflower	25,500	7.8
Rice	33,800	10.3
Irrigated Pasture	6,100	1.9
Orchard	77,450	23.7
Vineyard	14,750	4.5
Misc. Field Crops[2]	8,130	2.5
Misc. Vegetable Crops[3]	7,260	2.2
Organic Vegetable Crops	32,900	10.0
Nursery Products	391	0.1
Other Seed Crops	11,370	3.5
Total	327,401	100

[1]includes barley, oat, ryegrass, sudangrass, and volunteer hay
[2]includes beans, sorghum grain, and stubble.
[3]includes cabbage, cantaloupe, corn, cucumbers, lettuce, melons, peppers, and other truck crops

Table 2 indicates the trend in agricultural land uses in the county between 1988 and 2018. Over most of this 31-year period, general patterns are fairly consistent, changes occurring primarily in response to market conditions. The most notable change has been the dramatic increase in orchards beginning in 2006 and the corresponding reduction in field crops such as wheat and tomatoes.

Crop Patterns. The typical crop pattern throughout the survey area consists of a matrix of annually cultivated and rotated crops including tomatoes, wheat, safflower, and sunflower; short-term (3-5 years) perennial crops, such as alfalfa, and long-term or perennial crops, such as rice, vineyards, and orchards (Plate 1).

Annually rotated crop types, primarily row, grain, and field crops, are the dominant agricultural land use in the survey area in terms of acreage. As indicated in Table 2, the most common annually rotated crops in Yolo County over the last ten years are tomatoes, wheat, corn,

Table 2. Agricultural Crop Acreages in Yolo County, 1988 to 2018																
	1988	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Alfalfa Hay	31,000	30,500	36,000	41,638	30,500	30,350	31,775	24,584	28,193	33,983	42,430	43,024	38,720	45,885	53,231	55,914
Other Hays	16,100	14,500	12,600	17,940	16,219	8,197	8,414	11,903	6,296	6,018	8,802	7,340	7,566	7,826	13,466	10,958
Tomatoes	43,350	50,000	59,500	59,600	45,600	61,500	69,700	73,137	67,700	49,200	56,600	67,114	48,575	48,575	42,812	38,274
Wheat	51,254	80,800	70,247	59,681	69,277	53,676	59,031	42,857	54,172	54,836	39,014	33,832	43,144	43,774	33,076	56,227
Field Corn	16,700	18,200	15,000	12,900	21,200	16,380	21,650	24,536	31,371	36,915	18,518	13,513	28,125	18,308	9,195	6,495
Safflower	13,500	20,900	27,710	21,380	31,203	47,938	40,005	33,231	23,937	27,040	24,278	29,545	24,558	27,650	20,765	20,674
Sunflower	5,280	4,828	4,590	3,818	5,417	5,721	8,755	8,118	5,075	5,679	5,831	10,381	4,377	4,540	3,372	9,294
Sugar Beets	17,963	9,650	6,860	8,483	6,963	11,398	7,357	4,027	2,018	4,526	1,570	1,871	1,029	0	0	0
Misc. field	36,300	38,400	33,764	41,961	50,586	48,187	40,462	33,956	29,694	36,925	34,713	27,541	39,701	43,266	40,558	33,029
Misc. veg	4,983	4,755	6,644	4,295	3,288	4,459	6,240	3,329	4,659	7,124	3,773	5,861	7,072	5,319	5,374	5,674
Seed crops	10,373	10,827	12,964	8,459	10,087	11,301	13,878	9,987	14,740	18,464	16,768	14,782	14,331	12,214	13,247	11,414
Rice	28,940	24,200	25,000	13,646	21,680	21,909	20,917	25,012	25,999	25,800	17,816	24,483	36,229	28,717	32,446	37,303
Irr. Pasture	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000	13,000
Orchard	17,617	17,663	18,001	17,447	17,469	17,694	19,026	17,814	16,596	18,368	18,039	17,023	18,889	18,056	18,478	19,364
Vineyard	1,362	1,374	1,581	1,366	1,667	1,770	2,092	4,219	4,540	6,833	8,410	8,704	9,496	10,242	9,699	10,334
Organic	0	455	570	643	444	1,242	1,501	1,460	1,719	1,556	2,425	2,830	3,335	6,253	5,405	4,692
Nursery crops	358	568	506	454	441	430	443	453	338	524	293	406	440	584	502	515
Total	308,080	340,620	344,537	326,711	345,041	355,152	364,246	331,623	330,047	346,791	312,280	321,250	338,587	334,209	314,626	333,161

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Alfalfa Hay	52,904	45,776	59,269	53,959	56,710	49,450	42,934	41,023	42,565	41,030	37,093	33,600	30,200	26,000	25,000
Other Hays	7,383	7,855	16,110	11,168	16,813	8,156	11,799	11,442	10,568	15,978	17,786	18,500	13,800	11,200	15,900
Tomatoes	45,129	42,232	37,026	42,149	37,571	37,881	32,959	40,103	36,843	34,558	39,845	37,178	33,800	28,700	28,800
Wheat	44,098	34,647	20,976	35,613	42,398	28,062	33,885	42,913	35,754	33,276	29,185	22,100	24,000	20,100	26,500
Field Corn	9,523	4,238	2,452	11,596	8,118	6,502	16,260	20,225	23,537	19,368	6,917	3,292	5,510	5,440	7,550
Safflower	9,991	12,955	10,176	9,033	13,514	8,563	9,531	8,775	9,790	7,808	7,170	7,360	4,870	6,610	6,000
Sunflower	13,403	13,615	16,613	15,145	13,808	15,574	12,692	19,039	21,932	24,491	17,754	25,665	20,900	23,900	25,500
Sugar Beets	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Misc. field	33,962	54,226	49,293	39,020	30,416	72,000	62,734	81,187	89,465	88,744	6,887	8,025	5,830	8,420	8,130
Misc. veg	4,028	3,154	4,822	4,817	5,010	3,010	4,450	5,422	5,153	5,972	5,699	7,976	8,460	7,080	7,260
Seed crops	13,102	13,191	12,481	9,545	10,327	10,000	12,326	13,558	15,123	11,271	9,220	10,135	13,130	9,725	11,370
Rice	45,655	34,670	32,564	36,600	34,397	37,405	41,372	42,476	40,461	38,432	39,325	23,000	35,800	28,600	33,800
Irr. Pasture	13,000	13,000	13,000	13,000	13,000	13,000	11,500	11,500	11,500	11,500	16,131	14,527	12,400	12,100	6,100
Orchard	19,313	21,777	29,187	29,352	31,173	30,531	31,023	34,634	37,417	45,955	53,808	57,234	61,394	71,270	77,450
Vineyard	9,909	8,464	10,156	11,898	12,002	13,187	11,407	11,985	12,164	13,030	12,578	13,277	14,460	14,800	14,750
Organic	4,998	4,515	6,003	5,932	6,181	5,774	5,923	22,575	36,007	35,456	28,345	42,656	45,504	34,811	32,900
Nursery crops	489	505	571	492	522	534	385	301	303	347	422	439	470	501	391
Total	326,887	314,820	320,699	329,319	331,960	339,629	341,180	407,158	428,582	427,216	328,165	324,964	330,528	309,257	327,401

safflower, and sunflower. The distribution of annually rotated crops types is relatively uniform throughout the interior of the survey area.

Plate 1. Typical Yolo County irrigated cropland matrix northwest of Davis. Looking east along County Road 29 and Dry Slough.

Alfalfa and other hay crops are typically interspersed throughout the matrix of annually rotated crops. Other hay crops include oat, barley, ryegrass, and sudangrass. Alfalfa, and occasionally other hay types, may remain active for 3-5 years before rotating back to an annually cultivated crop type.

There are three generally distinct rice-growing regions in the survey area including portions of the Yolo Bypass, the Colusa Basin, and an area near the southwest corner of the survey area east of Interstate 505, west of County Road 95, south of Highway 16, and north of County Road 31. These areas are characterized by heavy clay or hardpan soils with poor drainage, which create suitable conditions for deep-flooded rice fields. Although harvested each year, rice fields are generally not rotated to other crop types and in some areas have remained productive for decades.

Orchards have expanded substantially, particularly since 2006 (Table 2) and occur throughout most of the survey area. Vineyards have also expanded, but are more concentrated in the survey area occurring primarily in the southeast panhandle and in the Dunnigan Hills.

Irrigated pasture is found primarily in the south Yolo Basin (Plate 2).

Plate 2. Irrigated pasture in the southern Yolo Basin.

Natural Lands

Natural lands within the survey area include seasonal wetland, emergent marsh, grassland and savanna, riparian woodland and other streamside habitats, small patches of remnant oak woodland on the valley floor, and patches of blue oak woodland along the western edge of the survey area.

Seasonal wetlands and marsh habitats are found primarily within the Yolo Bypass, including the Yolo Bypass Wildlife Area, private lands in the southern panhandle, the Conaway Ranch north of Interstate 80, and the City of Davis Wetlands (Plate 3). Additional wetland habitats are found at the recently restored Roosevelt Ranch Preserve east of Zamora and in several other isolated locations throughout the survey area.

Plate 3. Seasonal wetland and marsh habitats in the southern panhandle.

Riparian habitats occur along several drainages in the survey area, including Putah Creek, Cache Creek, Sacramento River, Willow Slough, Dry Slough, Elk Slough, and Chicahominy Slough (Plate 4, Figure 2).

Plate 4. Oak-dominated riparian along Willow Slough south of County Road 27.

The western edge of the survey area includes areas of open annual grasslands, valley oak savannah, and patches of blue oak woodland. These areas are mostly uncultivated (although in some areas they are interspersed foothill grainfields), retain natural topography, and are typically grazed by cattle (Plate 5).

Plate 5. Uncultivated grassland and valley oak savannah along the western edge of the survey area.

Throughout much of the survey area are isolated valley oak trees and small groves that are remnant of pre-agricultural groves and savannahs, and planted or volunteer rows of native and non-native trees along roadsides and field borders. These trees provide important habitat for many wildlife species that occur in the survey area and nest sites for Swainson's hawks and other raptors (Plate 6).

Developed Lands

Developed lands within the survey area include the communities of Davis, Woodland, Winters, West Sacramento, Esparto, Knights Landing, Yolo, Zamora, Dunnigan, Madison, Capay, and Clarksburg. These lands comprise approximately 8 percent of the survey area (Plate 7).

Plate 6. Row of roadside walnut trees along County Road 104 near Grasslands Regional Park.

Plate 7. City of Woodland, looking east along Highway 16.

Swainson's Hawk Natural History

Description

The Swainson's hawk is a medium-sized buteo most often characterized by its long, narrow, and tapered wings held in flight in a slight dihedral shape (Plate 8). The body size is somewhat smaller, thinner, and less robust than other buteos, although the wings are at least as long as other buteos. This body and wing shape allow for efficient soaring flight and aerial maneuverability, important for foraging, which Swainson's hawks do primarily from the wing, and during courtship and inter-specific territorial interactions.

Plate 8. Adult Swainson's hawk showing the long, tapered wings that allow for efficient soaring and flight maneuverability.

There are three definitive plumage morphs: light, rufous, and dark, with numerous intermediate variations between these plumage morphs. The two most distinguishing plumage characteristics are a dark breast band and the contrasting darker flight feathers and lighter wing linings on the underwings giving most individuals a distinctive bicolored underwing pattern (Plate 9). These characteristics are most pronounced in lighter morph birds and become less so as the plumage darkens, and can be indistinguishable in the definitive dark morph, which is completely melanistic. All three definitive plumage morphs are present in California, with a relatively large proportion of the population categorized as intermediate between the definitive morphs, with varying amounts of streaking or coloration in the belly and wing linings.

Plate 9. Light Morph Adult Swainson's Hawk

Breeding Range and Statewide Distribution

Swainson's hawks inhabit grassland plains, shrublands, and agricultural regions of western North America during the breeding season and inhabit similar habitats from Central Mexico to southern South America during the migration and winter non-breeding seasons (Bechard et al. 2010; Airola et al. 2019). Early accounts described Swainson's hawk as one of the most common raptors in the state, occurring throughout much of lowland California (Sharp 1902). Since the mid-1800s, the native habitats that supported the species have undergone a gradual conversion to agricultural uses, or as in the case of southern California coastal valleys, to urbanization. Today, with the exception of desert scrub communities in the high desert regions of the state, native landscapes that supported nesting and foraging Swainson's hawks are virtually nonexistent. This habitat loss is thought to have caused a substantial reduction in the breeding range and in the size of the breeding population in California, estimated in 1980 at 375 breeding pairs (Bloom 1980). A more recent statewide survey indicates a larger and possibly expanding breeding population in the Central Valley with a current estimate of 3,218 breeding pairs (Battistone et al. 2019).

The current range of the species in California includes the Central Valley, the high desert regions and valleys of northeastern California, the east side of the Sierra Nevada from Owens Valley and extending southwestward into the western Mojave Desert in the vicinity of Antelope Valley (Figure 3).

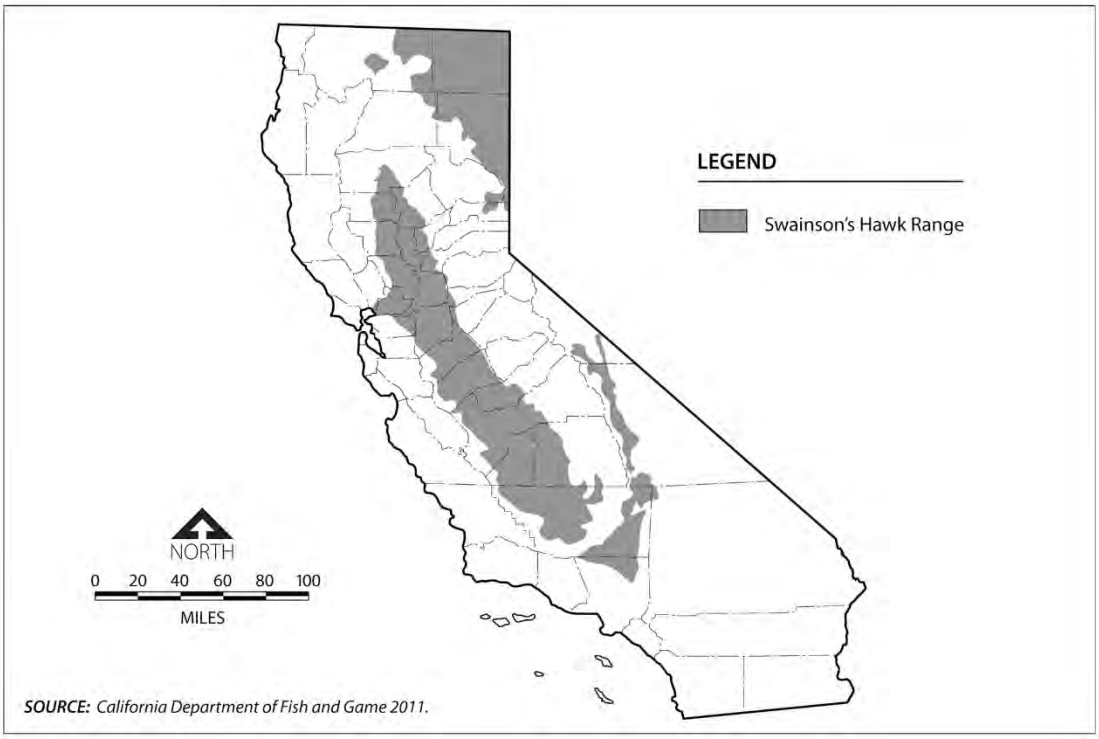


Figure 3. The breeding range of the Swainson's hawk in California.

Despite the loss of native habitats throughout the species' range in California, Swainson's hawks appear to have adapted relatively well to certain types of agricultural patterns in areas where suitable nesting habitat remains. Today, the species is most abundant in landscapes that are entirely under cultivation. The largest segment of the statewide population is in the Central Valley, with the highest nesting densities occurring in Yolo, Sacramento, Solano, and San Joaquin Counties (Bloom 1980, Estep 2007, 2008, LSA 2012, Battistone et al. 2019), and where the species is nearly entirely dependent on cultivated foraging habitats. The nesting distribution in the Central Valley follows the distribution of suitable hay, grain, and row crop agriculture compatible with the foraging requirements of the Swainson's hawk and where it occurs in association with suitable nesting habitat (Battistone et al. 2019, Estep and Dinsdale 2012). The association with cultivated lands has also been described throughout the species range outside of California (Schmutz 1987, Bechard et al. 2010, Alsup 2012), and during migration and on wintering ranges in Central and South America (Airola et al. 2019).

The Swainson's hawk has also shifted its distribution throughout the high desert region of northeast California to take advantage of cultivated habitats, where it occurs in greater breeding densities than it does in most native deserts or shrublands (Woodbridge 1991). The same association with cultivated habitats has occurred along the east side of the Sierra Nevada and the Mojave Desert (Estep 2013).

Habitats and Habitat Use

Nesting

In the Central Valley, Swainson's hawk nests in large native trees such as valley oak (*Quercus lobata*), cottonwood (*Populus fremontia*), walnut (*Juglans californica*), and willow (*Salix* sp.), and increasingly in nonnative trees, such as eucalyptus (*Eucalyptus* sp.) and ornamental pine trees. Prior to agricultural conversion, Central Valley populations nested primarily in riparian woodlands and on the edges of oak woodlands. Today, in addition to these habitats, the species nests in roadside trees, trees along field borders, isolated trees, trees around farm houses and farmyards, and in urban areas that are adjacent to cultivated lands (Bechard et al. 2010, Estep 2007, 2008, Alsup 2012) (Plate 10).

Nesting pairs are highly traditional in their use of nesting territories. Many monitored nesting territories in the state have been occupied annually since at least the early 1980s and banding studies conducted since 1986 confirm a high degree of territory and mate fidelity (Woodbridge 1991, Briggs 2007, Estep *in progress*).

Plate 10. Typical Swainson's hawk nest in a willow tree (center). Nests are often inconspicuous and difficult to see. The white objects in the nest are downy nestlings.

Foraging

Swainson's hawks are plains or open-country hunters, requiring large open landscapes for foraging. Historically, the species hunted the grasslands of the Central Valley and coastal valleys and the open desert scrub and shrublands in high desert regions. With the cultivation of

virtually all of the Central Valley, and a portion of the high desert region, Swainson's hawk foraging has largely shifted onto agricultural lands that provide a dynamic, regularly manipulated landscape that maximizes prey populations and accessibility of rodent prey (Estep 1989, Babcock 1995, Woodbridge 1991).

Foraging habitat use, particularly agricultural foraging habitat, is largely a function of two primary variables: abundance of prey and amount of vegetative cover that affects access to prey (Bechard 1982, Estep 1989, 2009). Suitability is in part a function of changing vegetation structure throughout the growing season, which influences prey accessibility. Agricultural cover types that provide suitable foraging habitat conditions include hay, grain and row crops, fallow fields, and irrigated and dryland pasture. The matrix of these cover types can create a dynamic foraging landscape as temporal changes in vegetation results in changing foraging patterns and foraging ranges (Estep 1989, Babcock 1995, Fleishman et al. 2016). Uncultivated habitats, such as grasslands, shrub-steppe communities in northeastern California, and desert scrub in the Mojave Desert provide more stable, consistent habitat value, but probably do not provide the extent of available prey resources that would support the high breeding densities found in some cultivated habitats.

Within the cultivated landscape, hay crops, particularly alfalfa, provide the highest value because of the low vegetation structure, relatively large prey populations, and because farming operations such as periodic mowing enhance prey accessibility. Foraging studies have demonstrated that use of alfalfa fields is significantly greater than other crop types (Estep 1989, Swolgaard et al., Nur et al. 2019). Most row and grain crops are planted in winter or spring and have foraging value while the vegetation remains low, but become less suitable as vegetative cover and density increases. During harvest, vegetation cover is eliminated while prey populations are highest, enhancing their suitability during this period. Some crop types, such as orchards, provide little to no value because of reduced accessibility and relatively low prey populations.

Home Ranges

Home ranges are highly variable depending on cover type, and fluctuate seasonally and annually with changes in vegetation structure (e.g., growth, harvest) (Estep 1989, Woodbridge 1991, Babcock 1995). Fleishman et al. 2016 also found that home range size was associated with life stage (e.g., arrival, pre-hatching, nestling, pre-migratory) and nesting status. Studies conducted in the 1980s and 1990s in the Central Valley found that home range size ranged from 830 to 21,543 acres (336 to 8,718 ha) (Estep 1989, Babcock 1995). Fleishman et al 2016 reports larger home ranges from 21,489 acres (8,696 ha) to 45,502 acres (18,414 ha), due in part to including arrival and pre-migratory life stages, periods when home range size was found to be larger and that were not entirely included in earlier studies. Smaller home ranges during the pre-hatching and nestling phases of the breeding cycle may be related to nest provisioning activity. At sites where nests failed, home range expanded (Fleishman et al 2016). Smaller home ranges generally consist of high percentages of alfalfa, fallow fields, and dry pastures (Estep 1989, Woodbridge 1991, Babcock 1995). Larger home ranges were associated with higher proportions of cover types with reduced prey accessibility, such as orchards and vineyards, or reduced prey abundance, such as flooded rice fields. Swainson's hawks regularly forage across a very large landscape compared with most raptor species. Because of their ability to rapidly move long

distances, it remains energetically feasible for Swainson's hawks to successfully reproduce when food resources are limited around the nest and large home ranges are required (Bechard et al. 2010) (Plate 11).

Plate 11. Swainson's hawk morphology is ideal for long-distance movements that allow it to expand its home range area in response to changing food resources in agricultural landscapes.

Breeding Season Phenology

Swainson's hawks arrive at the breeding grounds from early March to early April (Figure 4). Breeding pairs immediately begin constructing new nests or repairing old ones. Eggs are usually laid in mid- to late April, and incubation continues until mid-May when young begin to hatch. The brooding period typically continues through early to mid-July when young begin to fledge (Bechard et al. 2010). Studies conducted in the Sacramento Valley indicate that one or two—and occasionally three—young typically fledge from successful nests (Estep 2007, Estep and Dinsdale 2012, ICF 2019) (Plate 12). After fledging, young remain near the nest and are dependent on the adults for about 4 weeks, after which they permanently leave the breeding territory (Anderson and Estep, unpublished telemetry data). By mid-August, breeding territories are no longer defended, and Swainson's hawks begin to form communal groups. These groups begin their fall migration from late August to mid-September. Unlike most other Swainson's hawk populations, which migrate to southern Argentina for the winter, the Central Valley population winters from Central Mexico to central South America (Airola et al. 2019).

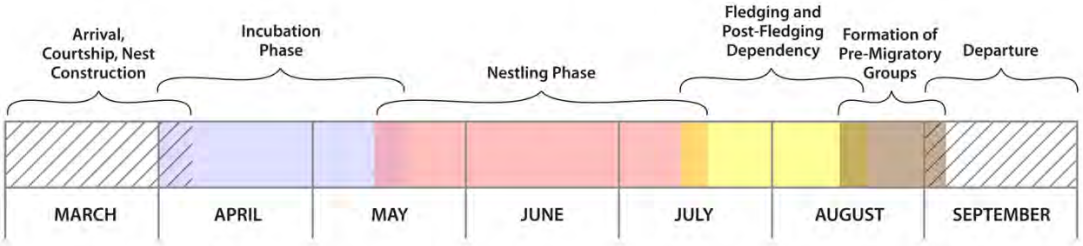


Figure 4
General Representation of Swainson's Hawk Breeding Cycle in the Central Valley

Plate 12. Nearly Fledged Swainson's Hawks.

Methods

Assessment of Populations

The goal of the survey was to document all active Swainson's hawk nesting territories in the survey area for the purpose of assessing the size the breeding population, compare results with the 2007 survey, and determine if the number of occupied territories is sufficient to meet the population threshold as described in Section 6.5.6.3.6 of the HCP/NCCP.

While conducting the survey, I also planned to collect and record similar data on several other species that may compete for nesting or foraging habitat and that may influence the distribution and abundance of Swainson's hawks, including the red-tailed hawk (*Buteo jamaiscensis*), red-shouldered hawk (*Buteo lineatus*), white-tailed kite (*Elanus leucurus*), and great-horned owl (*Bubo virginianus*).

The survey was designed as a complete census. With four notable exceptions, I surveyed all potential nesting areas throughout the survey area equally according to the protocol described below regardless of past survey effort or existing information on Swainson's hawk nesting locations. The exceptions, which were inadequately surveyed due to access and time constraints, include the portion of Putah Creek from Pierce Ranch Road west to Winters, the Sacramento River from County Road 98a north to China Bend, the eastern portion of Oat Creek through the northern Dunnigan Hills from the County Road 12a crossing to Interstate 505, and Capay Valley.

I also used occurrence data collected by others at two locations in the survey area related to ongoing monitoring projects. These included the vicinity of the Himalaya Ranch Conservation Easement along a portion of Willow Slough (data provided by Kevin Cahill at HT Harvey & Associates), and the Lower Yolo Restoration Project in the southern Yolo Bypass (data provided by Chris Campbell of cbec, Inc. and Carl Jensen at ICF International).

I conducted the surveys over 49 days primarily between mid-May and late July, with limited localized surveys conducted in April. The majority of surveys were not conducted during the courtship, nest building, or incubation phases (approximately late March through early May). Some nesting pairs could have failed in their nesting attempt early in the season and abandoned the nesting territory prior to the initiation of surveys. As a result, the number of unsuccessful nests and occupied nesting territories could be underrepresented in the results. Survey dates included April 3, 11, 14, 15; May 19, 21, 22, 23, 24, 26, 28, 29, 31; June 1, 3, 6, 7, 8, 9, 12, 13, 18, 19, 20, 22, 24, 25, 28, 29, 30; and July 1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 20, 23, 29.

The survey area was initially organized into smaller sub-areas based on accessibility and efficiency. These areas included:

- Colusa Basin
- Yolo Bypass, south of I-80
- Yolo Bypass, north of I-80
- Between the Sacramento River and the Deep Water Ship Channel
- Between the Sacramento River and the Tule Canal
- North of Woodland from I-5 to Knights Landing Ridge Cut
- Colusa Canal to Dunnigan Hills
- Dunnigan Hills
- Hungry Valley
- Capay Valley
- Cache Creek to Putah Creek, west of I-505
- Cache Creek to Putah Creek, between I-505 and Hwy 113
- Cache Creek to Putah Creek, between Hwy 113 and Yolo Bypass

Surveys were conducted by systematically driving all available roads within the survey area. Where roads were not available to drive or where there were no roads to access potential nest trees, I conducted the survey on foot unless access to private property was not granted. In general, access in the survey area was excellent; I was provided access to all major levees maintained by Yolo County, California Department of Water Resources, and Reclamation Districts 730, 785, 900, and 1600. Access onto private farmlands was also regularly granted or provided through numerous public roadways.

Using binoculars and spotting scope, I checked all suitable nesting habitats for the presence of active nests and adult Swainson's hawks and to note nesting activity and behavior (e.g., nest construction, courtship flights, and defensive behavior). I searched all trees for active nests. I recorded nest site and habitat data on a standardized field form. Activity was noted and mapped on field maps; locations of active nests were documented on 7.5-minute USGS quadrangle maps, and a hand-held GPS unit was used to record latitude-longitude coordinates of each nest. I also took photographs of most active nest sites and surrounding land use.

I conducted follow-up surveys as needed until all potential habitats were inspected, with the exception of the four areas noted above. As necessary and as time allowed, active nests were revisited to determine activity and reproductive status and to record the number of fledged young: the metric used to report reproductive performance. Activity data were recorded based on the following standard definitions (Postupalsky 1983):

- *Occupied Nesting Territory*: a nesting area in which a pair of raptors showed activity indicating territory establishment. Territories were considered occupied when the following activities and behaviors were observed: regular presence and activity of adults, courtship displays, circling low above the nest tree or nesting stand, defensive behavior, prey exchanges and prey delivery to the nest. The nesting territory location was plotted based on the location of the nest, or if the nest was not located, based on the primary area of observed activity within the potential nesting habitat.

- *Active Nest*: An occupied nesting territory at which egg laying was confirmed through direct observation of incubating adults or young in the nest, or if the nest is concealed from direct observation, a combination of behaviors that indicate the presence of an active nest (e.g., food provisioning, visual or auditory confirmation of young, defensive behaviors).

- *Occupied Inactive Nesting Territory*: an occupied nesting territory in which multiple observations confirmed that adults did not lay eggs.

- *Occupied Nesting Territory with Unconfirmed Nesting Status*: an occupied nesting territory for which reproductive outcome was not confirmed. This category includes occupied nesting territories where access was inadequate to determine nesting activity (in some cases the actual nest was not observed) or where repeat visits were inconclusive in determining if the nest was active.

- *Successful Nest*: an active nest that fledged at least one young.

- *Unsuccessful Nesting Attempt*: An occupied territory in which the pair did not lay eggs, or an active nest that failed to produce fledged young.

I measured productivity of the population as the average number of fledged young produced per occupied nesting territory with confirmed nesting status (active nests plus occupied nesting territories that did not nest). Brood size was measured as the average number of fledged young produced per successful nest.

Each active territory was characterized with respect to nesting habitat type, tree species, condition, location within the nesting habitat, and associated land cover.

Distribution of Nesting and Foraging Habitats

During the 2007 survey (Estep 2008), I used the California Department of Water Resources (DWR) 1997 Land Use Survey Data for Yolo County as a base map, which was updated through field ground-truthing conducted during the survey. Due to land use and crop distribution changes in the survey area over the intervening 13 years, using this map base would have resulted in substantial inaccuracies.

As an alternative, I conducted a desktop mapping of the survey area using aerial imagery from Google Earth Pro (2020). Using USGS 7-minute quadrangle maps as the map base, I measured, confirmed, and mapped boundaries and land cover type within the boundary of the entire survey area from 2018 images. Ground-truthing was conducted throughout much of the survey area during field surveys.

Ten land cover types were selected to represent land use throughout the survey area. For purposes of this study, foraging habitat associations were assessed on the basis of broad agricultural land use categories rather than specific cover types. The agricultural crop pattern

mosaic is dynamic in the survey area and throughout the Sacramento Valley and is subject to change annually and seasonally. Therefore, with the exception of several perennial cover types (e.g., vineyard, orchard, rice), cultivated lands were identified as a single land use category – annually or seasonally rotated cropland – which represents all hay, grain, and row crop agricultural lands in the survey area. As a result, land cover categories in the survey area include the following:

- Rotated cropland
- Orchard
- Vineyard
- Rice
- Irrigated pasture
- Grassland
- Seasonal wetland
- Marsh
- Woodland
- Urban (high and low density)

Following the initial mapping and ground-truthing, land cover maps were converted to graphic maps using Adobe Illustrator (See Figures C-1 through C-25 in Appendix C). The land cover acreages were then calculated from the graphic maps using a plug-in filter from Telegraphics Inc. Although this process provided a reasonably accurate mapping representation, and particularly for calculating the relative abundance of the mapped types across the landscape, it did not exclude roads and other edge features. As a result, the acreage totals may exceed the actual acreage for most types. These inclusions, however, were considered to have a negligible effect on meeting the study purposes of characterizing raptor responses at a broader landscape scale. Using the mapped and quantified habitat/land cover information, I then characterized and described the distribution and abundance of nesting Swainson's hawks in the survey area with regard to these broad habitat associations.

Trends in the abundance of suitable foraging habitats in the survey area were assessed using data from the Yolo County crop reports between 1988 and 2018.

The data collected during this survey and assessment were not subjected to statistical analysis for purposes of analyzing habitat use preferences or differences between data sets. The data were used solely to report and describe the nesting distribution and habitat associations of Swainson's hawk and other raptors within the Yolo County survey area.

Results

Distribution and Abundance

Appendix A provides the location, activity, habitat association, and reproductive data for each occupied territory. Figure 5 and Appendix B illustrate the distribution of occupied Swainson's hawk territories in the survey area in 2020. Table 3 summarizes activity and reproduction data.

Table 3. Activity and Reproduction Data for Swainson's Hawk Territories in the Yolo County Survey area, 2020.

Activity	
Total Occupied Nesting Territories	**381**
Occupied Nesting Territories with Confirmed Nesting (Active Nests)	377 (99%)
Active Nests with Confirmed Reproductive Outcome[1]	170 (45%)
Successful Nests	161 (95%)
Unsuccessful Nests	9 (5%)
Active Nests with Unconfirmed Reproductive Outcome	207 (55%)
Reproduction	
Total Number Fledged Young	196
Number Fledged Young/Occupied Territory with Confirmed Reproductive Outcome (N=170)	1.15
Number of Fledged Young/Successful Nest	1.21

[1]These were the nests that were monitored sufficiently to determine the outcome of the nesting attempt.

A total of 381 occupied Swainson's hawk nesting territories were documented in the survey area. Nesting was confirmed at 376 of the occupied territories. Reproductive outcome (i.e., number of fledged young) was documented at 171 of the active nests.

Figure 5 indicates that Swainson's hawks were distributed broadly, although somewhat unevenly, throughout survey area. Areas of lower nesting density were associated primarily with the lack of nesting habitat and large patches of unsuitable cultivated monoculture (e.g., rice, vineyard, or orchard). Examples of these areas include the Colusa Basin, Yolo Bypass, portions of the panhandle east of the Deep Water Ship Channel, and the Dunnigan Hills.

Because the survey was incomplete in several areas due to timing or access constraints, including the portion of Putah Creek from Pierce Ranch Road west to Winters, the Sacramento River from County Road 98a north to China Bend, the eastern portion of Oat Creek through the northern Dunnigan Hills from the County Road 12a crossing to Interstate 505, and Capay Valley; and the certainty that some proportion of active nests were not detected during the survey – particularly

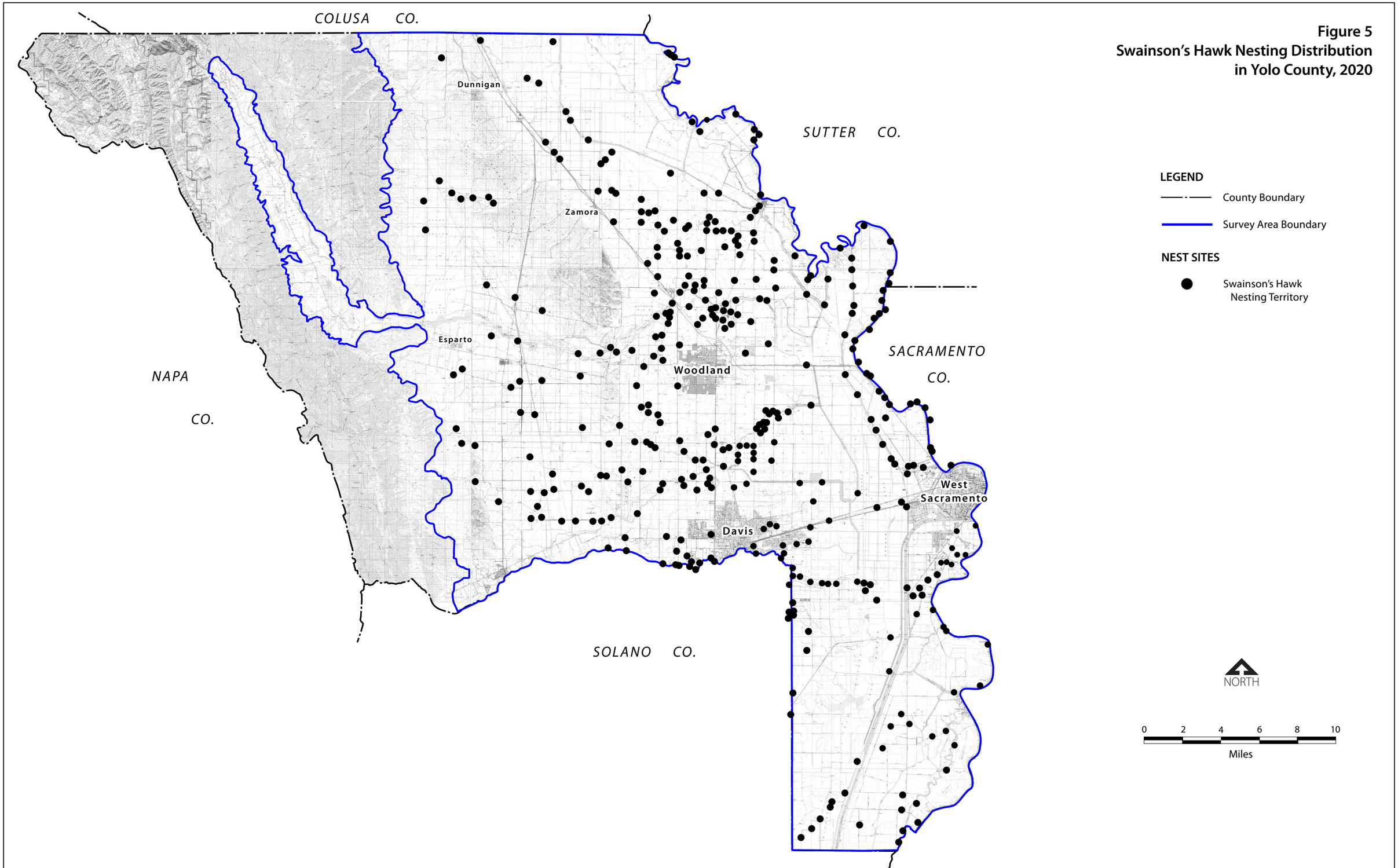


Figure 5
Swainson's Hawk Nesting Distribution in Yolo County, 2020

urban nests, the total number of occupied territories within the survey area is undoubtedly greater than the total found and very likely exceeds 400.

The density of Swainson's hawk nesting territories (i.e., number of nesting territories per km²/mi²) within the survey area was 0.19/km² (0.49/mi²), higher than reported from the survey area in 2007 (0.15/km² [0.38/mi²]), higher than reported from elsewhere in California, and substantially higher than in other regions outside of California (Estep and Dinsdale 2012, Estep 2007, Estep 2008, Woodbridge et al. 1995, Schmutz 1987, Bednarz et al, 1990).

Most of the Swainson's hawk pairs in the survey area were confirmed to have attempted nesting (98%). I was able to follow-up on the nesting status of 171 of these (45%) sufficient to determine reproductive outcome. I found that a large proportion of these (95%) successfully produced young. Although this is an unusually high success rate, the reproductive rate, as measured by the number of fledged young per the number of occupied nesting territories with confirmed reproductive outcome, was quite low and lower than that reported during the 2008 survey. Although expressed here with some caution because the reproductive rate is based on data collected incidentally as access and timing allowed (rather than a selection of nest sites to be examined for reproduction), the data collected from a fairly large number (171) of nests is nonetheless meaningful in examining the broader reproductive status of this population. Of the 171 nests, 136 (80%) produced only 1 fledged young; 26 produced 2 and 9 failed to produced young. So, although nest success and the overall number of active nests was unusually high in the survey area, the reproductive rate (the low number of young produced per nest) was low and suggests uncertain food resources or other reproduction-suppressing mechanisms.

Nonetheless, the results of the survey indicate that the total number of occupied territories is sufficient to meet and exceed the population threshold as described in Section 6.5.6.3.6 of the HCP/NCCP and thereby avoid implementing remedial actions.

Comparison with 2007 Survey Results

Table 4 compares the survey results with the results from the 2007 survey. The number of occupied Swainson's hawk territories documented during the survey increased by approximately 24% since 2007 along with an increase in the proportion of successful nests. Interestingly, while the number of occupied territories has increased, the reproductive rate has decreased over this 13-year timeframe. Although this could be a single-year-phenomena, annual monitoring results from the neighboring Natomas Basin HCP area in Sacramento County also report a gradual reduction in the number of fledged young per successful nest since 1999 (ICF 2020). The ICF (2020) report cites a study of a Swainson's hawk population in Saskatchewan (Houston and Schmutz 1995), which experienced a similar long-term decline in the number of fledged young per successful nest that coincided with a decline in the principal prey species, Richardson's ground squirrel (*Urocitellus richardsonii*). They further speculated that a local reduction in the California vole (*Microtus californicus*), possibly due to land use changes – including the expansion of orchards – may be a factor in local declines in reproductive rates.

Table 4. Comparison of 2007 and 2020 Activity and Reproduction Data for Swainson's Hawk Territories in the Yolo County Survey Area.

	2007	2020
Activity		
Total Occupied Nesting Territories	**290**	**381**
Occupied Nesting Territories with Confirmed Nesting (Active Nests)	283 (98%)	377 (99%)
Active Nests with Confirmed Reproductive Outcome[1]	195 (69%)	170 (45%)
Successful Nests	166 (85%)	161 (95%)
Unsuccessful Nests	29 (15%)	9 (5%)
Active Nests with Unconfirmed Reproductive Outcome	88 (31%)	207 (55%)
Reproduction		
Total Number Fledged Young	241	196
Number Fledged Young/Occupied Territory with Confirmed Reproductive Outcome	1.24	1.15
Number of Fledged Young/Successful Nest	1.45	1.21

Habitat Associations

Land Cover

Figure 6 and Appendix C illustrate the distribution of 10 defined land cover types across the survey area based on 2018 aerial images and ground truthing conducted during the 2020 survey. Totals do not include open water, drainage basins such as the Cache Creek basin, and riparian woodland. Table 5 indicates the relative abundance of each of the land cover types. Brief descriptions of each follows.

Table 5. Land Cover Acres in the Survey Area, 2018

Land Cover	Acres	Percent of Total
Rotated Cropland	174,806	36.8
Orchards	82,867	17.5
Grassland	63,178	13.3
Rice	47,859	10.1
Urban	34,991	7.4
Seasonal Wetland	25,482	5.4
Vineyards	22,697	4.8
Irrigated Pasture	17,016	3.6
Woodland	3,225	0.7
Marsh	2,291	0.5
Total	474,412	100

Rotated Cropland. This type is defined as areas that are dominated by crop patterns that involve annual, seasonal, or periodic rotation. This includes field and vegetable crops (e.g., tomatoes, wheat, corn, sunflower, safflower) and hay crops (e.g., alfalfa, barley, oats, ryegrass,

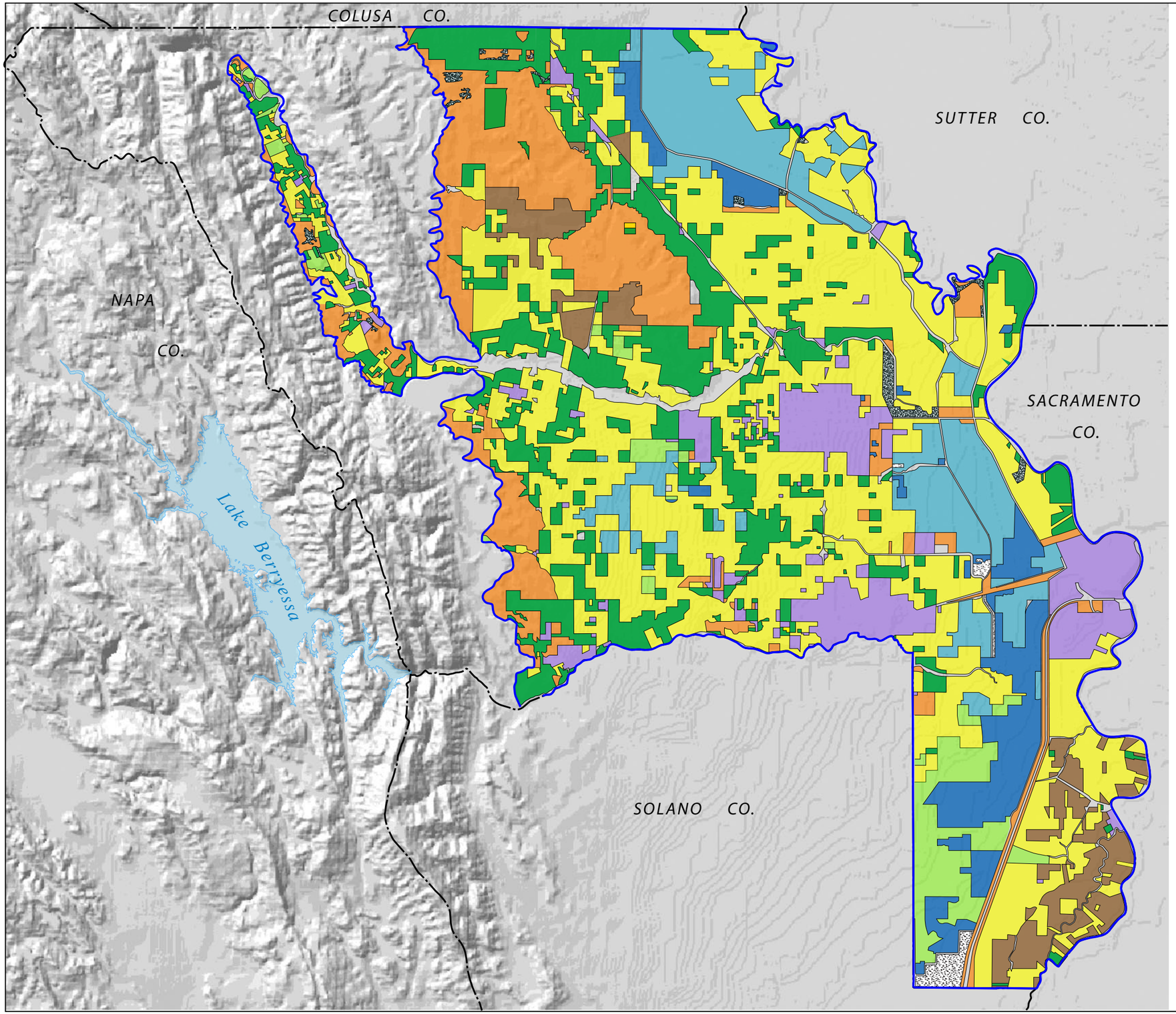


Figure 6
Distribution of Land Cover Types, Yolo County 2020

LEGEND

County Boundary

Survey Area Boundary

Land Use

- Irrigated Cropland
- Orchard
- Rice
- Grassland
- Vineyard
- Irrigated Pasture
- Seasonal Wetland
- Urban
- Marsh
- Woodland

NORTH

0 2 4 6 8 10
Miles

sudangrass). As a whole, this type is considered suitable foraging habitat for Swainson's hawk; however, suitability varies among specific crop types based on vegetation structure and planting/harvesting regime, which influence prey accessibility (Estep 2009, Bechard 1982). This is the dominant land cover type in the survey area comprising 36.8% of the land area (Table 5), and is distributed broadly throughout the survey area (Figure 6).

Orchard and Vineyard. These perennial crops develop a vegetative overstory that usually precludes access by foraging Swainson's hawks and most other raptors. Although Swolgaard et al. (2008) found some limited use of vineyard habitats, both types are generally considered incompatible with Swainson's hawk foraging. Both types, but particularly orchards, have undergone a substantial increase in areal extent in the survey area and currently represent a combined 22.3% of the land area (Figure 6, Table 5).

Rice. Rice cultivation has a more localized distribution in the survey area and tends to be relatively stable within the cultivated matrix because of its association with specific soil conditions. There are three primary rice-growing areas, the Yolo Bypass, the Colusa Basin, and to a lesser extent, southwest of Woodland (Figure 6). Active rice fields are flooded much of the spring/summer breeding season, and are therefore considered unsuitable as Swainson's hawk foraging habitat. Swainson's hawk generally avoid large rice monocultures. However, when rice fields are intermixed with other upland crop types, the edges and borders may provide some foraging value to Swainson's hawks. Fallowed rice fields often develop herbaceous weedy vegetation capable of supporting rodent or insect prey populations and thus can also provide some foraging value to Swainson's hawks and other raptors. Depending on the timing of spring flood-up, rice fields may also provide foraging value during field preparation and initial flood-up, which can expose rodent prey. Rice cultivation comprises 10.1% of the land area (Table 5).

Irrigated Pasture. Irrigated pastures grow irrigated grasses or forbs grazed by livestock or periodically cut for hay. These include large pasturelands found primarily in the Yolo Basin south of Putah Creek and smaller pastures associated with livestock operations or horse training or breeding facilities and farm residences scattered throughout the survey area (Figure 6). Depending on rodent availability, grazing intensity, and haying frequency, irrigated pastures can provide moderate to high value foraging habitat for Swainson's hawks and other raptors because they usually maintain low vegetative cover and are available for foraging throughout the breeding season. Irrigated pastures currently make up 3.6% of the survey area (Table 5).

Grasslands. Most of the natural areas within the survey area are grasslands, the majority of which are foothill prairies dominated by annual grasses found along the western edge of the survey area and in the Dunnigan Hills (Figure 6). Smaller grassland patches also occur throughout the survey area, including the Glide Ranch west of Davis, the Fremont Weir Wildlife Area at the north end of the Yolo Bypass, Grasslands Regional Park south of Davis, and as narrow corridors along the Deep Water Ship Channel. As a whole, grasslands are considered moderately suitable foraging habitat for Swainson's hawk, more closely resembling the pre-agriculture foraging landscape. Grasslands currently comprise 13.3% of the land use within the survey area (Table 5).

Seasonal Wetland. Seasonal wetlands, or managed wetlands, are usually former cultivated fields or pastures periodically flooded to provide wintering waterfowl habitat. During summer, these areas are typically dry and provide at least moderately suitable upland habitat for foraging raptors and other wildlife. Seasonal wetlands occur primarily in the Yolo Basin and currently comprise 5.4% of the land use within the survey area (Figure 6, Table 5).

Marshlands. These wetland habitats typically include dense emergent marsh vegetation and open water components that provide essential habitat for many species, but are generally avoided by foraging Swainson's hawks. Other than small unmapped patches that occur throughout the survey area, this type is found almost exclusively in the Yolo Basin and comprises 0.5% of the land use within the survey area.

Woodlands. Woodlands include patches of blue oak along the western edge of the survey area, small remnant valley oak groves on the valley floor, and oak/cottonwood woodlands associated with other natural or semi-natural areas, such as the valley oak/cottonwood woodlands on the Fremont Weir Wildlife Area. These areas typically provide suitable nesting habitat for Swainson's hawk, but have limited to no foraging value. They currently comprise 0.7% of the land use within the survey area (Table 5). Riparian woodlands, which also provide important nesting habitat, were not measured but along with other woodland types, are addressed below under Nesting Habitat.

Urban. Urban areas are defined as high density development, low density (ranchette-type) development, golf courses, and industrial areas including associated barren lands. Although Swainson's hawks will nest in suitable trees within urban areas (Figure 6), these types do not provide suitable foraging habitat for Swainson's hawk. Urban land uses currently comprises 7.4% of the land use within the survey area (Table 5).

Foraging Habitat

Within the survey area, land cover types considered suitable for Swainson's hawk foraging included rotated cropland, irrigated pasture, grassland, and seasonal wetland. The term 'suitable', however, is not synonymous with 'available'. Within the diverse agricultural landscape of Yolo County, Swainson's hawk foraging habitat tends to be spatially dynamic throughout the breeding season. Where irrigated hay, row, and grain crops dominate, hawk use of cultivated lands is primarily affected by vegetation structure (i.e., height and density) (Bechard 1982, Swolgaard et al. 2008, Estep 2009), which changes seasonally and annually based on planting, growth, and harvesting regimes of the many crops grown. The foraging value of suitable land uses and individual crop types ranges from highest value (alfalfa), moderate value (tomatoes, wheat, grasslands, pastures), to low value (corn, sunflower, safflower). Because of the seasonal and annual rotational changes, suitability varies across the cultivated matrix each season, which in turn influences Swainson's hawk foraging use and behavior. Grasslands, irrigated pastures, and seasonal wetlands provide more consistent moderate value less subject to seasonal variation, which provides come consistency in an otherwise dynamic foraging landscape.

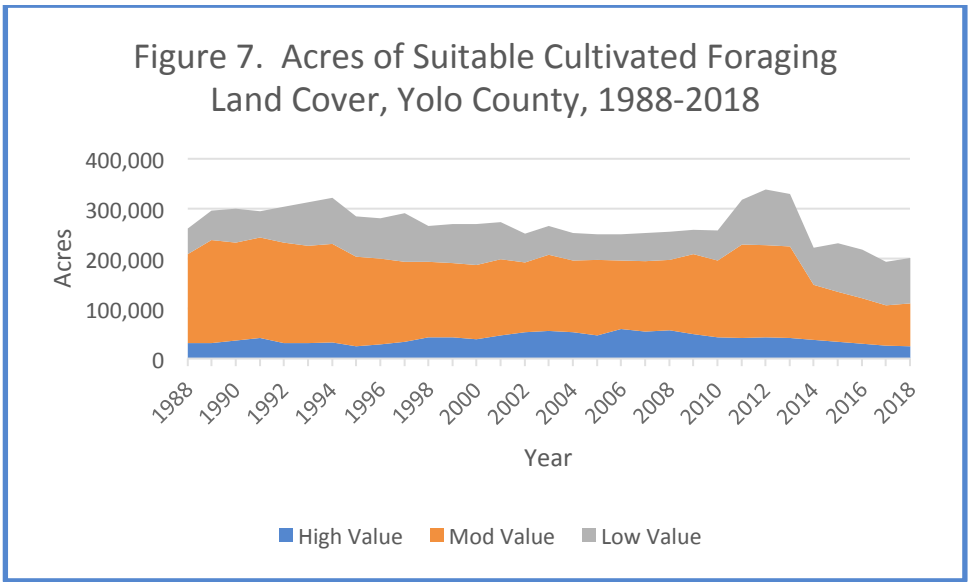
Within the survey area, suitable foraging habitat land cover occupies 280,482 acres or 59.1% of the survey area, including 25,000 acres of high value alfalfa (Table 6). These totals are just sufficient to meet the habitat thresholds (i.e., 267,750 acres of suitable habitat and 24,584 acres of high value habitat) as described in Section 6.5.6.3.6 and thereby avoid implementing remedial actions as described in Section 7.7.1.2.8 of the HCP/NCCP.

Table 6. Suitable Swainson's Hawk Foraging Land Cover, Yolo County, 2018.

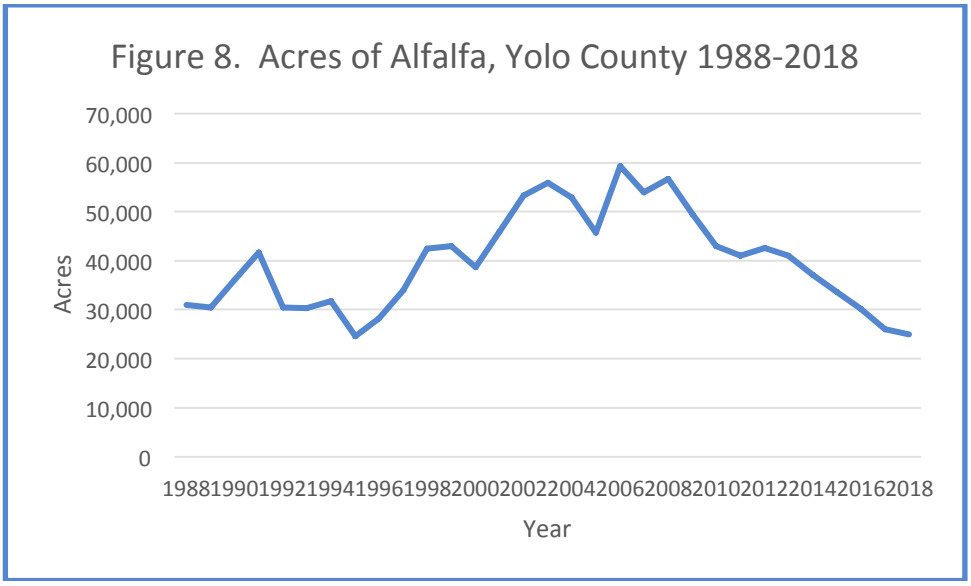
Land Cover	Acres
Rotated Cropland	174,806
Irrigated Pasture	17,016
Seasonal Wetland	25,482
Grassland	63,178
Total	**280,482**

Foraging Habitat Trends

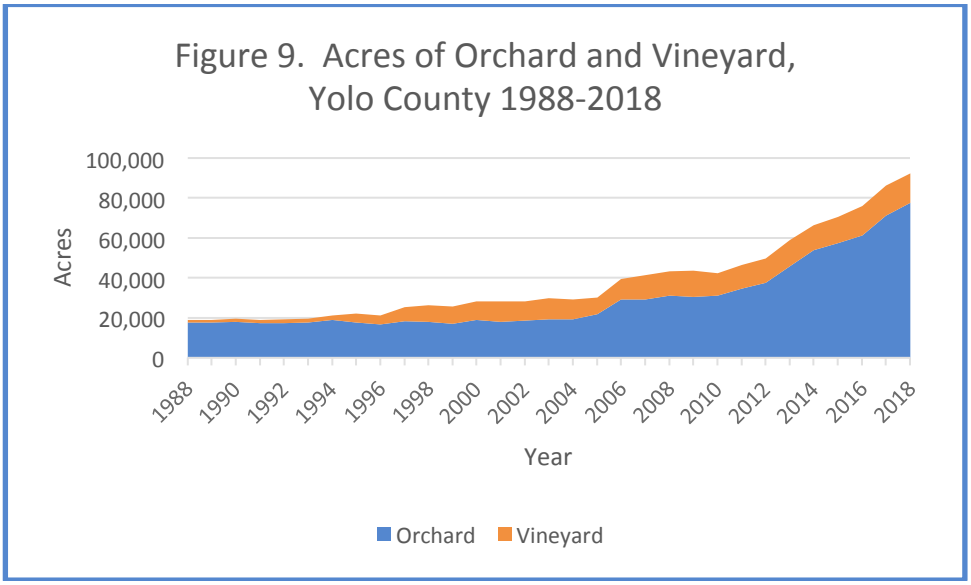
Historic mapping of the survey area is insufficient to assess long term trends in land cover types with regard to suitable habitat for the Swainson's hawk. As an alternative, I used the Yolo County annual crop report data to examine trends. However, the crop report data do not necessarily accurately represent the full extent of suitable habitat in the survey area. This is mainly because they do not include accurate acreage for grassland and seasonal wetland land cover, and do not include unproductive farmland acres (e.g., fallowed acres) in any given year. Still, over the last 30 years, they do provide important information regarding the trending of the key cultivated foraging habitats used by Swainson's hawk. Table 2 summarizes the annual totals of all reported agricultural acres in Yolo County since 1988. Figure 7 shows a gradual decline in suitable cultivated acreage since 1988 with moderate value land cover types experiencing the most significant declines. Based on these data, suitable cultivated foraging habitat has declined by 23% between 1988 and 2018.



High Value habitat, alfalfa, has fluctuated since 1988 with a sharp increase between 1994 and 2006, followed by a more precipitous decline from 2006 to 2018 (Figure 8). Alfalfa declined by 42% between 2006 and 2018, but only by 19% since 1988.



The reduction in suitable land cover appears to be due in large part to a corresponding increase in the extent of orchards, and to a lesser extent, vineyards throughout the county. Figure 9 shows the increase in orchards and vineyards between 1988 and 2018. As of 2018, orchards comprised 24% of the total cultivated landscape, a 300% increase since 2004 (Table 2).



Since the 2007 survey, suitable foraging habitat has declined by 45,828 acres (Table 7). With an increase in orchards of 48,090 acres, this may fully explain the loss of suitable habitat in the survey area.

Table 7. Comparison of Acreages of Suitable Foraging Land Cover in the Survey area between 2007 and 2018.

Land Cover	Acres	
	2007	**2018**
Rotated Cropland	238,849	174,806
Grassland	64,716	63,178
Seasonal Wetland	11,857	25,482
Irrigated Pasture	11,661	17,016
Total	327,083	280,482

Nesting Habitat

Distribution and Availability. Nesting habitat for Swainson's hawks and other raptors is widely distributed throughout the survey area. Riparian and other woodland nesting habitat was mapped and quantified in 2007 (Estep 2008). A review of aerial images and ground-truthing indicates that these habitats have not substantially changed since then, and thus Figure 10 and Table 8 are considered reasonable representations of the available acres of riparian and oak woodland nesting habitat in the survey area. Other nesting habitat types, including tree rows, roadside trees, isolated trees, and urban trees were not mapped or quantified. As a result, Figure 10 and Table 8 only partially represent available nesting habitat in the survey area.

Table 8. Acreages of available riparian and woodland nesting habitat in the survey area.

Nesting Habitat	Acres (Hectares)
Riparian Woodland	8,036.7 (3,252.3)
Valley Oak Woodland	185.3 (75.0)
Blue Oak Woodland	2,671.0 (1,080.9)
Eucalyptus Grove	388.7 (157.3)
Total	11,281.7 (4,565.5)

Riparian nesting habitat occurs primarily along the larger drainages in the survey area, including the Sacramento River, Putah Creek, Cache Creek, Dry Slough, Willow Slough, and Elk Slough. Several smaller drainages also support suitable riparian trees, including Oat Creek, Bird Creek, and Union School Slough. Woodland nesting habitats occur primarily along the eastern edge of the survey area where patches of blue oak woodland extend into the grassland foothills. Other woodland types include remnant patches of valley oak woodland, such as Nelson's Grove north of Woodland, and several large eucalyptus groves. Smaller woodlots (<1 acre) that are scattered throughout the survey area, are not included in these totals.

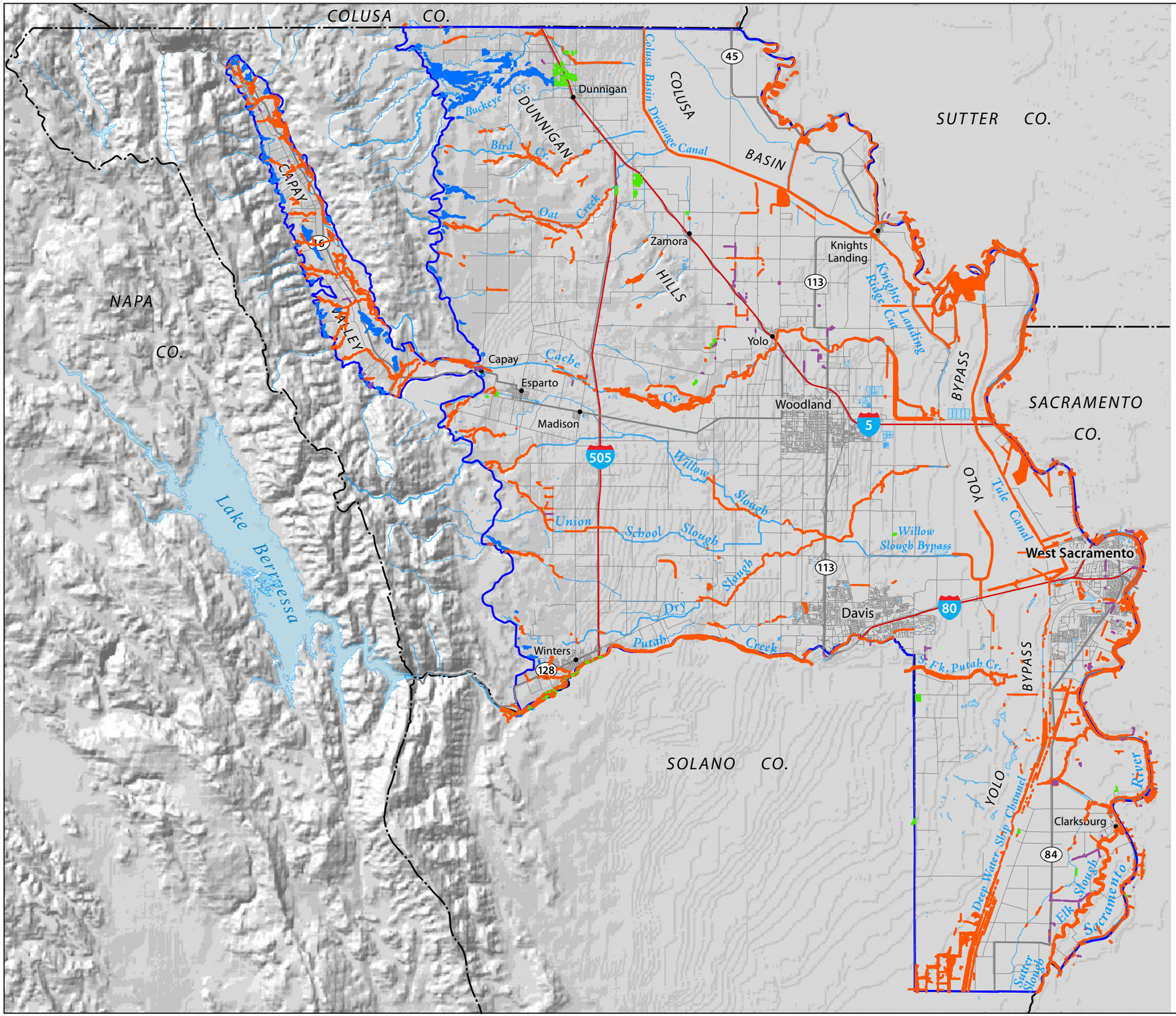


Figure 10
Distribution of Riparian and Other Woodland Types

LEGEND

County Boundary

Survey Area Boundary

Land Use

Blue Oak Woodland

Eucalyptus Grove

Riparian Woodland

Valley Oak Woodland

NORTH

0 2 4 6 8 10
Miles

09/15/20

Most of the survey area also supports non-riparian or woodland habitat types. Isolated trees, roadside tree rows, tree rows, and isolated roadside trees are abundant throughout most of the survey area. The area immediately north of Woodland supports the largest concentration of remnant isolated and roadside valley oak trees, which are the primary nesting sites for Swainson's hawks north of Woodland. Tree rows along roadsides and field borders are found throughout the survey area. Potential nesting trees are limited in the rice-growing regions within the Yolo Bypass and the Colusa Basin; in the southeastern panhandle west of the Deep Water Ship Channel; and in and around the Dunnigan Hills. Potential nesting trees do not appear to be limited elsewhere in the survey area.

Nesting Habitat Associations. Swainson's hawk territories were associated with 11 nesting habitat types (Table 9). These types represent all of the nesting habitat types in the survey area. Each is described below.

Table 9. Nesting Habitat Associations of Swainson's Hawk Territories, Yolo County 2020

Nesting Habitat Type	Number of Territories	Percent of Total
Riparian (natural)	154	40.4
Roadside Tree Row	46	12.1
Tree Row	38	10.0
Rural Residence	35	9.2
Grove	27	7.2
Isolated Tree	28	7.3
Isolated Roadside Tree	18	4.7
Riparian (channelized)	18	4.7
Urban	9	2.4
Farmyard	6	1.6
Savannah	2	0.5
Total	381	100

Riparian (natural). This includes valley oak, cottonwood, and willow-dominated riparian woodland along natural stream corridors. The Sacramento River, Putah Creek, and Cache Creek represent the most significant riparian habitat corridors in the survey area. Other drainages, such as Willow Slough, Dry Slough, Union School Slough, and Elk Slough represent smaller but extremely important riparian corridors. Figure 10 illustrates the distribution of potential riparian nesting habitat throughout the survey area.

Riparian (channelized). There is also significant riparian nesting habitat along channelized watercourses such as the Colusa Canal, Tule Canal, Knights Landing Ridge Cut, and the Deep Water Ship Channel (Figure 10). These are channels that were constructed for flood control, irrigation, or transportation purposes.

Tree Row. Tree row consists of planted rows of trees not associated with roadsides. These often occur along field borders or rural driveways and were planted as wind breaks, for landscaping purposes, or as wildlife habitat.

Roadside Tree Row. Roadside tree rows are most often planted rows of trees along roadsides, which were planted as visual barriers or windbreaks, but can also be a collection of remnant valley oak or other naturally occurring trees allowed to grow and mature along the roadside. Most of these are walnut, valley oak, or eucalyptus trees. They are distinguished from other tree rows because they are subject to vehicle traffic and related disturbances.

Isolated Trees. Isolated trees are single trees (and occasionally two or three trees) that are not associated with roadsides, residences, or other features. Many are large, mature valley oak trees within agricultural fields that are remnants of pre-agricultural oak woodlands or trees that have grown along field edges. This type is distributed throughout most of the survey area; however, isolated trees occur in the greatest density in the area between Woodland and Colusa Canal.

Isolated Roadside Tree. Isolated roadside trees can also be remnant valley oak trees, but many also appear to be more recent, either planted or naturally occurring. Other species, including cottonwood, walnut, locust (*Robinia pseudoacacia*), and eucalyptus also occur as isolated roadside trees. Isolated roadside trees are distinguished from other isolated trees because they generally receive a substantially greater amount of noise and other human disturbances. They also provide less cover and fewer perching and roosting opportunities than roadside tree rows.

Groves and Savannah. Groves are defined as at least six mature trees in a planted or remnant native stand. Several small valley oak groves occur in the survey area that are remnants of pre-agricultural oak woodlands (e.g, Nelson's Grove north of Woodland). Other large groves or woodlands include stands of valley oak and cottonwood at the Fremont Weir Wildlife Area and eucalyptus groves near Dunnigan and at Grasslands Regional Park south of Davis. The western edge of the survey area supports oak savannah and patches of blue oak/foothill pine woodland.

Farmyard. Farmyards are sites along the edges of agricultural fields that are used for equipment staging for planting and harvesting operations or storage of farm equipment. They are usually less than 1 acre in size and often have trees within or around their perimeter, which provide nesting opportunities for Swainson's hawks. Farmyard trees are typically walnut, eucalyptus, or valley oak trees. In some cases, farmyards were placed within remnant valley oak groves.

Rural Residence. Rural residential includes trees planted for windbreak cover, shade or ornamentals around rural farmsteads. These trees are of a variety of species, including valley oak, walnut, eucalyptus, and pine. Some are quite old and very large and are associated with historic farmsteads.

Urban. Urban trees are large remnant native or nonnative ornamental trees within dense urban areas. Swainson's hawks will occasionally occupy these sites if the tree is large and the nest can be visually protected from disturbance, and the site is within 1 to 2 miles from foraging habitat (England et al. 1995). Swainson's hawk nests have been documented within the urban

areas of Davis and Woodland, most in ornamental pines or redwoods or remnant native valley oaks (England et al. 1995).

The majority of nests (40.4%) were associated with riparian habitats (including riparian habitat along both natural and channelized watercourses). The remaining 59.6% of the nests were associated with non-riparian habitats, most of which are subject to substantial human disturbances (e.g., farming operations, vehicle traffic, urban disturbances).

Nest Tree Species. Table 10 indicates the tree species used by nesting Swainson's hawks in the survey area. Valley oak and cottonwood were the two most frequently used nest trees, which is consistent with other populations in the Central Valley, and along with walnut and willow trees represent the four most frequently selected nest tree species in the survey area and throughout the Central Valley (Estep 2007, 2008, Estep and Dinsdale 2012).

Table 10. Nest Tree Species used by Nesting Swainson's Hawks.

Tree Species	Number of Active Nest Sites	Percent of Total
Valley Oak	113	30.0
Cottonwood	110	29.3
Willow	66	17.5
Walnut	27	7.2
Eucalyptus	24	6.4
Pine	19	5.0
Redwood	9	2.4
Locust	3	0.8
Sycamore	3	0.8
Oregon Ash	1	0.3
Foothill Pine	1	0.3
Total	376	100

Relationship Between Swainson's Hawk Distribution and Abundance and Habitat Associations

The large and dense Swainson's hawk nesting population in the survey area suggests a strong association with a dynamic agricultural landscape that provides seasonally diverse food resources. Together with abundant and diverse nesting opportunities, the combination of high value nesting and foraging habitat in the survey area supports the highest breeding density of Swainson's hawks in the species' range. Figure 11 suggests the association with the essential elements of this landscape – suitable foraging habitat as indicated by the distribution of rotated cropland, and less association with rice and orchard areas. This association has also been identified in other Central Valley studies (Estep and Dinsdale 2012, Swolgaard et al, 2008, Fleishman et al. 2016, Battistone et al. 2019).

Another key association is the distribution of nesting habitat. To large extent, areas where nesting habitat is limited also corresponds with a less suitable foraging landscape. This may be in part due to the incompatibility of potential nesting habitat with rice, orchard, and vineyard

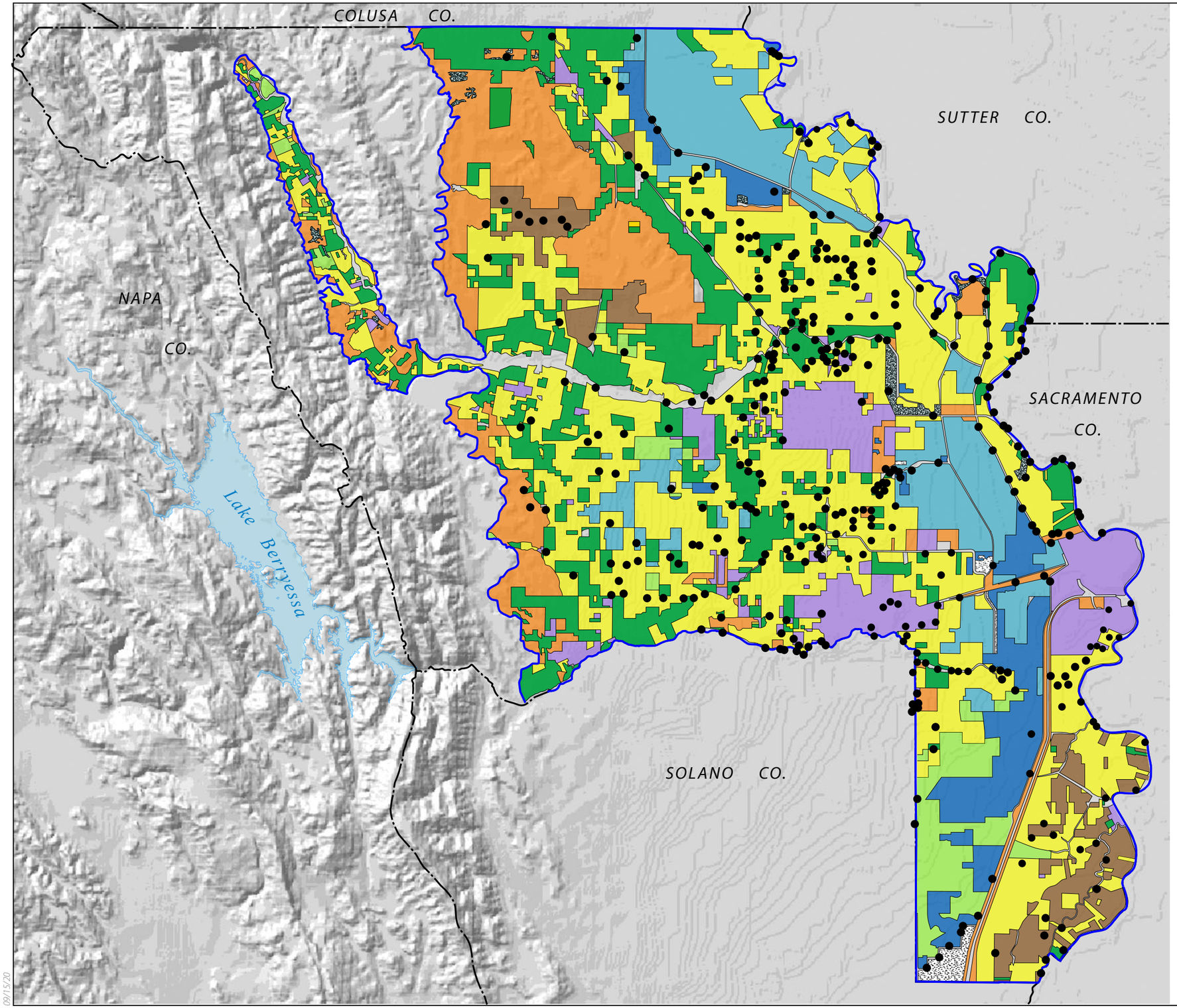


Figure 11
Distribution of Land Cover and Swainson's Hawk Territories, Yolo County, 2020

LEGEND

- County Boundary
- Survey Area Boundary
- Swainson's Hawk Nest

Land Use

- Irrigated Cropland
- Orchard
- Rice
- Grassland
- Vineyard
- Irrigated Pasture
- Seasonal Wetland
- Urban
- Marsh
- Woodland

NORTH

0 2 4 6 8 10
Miles

09/15/20

cultivation compared with rotated cropland. But there are also areas that otherwise support a suitable foraging landscape that also lack abundant trees, such as the Dunnigan Hills and portions of the south Yolo Bypass. Because rice cultivation will likely remain constrained within the existing rice-growing regions, it's long-term influence on Swainson's hawk distribution is likely to be minimal. However, continued expansion of orchards and vineyards is possible throughout much of the survey area, potentially replacing rotated cropland, removing potential nesting habitat, and having a greater long-term effect on Swainson's hawk distribution and abundance.

Other Nesting Raptors

Several other species compete with Swainson's hawk for nesting and food resources that can affect distribution, abundance, and reproductive performance. Interspecific competition for nesting and food resources is a normal ecological process in raptor communities that influences local and regional population structure (Newton 1979, Rothfels and Lein 1983, Thurow and White 1983, Janes 1984, Hansen and Flake 1995). However, in an environment with depleting or uncertain resources, these interactions can have a greater negative affect on some raptor populations. This can be particularly important to Swainson's hawks because spring arrival onto breeding territories is later than other raptor species. Other raptor species, particularly red-tailed hawk, white-tailed kite, and great-horned owl sometimes occupy traditional Swainson's hawk nesting areas prior to the arrival of Swainson's hawks. This can result in aggressive territorial interactions with variable results depending on the species involved.

Although Swainson's hawk was the focus of the survey, I also documented other raptor nests and nesting territories to provide a brief comparative examination of their distribution relative to that of the Swainson's hawk. Because of their similarity in nesting habitat use and their general conspicuousness, the overall success of documenting active red-tailed hawk sites is considered similar to the Swainson's hawk. Other species (e.g., red-shouldered hawks, white-tailed kites, great-horned owl), because they tend to be less conspicuous – particularly in the selection of nest sites, or because of timing (e.g., great-horned owls had already fledged or nearly fledged young at the time the survey began), data were considered incidental and less likely to represent an accurate documentation of their distribution and abundance in the survey area. Osprey nests were also documented incidentally due to their uniqueness and expanding population in the region. As a result, interspecies comparisons are limited to Swainson's hawk and red-tailed hawk.

Nest territory data for red-tailed hawks and other nesting raptors are presented on Figure 12, Appendix B (Figures B-1 through B-25), and Appendix D (Tables D-1 and D-2). Table 5-9 is a comparison of activity and reproductive data for Swainson's hawk and red-tailed hawk.

Although Figure 12 illustrates that their nesting distribution is similar within the survey area, nesting Swainson's hawks are approximately three times more common in the survey area than nesting red-tailed hawks. Although they continue to be the far more common nesting species, in 2007 nesting Swainson's hawks were over four times more common than nesting red-tailed hawks (Estep 2008).

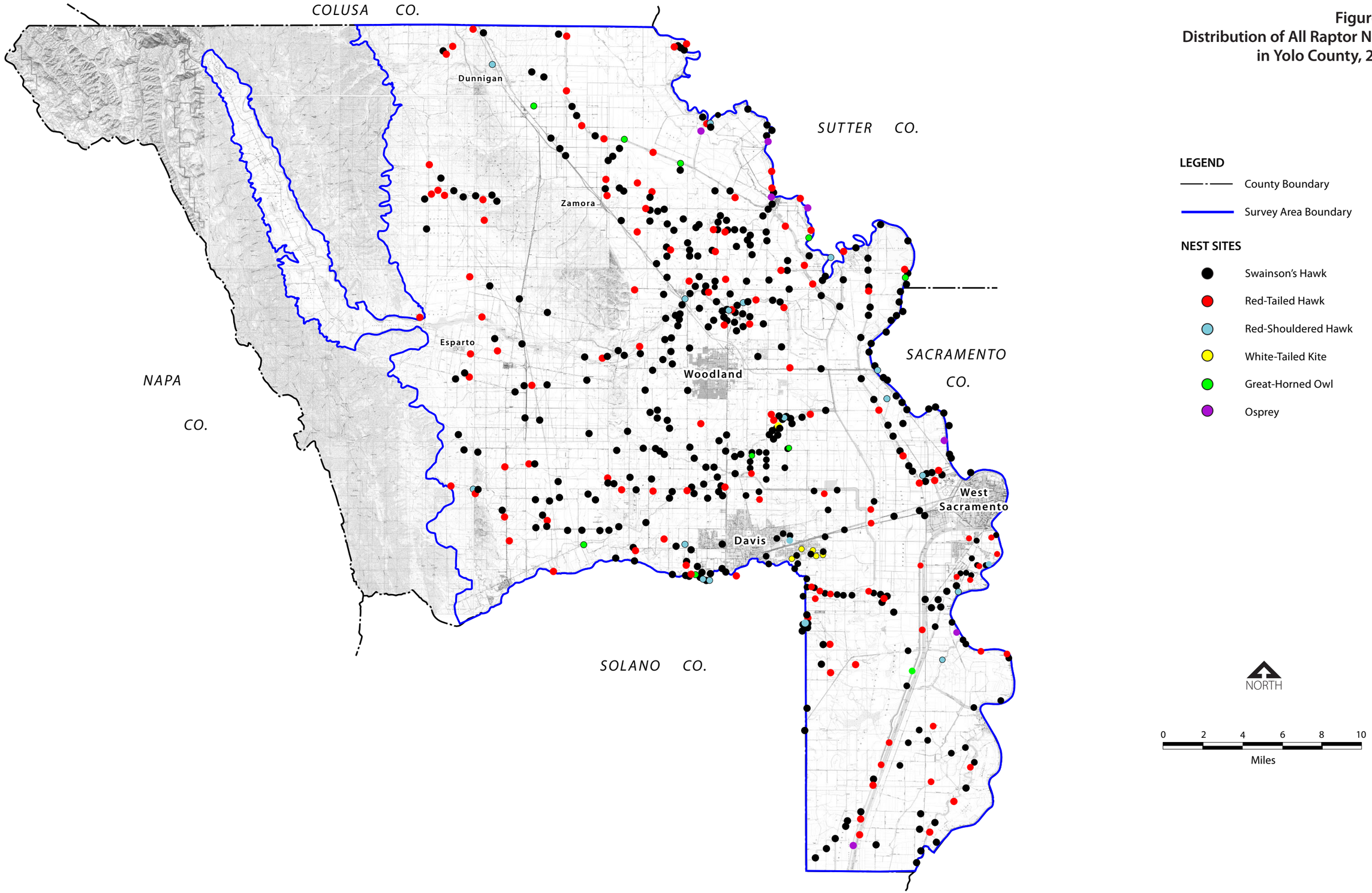


Figure 12
Distribution of All Raptor Nests in Yolo County, 2020

09/15/20

As with the Swainson's hawk, reproductive data collected for the red-tailed hawk was incidental as time and access permitted; however, reproductive results were confirmed at a large proportion of active nests (Table 11). Note, however, that because red-tailed hawks begin their breeding cycle 2 to 3 weeks earlier than Swainson's hawks, the survey did not include the earlier stages of the breeding cycle and thus any failed nests could not be detected or otherwise confirmed. As a result, reproductive output could only be confirmed at successful nests.

Nonetheless, reproductive rates for red-tailed hawks are generally consistent with long-term trends in the Central Valley at nearly twice that of Swainson's hawks. These results are also similar to the 2007 data (Estep 2008) indicating that although nesting Swainson's hawks are more common in the survey area, red-tailed hawks are more reproductively successful.

Table 11. Comparison of Activity and Reproduction Data of Swainson's Hawk and Red-tailed Hawk Breeding Territories in the Yolo County Survey Area, 2020.

	Swainson's Hawk	Red-tailed Hawk
	Activity	
Total Occupied Nesting Territories	**381**	**122**
Occupied Nesting Territories with Confirmed Nesting (Active Nests)	377 (99%)	121(99%)
Active Nests with Confirmed Reproductive Outcome[1]	170 (45%)	77 (64%)
Successful Nests	161 (95%)	77 (100%)
Unsuccessful Nests	9 (5%)	0
Active Nests with Unconfirmed Reproductive Outcome	207 (55%)	44 (36%)
	Reproduction	
Total Number Fledged Young	196	149
Number Fledged Young/Occupied Territory with Confirmed Reproductive Outcome	1.15	1.9
Number of Fledged Young/Successful Nest	1.21	1.9

Tables 12 and 13 compare and indicate the general similarity in selection of nesting habitat and nesting substrate between Swainson's hawk and red-tailed hawk. Interestingly, the Swainson's hawk is more likely to select nesting sites in areas of greater human presence and disturbance, such as roadsides, farmyards, rural residences, and in urban areas (Table 12).

The selection of nest trees or other nesting substrates is fairly similar between the two species, particularly the use of valley oak, cottonwood, and willow trees (Table 13). However, Swainson's hawks will use a broader range of tree species, in part associated with their use of urban habitats and tolerance of human disturbances; while red-tailed hawks are more likely to use artificial structures such as transmission towers and pole basket nests.

Table 12. Comparison of Nesting Habitat Associations of Swainson's Hawk and Red-tailed Hawk, Yolo County 2020

	Swainson's Hawk		Red-tailed Hawk	
Nesting Habitat Type	**Number of Territories**	**Percent of Total**	**Number of Territories**	**Percent of Total**
Riparian (natural)	154	40.4	39	32.2
Roadside Tree Row	46	12.1	4	3.3
Tree Row	38	10.0	15	12.4
Rural Residence	35	9.2	6	4.9
Grove	27	7.2	18	14.9
Isolated Tree	28	7.3	13	10.7
Isolated Roadside Tree	18	4.7	2	1.7
Riparian (channelized)	18	4.7	14	11.6
Urban	9	2.4	0	0
Farmyard	6	1.6	0	0
Savannah	2	0.5	10	8.3
Total	381	100	121[1]	100

[1]one red-tailed hawk nest was in a transmission tower

Table 13. Comparison of Nest Tree Species used by Nesting Swainson's Hawks and Red-tailed Hawks, Yolo County, 2020.

	Swainson's Hawk		Red-tailed Hawk	
Tree Species	**Number of Active Nests**	**Percent of Total**	**Number of Active Nests**	**Percent of Total**
Valley Oak	113	30.0	32	27.1
Cottonwood	110	29.3	37	31.3
Willow	66	17.5	18	15.2
Walnut	27	7.2	2	1.7
Eucalyptus	24	6.4	23	19.5
Ornamental Pine	19	5.0	4	3.4
Redwood	9	2.4	0	0
Locust	3	0.8	0	0
Sycamore	3	0.8	0	0
Oregon Ash	1	0.3	0	0
Foothill Pine	1	0.3	2	1.7
Total	376	100	118[1]	100

[1]three red-tailed hawk nests were in artificial structures including one transmission tower and two pole baskets.

Management Implications and Recommendations

The survey effort summarized in this report satisfies the 5-year monitoring requirement for Swainson's hawk described in Section 6.5.6.3.6 of the HCP/NCCP. Because the number of occupied territories and the extent of suitable land cover exceeded thresholds described in Sections 6.5.6.3.6. and 7.7.1.2.8 of the HCP/NCCP, no remedial actions are required.

The results of the 2020 Swainson's hawk survey in Yolo County are consistent with the apparent reported increases of the Central Valley and statewide populations (Gifford et al. 2012, Battistone 2019) and various unpublished reports indicating local increases or range expansions. Although it's been 13 years since the initial baseline survey was conducted in Yolo County, results of annual monitoring within my Yolo County study area (a smaller subarea within the larger Yolo County survey area), also indicate a gradual expanding population since the mid-1980s (Estep *in progress*). Given that suitable land cover has declined – primarily from ongoing conversion of rotated cropland to orchard – while the nesting population has expanded since the 2007 baseline survey – this suggests the current extent of suitable land cover remains sufficient to support this larger and more dense breeding population. Because it appears problematic to accurately estimate a threshold acreage required to support the target population, it will be essential to continue to monitor both the breeding population and the extent and quality of available habitat within the plan area.

It is also important to consider a key complicating factor influencing habitat needs and the ongoing status of this population – reproduction. The Yolo County breeding population, while experiencing an increase in the number and density of breeding pairs and the nesting success of those breeding pairs, has also experienced low reproductive output (i.e., the number of fledglings produced per successful nest). A reduction in clutch or brood size and low production rates among successful nests are often associated with food resource availability (Houston and Schmutz 1995, McIntyre 2002). As a periodic phenomenon, resulting from natural prey fluctuations, this would not necessarily be associated with a declining population or insufficient food resources in the environment. But if continued over time, it could result in population reductions and signal potential causes related to the quality of the foraging landscape.

Prey Availability within the Survey Area. Reproductive rates for Central Valley Swainson's hawks tend to be variable over time, most likely due to their reliance on the California vole as a principal food. Vole populations undergo natural population cycles and in cultivated habitats can have spotty distributions. This may, in turn, contribute to the variability of annual reproductive rates of Swainson's hawks and other raptors that rely on them. But other factors can also influence available prey within an otherwise suitable foraging landscape, including farm management practices (e.g., changes in irrigation, selection of pest-resistant seed varieties,

rodent control measures), and potentially result in longer term effects. As a result, continued high territory occupancy and nest success rates may persist if the levels of nesting and foraging habitat are sustained, but if those habitats become incapable of supporting sufficient prey, then reproductive output can decline (Houston and Schmutz 1995, McIntyre 2002), which can ultimately affect population levels.

Energetics. In cultivated landscapes, Swainson's hawk foraging ranges can be very large and seasonally variable depending on land cover patterns and prey availability (Estep 1989, Babcock 1995, Fleishman et al. 2016). Breeding adults have the ability to travel long distances in search of fields that support accessible prey. Where suitable habitat is reduced locally, Swainson's hawks have the ability to expand their foraging range. But due to the increased effort required to capture prey, there may be an energetic cost in terms of the amount of food available to breeding adults, potentially influencing clutch size, or the amount of food that can be delivered to a nest, potentially influencing brood size. As the local foraging landscape becomes increasingly interspersed with unsuitable land cover (even though the total acreage remains above the threshold established in the conservation strategy), food availability may be reduced and adults may respond by expanding their foraging ranges, ultimately influencing the number of young produced.

Because of the broad distribution of nesting Swainson's hawks and their reliance on cultivated habitats, the ability of the HCP/NCCP to manage this population is limited. The historical agricultural pattern in Yolo County suggests a continuation of suitable agricultural practices throughout the plan area during the permit period. This provided the basis for the broader conservation strategy for the Swainson's hawk – reliance on a continuation of this pattern while focusing specific conservation and management efforts within the preserve network. The HCP/NCCP will ultimately preserve a total of 18,792 acres of Swainson's hawk habitat (cultivated land and grassland types), which is 7% of the total currently available suitable habitat in the plan area. Although there are provisions for landowner incentives built into the conservation strategy, the Conservancy will otherwise have limited ability to manage the remaining 93% of the suitable habitat in the plan area, which is under private ownership and subject to economic-driven agricultural land use practices, including conversion of rotated crop fields to orchards.

This suggests emphasis on two principal elements of the conservation strategy, 1) coordinated and strategic selection of preserve lands that provide the necessary nesting and foraging habitat elements required by Swainson's hawks, and 2) management of the preserve lands to enhance sustainability and productivity of prey. In other words, enhance the value of the preserve lands to maximize their value to Swainson's hawks. Each preserve management plan should include provisions for sustaining the highest possible suitable land cover with emphasis on maintaining abundant and accessible prey. Each management plan should also include provisions for tree planting and where possible, development of hedge row habitats that support refugia and source populations of prey species.

Literature Cited

Airola, D. A., J. A. Estep, D. Krolick, D. Anderson, and J. Peters. 2019. Wintering Areas and Migration Characteristics of Swainson's Hawks that Breed in the Central Valley of California. *Journal of Raptor Research* 53(3):237-252.

Alsup, S. E. 2012. Productivity and Habitat Features of Swainson's Hawks (*Buteo swainsoni*) Nesting in Suburban and Agricultural Areas of Southwest Idaho. A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Raptor Biology, Boise State University, May 2012

Babcock, K. W. 1995. Home Range and Habitat Use of Breeding Swainson's Hawks in the Sacramento Valley of California. Journal of Raptor Research 29:193–197.

Battistone, C.L., B.J. Furnas, R.L. Anderson, J.L. Dinsdale, K.M. Cripe, J.A. Estep, C. Chun, and S.G. Torres. 2019. Population and Distribution of Swainson's Hawk (*Buteo Swainsoni*) in California's Great Valley: A Framework for Long-Term Monitoring. Journal of Raptor Research 53(3):253-265.

Bechard, M. J. 1982. Effect of Vegetative Cover on Foraging Site Selection by Swainson's Hawk. Condor 84:153–159.

Bechard, M. J., C. S. Houston, J. H. Sarasola, and A. S. England. 2010. Swainson's Hawk (*Buteo swainsoni*). In A. Pool, (ed.), *The Birds of North America* online. Ithaca, NY: Cornell Lab of Ornith. Available: http://bna.birds.cornell.edu/bna/species/265

Bednarz, J.C. T. Hayden, and T. Fischer. 1990. The raptor and raven community of the Los Medanos area in southeastern New Mexico: a unique and significant resource. N.Y. State Mus. Bull. 471: 92-101.

Bloom, P. H. 1980. The Status of the Swainson's Hawk in California. California Department of Fish and Game, Nongame Wildlife Investigations. Project Report W-54-R-12, Sacramento, California.

Briggs, C. 2007. Survival and nesting ecology of the Swainson's hawk in Butte Valley, California. M.S. Thesis, University of Nevada, Reno.

EDAW. 2007. Yolo Bypass Wildlife Area, Draft Land Management Plan. Prepared for the California Department of Fish and Game, Yolo Bypass Wildlife Area, Davis, CA.

England, A. S., J. A. Estep, and W. Holt. 1995. Nest-Site Selection and Reproductive Performance of Urban-Nesting Swainson's Hawks in the Central Valley of California. Journal of Raptor Research 29(3):179–186.

Estep, J.A. 1989. Biology, Movements, and Habitat Relationships of the Swainson's Hawk in the Central Valley of California, 1986–1987. California Department of Fish and Game, Nongame Bird and Mammal Section, Sacramento, CA.

_____. 2007. The Distribution, Abundance, and Habitat Associations of the Swainson's Hawk (*Buteo swainsoni*) in South Sacramento County. Prepared by Estep Environmental Consulting for the City of Elk Grove, CA.

_____. 2008. The Distribution, Abundance, and Habitat Associations of the Swainson's Hawk (*Buteo swainsoni*) in Yolo County, California. Prepared for TAIC and the Yolo Natural Heritage Program, Woodland, CA.

_____. 2009. The Influence of Vegetation Structure on Swainson's Hawk *(Buteo Swainsoni)* Foraging Habitat Suitability in Yolo County, CA. Prepared for the Yolo Natural Heritage Program, Woodland, CA.

_____. 2013. The Status, Distribution and Habitat Associations of the Swainson's Hawk in the Antelope Valley, California. Prepared for Recurrent Energy, San Francisco, California.

_____. 2015. A Proposed Conservation Strategy for the Swainson's Hawk in Yolo County. Prepared for the Yolo County Natural Heritage Program, March 20, 2015

_____. *In preparation*. Ecology of the Swainson's Hawk in the Central Valley of California.

Estep, J. A., and J. Dinsdale. 2012. Distribution, abundance, and habitat associations of nesting Swainson's hawks in the Central San Joaquin Valley. Central Valley Bird Club Bulletin 15(4):84-106.

Fleishman, E., J. Anderson, B. G. Dickson, D. R. Krolick, J. A. Estep, R. L. Anderson, C. Elphick, D. S. Dobkin, and D. A. Bell. 2016. Space Use by Swainson's Hawks (*Buteo swainsoni*) in the Natomas Basin, California. *Collabra* 2:1–12.

Gifford, D.L, P.S. Hofmann, A.A. Truex, and D.H. Wright. 2012. Monitoring Distribution and Abundance of Nesting Swainson's Hawks in the Sacramento Valley and Sacramento River Delta, California. California Fish and Game 98(1): 7-18.

Hansen, R.W. and L.D. Flake. 1995. ecological relationships between nesting Swainson's and Red-tailed Hawks in Southeastern Idaho. J. Raptor Res. 29(3): 166-171.

Houston, C. S. and J. K. Schmutz. 1995. Declining reproduction among Swainson's Hawks in prairie Canada. J. Raptor Res. no. 29:198-201.

ICF. 2018. Yolo Habitat Conservation Plan/Natural Community Conservation Plan, Volume 1, Final. Prepared for: Yolo Habitat Conservancy, Woodland, CA.

ICF. 2019. *Biological Effectiveness Monitoring for the Natomas Basin Habitat Conservation Plan Area 2018 Annual Survey Results*. Agency Final. April. (ICF Prepared for the Yolo County Natural Heritage Program March 20, 2015 (ICF 00890.10.) Sacramento, CA. Prepared for The Natomas Basin Conservancy, Sacramento, CA.

Janes, S.W. 1984. Influences of territory composition and interspecific competition on red-tailed hawk reproductive success. Ecology 65: 862-870.

LSA. 2012. Solano Habitat Conservation Plan. Prepared for the Solano County Water Agency, October 2012.

McIntyre, C.L. 2002. Patterns in Nesting Area Occupancy and Reproductive Success of Golden Eagles (*Aquila chrysaetos*) in Denali National Park and Preserve, Alaska, 1988-99. J. Raptor Res. 36(1): 50-54.

Newton, I. 1979. Population Ecology of Raptors. Buteo Books, Vermillion, South Dakota.

Nur N., D. Jongsomjit, and S. Veloz. 2019. Swainson's Hawk Foraging Study: Analysis of Foraging in Relation to Crop Characteristics in the Central Valley, California. Technical Report to Swainson's Hawk Technical Advisory Committee. Point Blue Conservation Science, Petaluma, CA.

Postupalsky, S. 1983. Techniques and terminology for surveys of nesting Bald Eagles. Appendix D in J.W. Grier et al. (eds.), Northern States Bald Eagle Recovery Plan, USDI, Fish and Wildlife Service, Twin Cities, MN.

Rothfels, M. and M.R. Lein. 1983. Territoriality in sympatric populations of red-tailed and Swainson's hawks. Can. J. Zool. (61): 60-63.

Schmutz, J.K. 1987. The effect of agriculture on Ferruginous and Swainson's hawks. Journal of Range Management 40(5): 438-440.

Sharp, C. S. 1902. Nesting of Swainson's hawk. Condor 4:116–118.

Swolgaard, C.A., K.A. Reeves, and D.A. Bell. 2008. Foraging by Swainson's Hawks in a vineyard-dominated landscape. Journal of Raptor Research 42: 188-196.

Thurow, T.L. and C.M. White. Nest site relationship between the Ferruginous Hawk and Swainson's hawk. J. Field Ornithol. 54(4): 401-406.

Woodbridge, B. 1991. Habitat selection by nesting Swainson's hawks: a hierarchical approach. M.S. thesis, Oregon State University., Corvallis.

Woodbridge, B., K.K. Finley, and P.H. Bloom. 1995. Reproductive performance, age structure, and natal dispersal of Swainson's hawks in the Butte Valley, California. J. Raptor Res. 29:187-192.

Yolo County. 2009. 2030 Countywide General Plan, Agricultural and Economic Development Element, County of Yolo, Planning and Public Works Department, Woodland, CA.

Yolo County Agriculture Department. 2019. Agricultural Crop Reports, 1998-2018. Environmental Protection and Agricultural Services Division, Woodland, CA. (www.yolocounty.org/org/AG/stats.htm).

Appendix A. Swainson's Hawk Data

Appendix B. Swainson's Hawk and Other Raptor Nesting Territory Locations

Attached Separately

Appendix C. Land Cover Maps

Attached Separately

Appendix D. Other Raptor Data

Table D-1. Red-tailed Hawk Data, Yolo County 2020

Territory #	Coordinates		USGS Quad	General Location	Land Cover Association	Nesting Habitat	Nest Tree Species	Nest Status	# young
	Lat	Long							
RTHA 1	38.911471°	-121.815674°	Kirkville	Bullock Bend - Sacramento River	rotated cropland	Riparian	Cottonwood		
RTHA 2	38.923629°	-122.000740°	Wildwood School	Little Buckeye Creek - 400ft W of I-5	orchard	Riparian	Ornamental pine		
RTHA 3	38.814676°	-121.877262°	Zamora	West side of CR94, 528 ft S of CR11B	orchard, rotated cropland	Roadside tree row	Willow		
RTHA 4	38.804309°	-121.878489°	Zamora	0.2 mi E of CR93B, 0.3 mi S of CR12	rotated cropland, orchard	Willow grove	Willow		
RTHA 5	38.801052°	-121.762608°	Eldorado Bend	0.35mi S of CR112 and Colusa Canal intersect	rotated cropland, orchard	Tree row	Willow		
RTHA 6	38.808338°	-121.724210°	Knights Landing	Sacramento River, 0.48mi NE of Colusa Canal	rice, rotated cropland	Riparian	Cottonwood	Successful	2
RTHA 7	38.820976°	-121.724537°	Knights Landing	Sacramento River at Leiser Road (Sutter side)	rice, rotated cropland	Riparian	Cottonwood	Successful	2
RTHA 8	38.910247°	-122.021034°	Wildwood School	380ft S of CR2 and 0.2mi E of CR86	grassland, oak savannah, orchard	Savanna	Foothill pine	Successful	3
RTHA 9	38.904089°	-122.026314°	Wildwood School	500ft W of CR86, 0.5mi S of CR2	grassland, oak woodland, orchard	Oak woodland	Foothill pine	Successful	3
RTHA 10	38.820141°	-122.043276°	Bird Valley	East side of CR85, 0.3mi S of CR11	grassland, vineyard	Isolated roadside tree	Willow	Successful	3
RTHA 11	38.805488°	-122.039523°	Bird Valley	SF Oat Cr, 0.2mi E of CR85, 0.31mi S of CR12	rotated cropland, vineyard, grassland	Riparian	Cottonwood	Successful	3
RTHA 12	38.806757°	-122.036178°	Bird Valley	SF Oat Cr, 0.39mi E of CR85, 0.22mi S of CR12	rotated cropland, vineyard, grassland	Riparian	Cottonwood	Successful	2
RTHA 13	38.803085°	-122.028589°	Bird Valley	Trans tower, 0.18mi SW of CR86 x CR12a	vineyard	Trans tower	Trans tower	Successful	
RTHA 14	38.801429°	-121.993807°	Zamora	725ft S of CR12A, 0.72mi E of CR87	vineyard, grassland	Small grove	Cottonwood	Successful	2
RTHA 15	38.565079°	-121.633381°	Davis	200ft N of I-80, 0.29mi E of CR32B	rotated cropland, rice, seasonal wetland	Eucalyptus grove	Eucalyptus	Successful	2
RTHA 16	38.587755°	-121.675576°	Davis	200ft W of CR105, 640ft S of CR29	rotated cropland	Tree row	Eucalyptus	Successful	2
RTHA 17	38.582864°	-121.739374°	Davis	0.5mi W of CR102, 0.5mi S of CR29	rotated cropland	Isolated tree	Cottonwood Snag	Successful	
RTHA 18	38.519330°	-121.688995°	Davis	Putah Creek, 0.33mi E of CR104	rotated cropland, orchard	Riparian	Cottonwood		
RTHA 19	38.511248°	-121.685986°	Davis	0.5mi E of CR105, 0.63mi N of CR35	rotated cropland, orchard	Isolated tree	Valley oak		
RTHA 20	38.462275°	-121.647592°	Saxon	0.5mi E of CR106, 0.27mi E of CR38	rotated cropland, irrigated pasture	Isolated tree	Willow Snag		
RTHA 21	38.457924°	-121.670903°	Saxon	500ft S of CR38, 0.23mi E of CR105	rotated cropland, irrigated pasture	Small grove	Eucalyptus		
RTHA 22	38.477408°	-121.671806°	Saxon	0.2mi E of CR105, 0.25mi N of Maxwell Ln	rotated cropland	Tree row	Eucalyptus		
RTHA 23	38.515703°	-121.753339°	Merritt	SF Putah Cr, S Levee, 0.2mi E of Old Davis Rd	rotated cropland	Tree row	Eucalyptus	Successful	3
RTHA 24	38.526278°	-121.759259°	Merritt	620ft W of Old Davis Rd, 320ft SE of I-80	rotated cropland, orchard	Small grove	Cottonwood	Successful	2
RTHA 25	38.589788°	-121.836337°	Merritt	0.2mi E of CR96, 300ft S of CR29	rotated cropland	Rural Residence	Eucalyptus		
RTHA 26	38.597364°	-121.878865°	Winters	0.45mi N of CR29, 480ft W of CR94	rotated cropland	Tree row	Eucalyptus	Successful	
RTHA 27	38.554641°	-121.543390°	Sacramento West	0.13mi S SP Pkway, 0.15mi W Lk Wash Blvd	grassland, urban	Riparian	Valley oak	Successful	2
RTHA 28	38.535183°	-121.587766°	Sacramento West	West side DWSC at Marshall Road	grassland, seasonal wetland, urban	Savanna	Cottonwood	Successful	2
RTHA 29	38.380703°	-121.578914°	Clarksburg	0.2mi E Jefferson Blvd, 0.2mi N Hamilton	rotated cropland, vineyard	Small grove	Cottonwood	Successful	2
RTHA 30	38.748843°	-121.716909°	Grays Bend	CR16, 0.67mi E of CR102	rotated cropland	Channel riparian	Cottonwood	Successful	2
RTHA 31	38.776529°	-121.769175°	Eldorado Bend	700ft S of CR14, 0.3mi E of Hwy113	rotated cropland	Isolated tree	Valley oak	Successful	2
RTHA 32	38.777317°	-121.850499°	Eldorado Bend	720ft S of CR14, 0.55mi W of CR96	rotated cropland	Isolated tree	Valley oak	Successful	2
RTHA 33	38.812260°	-121.850841°	Eldorado Bend	0.25mi N of CR12, 0.4mi E of CR95	rotated cropland	Tree row	Cottonwood	Successful	3
RTHA 34	38.804015°	-121.837693°	Eldorado Bend	CR96, 0.3mi S of CR12	rotated cropland	Roadside tree row	Valley oak	Successful	2
RTHA 35	38.793800°	-121.841727°	Eldorado Bend	S side of CR13, 435ft W of CR96	rotated cropland	Roadside tree row	Valley oak	Successful	2
RTHA 36	38.786306°	-121.990887°	Zamora	1mi NE of CR14 and CR87 intersection	grassland, rotated cropland, vineyard	Riparian	Willow		
RTHA 37	38.764132°	-121.820821°	Eldorado Bend	300ft SE of CR15 and CR97 intersection	rotated cropland	Rural Residence	Valley oak		

RTHA 38	38.496958°	-121.692658°	Saxon	0.16mi E of CR104, 0.14mi N of Tremont Rd	grassland, rotated cropland	Grove	Eucalyptus		
RTHA 39	38.517537°	-121.762094°	Merritt	0.27mi W of Old Davis Rd, S Fork Putah Cr	rotated cropland	Riparian	Cottonwood		
RTHA 40	38.602898°	-121.571327°	Sacramento West	N side Sacramento BP, 0.68mi W Old Riv Rd	rotated cropland, seasonal wetland	Riparian	Cottonwood	Successful	2
RTHA 41	38.749079°	-121.601471°	Taylor Monument	0.25mi W of Sacramento River along CR16	orchard, rotated cropland	Isolated roadside tree	Walnut	Successful	2
RTHA 42	38.709788°	-121.746605°	Grays Bend	200ft N of CR18c, 0.24mi E of CR100b	rotated cropland	Tree row	Eucalyptus	Successful	1
RTHA 43	38.720084°	-121.763047°	Woodland	370ft E of Hwy113 along Cache Creek	orchard, rotated cropland	Riparian	Cottonwood	Successful	2
RTHA 44	38.710564°	-121.768070°	Woodland	0.2mi S of Coil Lane, 0.15mi W of Hwy 113	rotated cropland	Sparse grove	Valley oak	Successful	2
RTHA 45	38.533302°	-121.806529°	Merritt	0.17mi W of CR98, 0.41mi N of Putah Cr	rotated cropland	Tree row	Ornamental pine		
RTHA 46	38.554196°	-121.826041°	Merritt	0.23mi W of CR97, 0.5mi N of Russell Blvd	rotated cropland, orchard	Small grove	Eucalyptus		
RTHA 47	38.544723°	-121.851056°	Merritt	0.13mi S of Russell Blvd, 0.19mi E of CR95a	rotated cropland, orchard	Riparian	Willow	Successful	2
RTHA 48	38.569358°	-121.934204°	Winters	0.19mi E of CR90a, 0.5mi N of CR31	rotated cropland	Rural residence	Eucalyptus		
RTHA 49	38.485020°	-121.586925°	Clarksburg	W side DWSC, 1.35mi S of Jefferson Blvd	rotated cropland, seasonal wetland	Grove	Cottonwood	Successful	2
RTHA 50	38.405885°	-121.617793°	Clarksburg	W side DWSC at Gaffney Road	grassland, seasonal wl, rotated cropland	Savanna	Pole basket	Successful	2
RTHA 51	38.374827°	-121.632002°	Saxon	W side DWSC, 4.4mi N of County Line	grassland, seasonal wl, rotated cropland	Savanna	Pole basket	Successful	2
RTHA 52	38.351337°	-121.642198°	Liberty Island	W side DWSC, 2.6mi N of County Line	grassland, seasonal wl, rotated cropland	Savanna	Willow	Successful	2
RTHA 53	38.335513°	-121.645844°	Liberty Island	E side of DWSC, 1.5mi N of County Line	grassland, seasonal wl, rotated cropland	Riparian	Willow		
RTHA 54	38.762910°	-121.776649°	Eldorado Bend	400ft S of CR15, 365ft W of Hwy 113	rotated cropland	Isolated tree	Valley oak	Successful	3
RTHA 55	38.741161°	-121.800178°	Woodland	0.1mi S of CR16a, 0.17mi E of CR98	rotated cropland, orchard	Isolated tree	Valley oak	Successful	2
RTHA 56	38.735236°	-121.851972°	Woodland	190ft S of CR17, 0.16mi W of CR95a	rotated cropland, orchard	Channel riparian	Eucalyptus	Successful	2
RTHA 57	38.646017°	-121.728162°	Grays Bend	212ft E of CR102, 0.12mi S of CR25	grassland, rotated cropland, Urban	Isolated tree	Walnut		
RTHA 58	38.646804°	-121.688967°	Grays Bend	Willow Sl, 360ft S of CR25, 1.15mi E CR103	rice, rotated cropland	Riparian	Willow		
RTHA 59	38.555201°	-121.522961°	Sacramento West	NW of Village Parkway and Stonegate Dr	Urban, rotated cropland	Oak grove	Valley oak		
RTHA 60	38.543140°	-121.516958°	Sacramento West	0.1mi E of Village Pkway, 0.1mi N Linden Rd	urban, rotated cropland	Grove	Eucalyptus	Successful	2
RTHA 61	38.534861°	-121.532057°	Sacramento West	0.1mi W of Village Pkway, 0.4mi N Davis Rd	urban, rotated cropland	Tree row	Valley oak		
RTHA 62	38.524772°	-121.540437°	Sacramento West	285ft SE Village Pkway at Salmon Rd	urban, rotated cropland	Grove	Valley oak	Successful	2
RTHA 63	38.526855°	-121.552961°	Sacramento West	0.2mi N of Bevan Rd., 0.2mi E of Gregory Rd	Urban, rotated cropland	Grove	Cottonwood	Successful	2
RTHA 64	38.418238°	-121.575689°	Clarksburg	0.4mi E Jefferson Blvd, 0.25mi N Clarksburg Rd	rotated cropland	Isolated tree	Willow	Successful	2
RTHA 65	38.342785°	-121.580398°	Courtland	Elk Slough, 400ft N of Courtland Rd	orchard, rotated cropland	Riparian	Valley oak		
RTHA 66	38.744449°	-122.004454°	Esparto	825ft E of CR87, 0.55 N of CR17	orchard, rotated cropland	Tree row	Eucalyptus	Successful	2
RTHA 67	38.714493°	-122.049438°	Esparto	0.14mi W of CR85, 0.16mi N of Cache Creek	oak savannah, rotated cropland, orchard	Savanna	Valley oak		
RTHA 68	38.715952°	-121.993686°	Madison	CR19a (N side of Cache Cr), 0.87mi E of CR87	orchard, rotated cropland	Isolated tree	Valley oak	Successful	2
RTHA 69	38.687676°	-122.003996°	Esparto	200ft N of Hwy 16, 0.7mi E of Yolo Ave	rotated cropland, orchard	Riparian	Cottonwood	Successful	2
RTHA 70	38.646857°	-121.625011°	Grays Bend	Tule Canal, 0.43mi N of CR124	rotated cropland, rice	Riparian	Willow	Successful	2
RTHA 71	38.526791°	-121.801795°	Merritt	Putah Creek, 0.09mi E of CR98	rotated cropland	Riparian	Valley oak		
RTHA 72	38.590206°	-121.803904°	Merritt	NW corner of CR98 and CR29	rotated cropland, orchard	Rural residential	Eucalyptus	Successful	1
RTHA 73	38.665794°	-121.947286°	Madison	Cottonwood Sl, 0.24mi E of I-505	rotated cropland	Riparian	Valley oak		
RTHA 74	38.690360°	-121.976491°	Madison	0.36mi E of CR88b, 0.5mi N of Hwy16	orchard, rotated cropland	Tree row	Eucalyptus		
RTHA 75	38.592449°	-121.768677°	Merritt	CR99d, 0.15mi N of CR29	rotated cropland, orchard	Grove	Eucalyptus	Successful	2
RTHA 76	38.671260°	-122.007371°	Esparto	N side of CR23, 0.5mi E of CR86a	rotated cropland	Rural residential	Eucalyptus	Successful	2
RTHA 77	38.608318°	-121.949686°	Winters	Union School Sl, 0.17mi E of I-505	rotated cropland	Riparian	Valley oak		

RTHA 78	38.750082°	-121.766531°	Woodland	150ft W of CR100, 1mi N of CR17	rotated cropland	Isolated tree	Valley oak	Successful	1
RTHA 79	38.570243°	-121.973967°	Winters	0.14mi W of CR89, 0.58mi N of CR31	rotated cropland, orchard	Isolated tree	Eucalyptus		
RTHA 80	38.553684°	-121.969791°	Winters	W side of CR89, 0.55mi S of CR31	rotated cropland, orchard	Tree row	Eucalyptus	Successful	2
RTHA 81	38.587828°	-121.998439°	Winters	Chickahominy Slough, 0.46mi W of CR88	rotated cropland, orchard, grassland	Riparian	Valley oak		
RTHA 82	38.590901°	-122.020558°	Monticello Dam	0.13mi S of CR29, 1.65mi W of CR88	grassland, rotated cropland, orchard	Savanna	Valley oak		
RTHA 83	38.606067°	-121.971750°	Winters	W side of CR89 at CR28	rotated cropland, orchard	Channel riparian	Eucalyptus	Successful	2
RTHA 84	38.802113°	-121.700239°	Knights Landing	W side Sacramento R, 1.1mi E of Hwy113	rotated cropland	Riparian	Cottonwood	Successful	2
RTHA 85	38.778215°	-121.687056°	Knights Landing	W side Sacramento R, 0.6mi S of Mary Lake	rotated cropland	Riparian	Cottonwood	Successful	2
RTHA 86	38.854806°	-121.786360°	Eldorado Bend	W side of CR98a, 0.1mi SW of Hwy 45	rice, rotated cropland, orchard	Grove	Valley oak	Successful	2
RTHA 87	38.472967°	-121.528201°	Clarksburg	W side Sacramento R, 1.3mi S of Babel Sl	rotated cropland, vineyard, urban	Riparian	Valley oak	Successful	2
RTHA 88	38.470516°	-121.507996°	Clarksburg	W side Sacramento R, 1mi N Freeport Bridge	vineyard, rotated cropland, urban	Rural Residential	Ornamental pine	Successful	2
RTHA 89	38.388768°	-121.542860°	Clarksburg	Elk Slough at Bogle Vineyards	vineyard	Riparian	Valley oak	Successful	2
RTHA 90	38.363765°	-121.556985°	Courtland	Elk Slough 0.24mi S of CR144	vineyard, rotated cropland	Riparian	Valley oak	Successful	3
RTHA 91	38.727951°	-121.739635°	Grays Bend	Cache Creek, 0.5mi W of CR102	rotated cropland, orchard	Riparian	Cottonwood	Successful	2
RTHA 92	38.733525°	-121.784880°	Woodland	Cache Creek, 0.19mi W of CR99a	rotated cropland, orchard	Riparian	Valley oak	Successful	2
RTHA 93	38.722449°	-121.715830°	Grays Bend	Cache Creek, 0.67mi N of CR18b	rotated cropland	Riparian	Cottonwood	Successful	2
RTHA 94	38.678702°	-121.708751°	Grays Bend	SW Cache Cr Set. Basin, 1mi E of CR102	rotated cropland	Grove	Cottonwood	Successful	2
RTHA 95	38.911845°	-121.805086°	Kirkville	W side of Sacramento River at Bullock Bend	rotated cropland	Riparian	Cottonwood		
RTHA 96	38.916837°	-121.915582°	Dunnigan	Colusa Canal, 0.58mi S of CR1	rice, rotated cropland	Channel riparian	Willow		
RTHA 97	38.877972°	-121.915723°	Dunnigan	Colusa Canal, 3.2mi S of CR1	rice, rotated cropland, seasonal wetland	Channel riparian	Cottonwood		
RTHA 98	38.854454°	-121.900184°	Zamora	Colusa Canal, 1.13mi N of CR10	rice, rotated cropland, seasonal wetland	Channel riparian	Cottonwood		
RTHA 99	38.844750°	-121.881032°	Zamora	Colusa Canal, 0.48mi N of CR10	rice, rotated cropland	Channel riparian	Cottonwood	Successful	1
RTHA 100	38.834258°	-121.835632°	Eldorado Bend	Colusa Canal, 0.51mi SE of CR95b	rice, rotated cropland, seasonal wetland	Channel riparian	Cottonwood	Successful	2
RTHA 101	38.734572°	-121.634774°	Grays Bend	Tule Canal, 0.95mi S of CR16	rotated cropland, grassland	Channel riparian	Willow	Successful	2
RTHA 102	38.782603°	-121.712498°	Knights Landing	KLRC, 1mi SE of Hwy113	rotated cropland	Channel riparian	Cottonwood	Successful	2
RTHA 103	38.753568°	-121.694247°	Knights Landing	KLRC, 0.33mi N of CR16	rotated cropland	Channel riparian	Valley oak		
RTHA 104	38.739714°	-121.687013°	Grays Bend	KLRC, 0.73mi SE of CR16	rotated cropland	Channel riparian	Willow	Successful	1
RTHA 105	38.693096°	-121.848916°	Woodland	CR 20 at Cache Creek	rotated cropland, orchard	Tree row	Eucalyptus	Successful	3
RTHA 106	38.515820°	-121.637389°	Davis	Putah Creek, 0.63mi E of CR106a	rotated cropland, seasonal wetland	Riparian	Cottonwood	Successful	1
RTHA 107	38.511277°	-121.620707°	Sacramento West	Putah Creek Sinks, 1.55mi E of CR106a	rotated cropland, seasonal wetland	Riparian	Cottonwood		
RTHA 108	38.514974°	-121.679777°	Davis	Putah Creek, 0.83mi E of CR104	orchard, rotated cropland	Riparian	Cottonwood	Successful	2
RTHA 109	38.530710°	-121.928808°	Winters	Putah Creek, 1.3mi E of I-505	orchard, rotated cropland	Riparian			
RTHA 110	38.594556°	-121.587733°	Sacramento West	Tule Canal, SW corner of Sacramento BP	rice, rotated cropland, seasonal wetland	Channel riparian	Cottonwood		
RTHA 111	38.597325°	-121.572665°	Sacramento West	NW corner CHP track; S side Sacramento BP	seasonal wetland, rice	Savanna	Ornamental pine	Successful	2
RTHA 112	38.686465°	-121.879401°	Madison	Cache Creek, 0.69mi W of CR94b	rotated cropland	Riparian	Cottonwood	Successful	2
RTHA 113	38.603208°	-121.745032°	Davis	Willow Slough, 1.1mi S of CR27	rotated cropland	Riparian	Valley oak	Successful	1
RTHA 114	38.638830°	-121.791647°	Woodland	0.16mi S of CR25a, 0.38mi W of CR99	rotated cropland, orchard	Tree row	Valley oak	Successful	2
RTHA 115	38.590448°	-121.863238°	Merritt	CR29, 0.24mi W of CR95	rotated cropland	Tree row	Eucalyptus		
RTHA 116	38.778625°	-121.780204°	Eldorado Bend	CR14, 0.28mi W of Hwy113	rotated cropland	Roadside tree row	Valley oak		
RTHA 117	38.762705°	-121.659555°	Knights Landing	Fremont Weir	grassland, rotated cropland, orchard	Savanna	Valley oak	Successful	2

RTHA 118	38.643300°	-121.725223°	Grays Bend	0.21mi E of CR102, 0.31mi S of CR25	grassland, rotated cropland, rice	Savanna	Cottonwood	Successful	1
RTHA 119	38.575617°	-121.634246°	Davis	0.78mi N of I-80 at Davis Wetlands	rotated cropland, rice, marsh	Channel riparian	Willow	Successful	2
RTHA 120	38.513484°	-121.669995°	Davis	Putah Creek, 1.37mi E of CR104	rotated cropland, orchard	Riparian	Cottonwood		
RTHA 121	38.612546°	-121.601765°	Sacramento West	Tule Canal, 1.1mi N of Sacramento Bypass	rotated cropland	Riparian	Willow		
RTHA 122	38.391494°	-121.623709°	Clarksburg	DWSC at Central Ave.	rotated cropland, seasonal wetland	Isolated tree	Willow		

Table D-2. Other Raptor Data, Yolo County 2020

Territory #	Coordinates		USGS Quad	General Location	Land Cover Association	Nesting Habitat	Nest Tree Species
	Lat	Long					
RSHA 1	38.897701°	-121.982978°	Dunnigan	Dunnigan - 250ft W of I-5, 510ft N of CR4	urban, rotated cropland, orchard	Eucalyptus grove	Eucalyptus
RSHA 2	38.656557°	-121.618483°	Taylor Monument	0.4mi SW of Old River Road, 0.2mi NW of CR124	rotated cropland	Tree row	Willow
RSHA 3	38.536343°	-121.522768°	Sacramento West	Sacramento River, 0.54mi S of Linden Road	urban, rotated cropland	Riparian	Cottonwood
RSHA 4	38.515629°	-121.552017°	Sacramento West	S. River Rd, 0.07mi E of Gregory Road	urban, rotated cropland	Isolated Tree	Walnut
RSHA 5	38.758745°	-121.669793°	Knights Landing	Old River at Sacramento River	rotated cropland, grassland	Riparian	Cottonwood
RSHA 6	38.523045°	-121.783482°	Merritt	Putah Creek, confluence with South Fork	rotated cropland, orchard	Riparian	Cottonwood
RSHA 7	38.524043°	-121.789625°	Merritt	Putah Creek at Hopkins Road	rotated cropland, orchard	Riparian	Cottonwood
RSHA 8	38.550691°	-121.806195°	Merritt	0.16mi W of CR98, 0.26mi N of Russell Blvd	rotated cropland, orchard	Riparian	Eucalyptus
RSHA 9	38.493923°	-121.694977°	Saxon	Grasslands Regional Park	grassland, rotated cropland	Grove	Eucalyptus
RSHA 10	38.589141°	-122.001417°	Monticello Dam	Chickahominy Slough, 0.62mi W of CR88	grassland, rotated cropland, orchard	Riparian	Valley oak
RSHA 11	38.854998°	-121.783906°	Eldorado Bend	0.11mi SE of CR98a and Hwy45 intersection	rice, rotated cropland, orchard	Grove	Valley oak
RSHA 12	38.467693°	-121.565801°	Clarksburg	Babel Slough, 1.2mi SW of Sacramento River	rotated cropland, vineyard	Riparian	Valley oak
RSHA 13	38.726645°	-121.749938°	Woodland	Cache Creek, 1.07mi W of CR102	rotated cropland, vineyard	Riparian	Cottonwood
RSHA 14	38.720730°	-121.764914°	Woodland	Cache Creek just W of Hwy 113	rotated cropland, orchard	Riparian	Cottonwood
RSHA 15	38.728250°	-121.806351°	Woodland	Cache Creek, east side of I-5	rotated cropland, orchard	Riparian	Cottonwood
RSHA 16	38.676074°	-121.627443°	Grays Bend	E side Sacramento River, 0.23mi N of I-5	rotated cropland	Riparian	Cottonwood
RSHA 17	38.600043°	-121.584581°	Sacramento West	N side of Sacramento BP, 0.3mi E of Tule Canal	rotated cropland, seasonal wetland	Channel Riparian	Cottonwood
RSHA 18	38.556631°	-121.710637°	Davis	730ft SE of Loyola Dr and Monarch Ln	urban, rotated cropland	Urban	Valley oak
RSHA 19	38.642552°	-121.713442°	Grays Bend	Willow Slough, 0.14mi W of CR103	rotated cropland, orchard, rice	Riparian	Valley oak
RSHA 20	38.528548°	-121.765336°	Merritt	N Fork Putah Creek, E of Hwy 113	urban, rotated cropland	Riparian	Valley oak
GHOW 1	38.867675°	-121.944395°	Zamora	North side of CR7, 0.5 mi east of 99W	orchard, rotated cropland	Rural residence	Valley oak
GHOW 2	38.620206°	-121.710560°	Davis	160ft E of CR103, 500ft N of CR27	rotated cropland, rice	Farmyard	ornamental pine
GHOW 3	38.550530°	-121.900034°	Winters	Dry Slough, 0.2mi E of CR93a	orchard, rotated cropland	Riparian	Cottonwood
GHOW 4	38.456749°	-121.595481°	Clarksburg	Tow Drain, 1.22mi S of Old Railroad Grade	seasonal wetland, rotated cropland	Riparian	Cottonwood
GHOW 5	38.527079°	-121.799603°	Merritt	Putah Creek, 0.2mi E of CR98	rotated cropland	Riparian	Cottonwood
GHOW 6	38.773613°	-121.687598°	Knights Landing	Sacramento River, 0.9mi S of Mary Lake	rotated cropland	Riparian	Valley oak
GHOW 7	38.825934°	-121.808857°	Eldorado Bend	Colusa Canal, 0.73mi W of CR98a	rice, rotated cropland, savannah	Channel Riparian	Willow
GHOW 8	38.842782°	-121.863433°	Eldorado Bend	Colusa Canal, 3.9mi W of CR98a	rice, rotated cropland	Channel Riparian	Willow
GHOW 9	38.616632°	-121.744810°	Davis	Willow Slough, 0.16mi S of CR27	rotated cropland	Riparian	Valley oak
GHOW 10	38.745843°	-121.599408°	Grays Bend	Sacramento River, 0.2mi S of CR16	orchard, rotated cropland	Riparian	Willow
WTKI 1	38.539072°	-121.706768°	Davis	NW corner of Montgomery and Willowbank Rds	urban, rotated cropland	Urban	ornamental pine
WTKI 2	38.547384°	-121.687473°	Davis	El Macero, N El Macero Blvd at Middle Golf Rd	urban, rotated cropland	Urban	Redwood
WTKI 3	38.541133°	-121.677511°	Davis	El Macero, E El Macero Blvd at Eagle View Ct	urban, rotated cropland	Urban	Redwood
WTKI 4	38.540638°	-121.683773°	Davis	El Macero, E El Macero Blvd at Golf View Road	urban, rotated cropland	Urban	Redwood
WTKI 5	38.547774°	-121.697211°	Davis	Cowell Blvd at Sunrise Court	urban, rotated cropland	Urban	Redwood
WTKI 6	38.635442°	-121.719352°	Grays Bend	Willow Slough, 0.52mi E of CR102	rotated cropland	Riparian	Valley oak
OSPR 1	38.802807°	-121.724640°	Knights Landing	Confl. of Sacramento River and Colusa Canal	rice, rotated cropland	Tower	Tower

OSPR 2	38.848280°	-121.791812°	Eldorado Bend	Across canal from CR98a, 0.6mi S of Hwy45	rice	Utility pole	Utility pole
OSPR 3	38.625276°	-121.564886°	Taylor Monument	320ft W of Old River Road, 0.3mi N of CR128A	rotated cropland, orchard	Cell tower	Cell tower
OSPR 4	38.321958°	-121.651684°	Liberty Island	W side DWSC, 0.59mi N of County Line	seasonal wetland, rotated cropland	Riparian	Willow
OSPR 5	38.792724°	-121.693256°	Knights Landing	Sacramento River at Portuguese Bend	riparian, wetland, rotated cropland	Riparian	Sycamore snag
OSPR 6	38.845007°	-121.729799°	Knights Landing	Sacramento River at 4-mile Bend	rotated cropland, rice	Riparian	Cottonwood
OSPR 7	38.487231°	-121.554339°	Clarksburg	W side Sacramento River, 0.53mi N of Babel Slough	rotated cropland	Cell tower	Cell tower