



## **A Proposed Conservation Strategy for the Swainson's Hawk in Yolo County**

**Prepared for the Yolo County Natural Heritage Program  
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### **Background**

The Yolo County Natural Heritage Program is preparing a Habitat Conservation Plan/Natural Community Conservation Plan (HCP/NCCP) pursuant to Section 10 of the federal endangered species act and the state NCCP act. While both are regional planning processes, unlike HCPs that require only mitigation of impacts, NCCPs focus on protecting intact ecosystems across a region. The California Department of Fish and Wildlife (CDFW) further interprets the NCCP statute as containing conservation standards that require actions that provide a net benefit to covered species to bring about their recovery (Pollak 2001). The state-threatened Swainson's hawk (*Buteo swainsoni*) is a covered species in the HCP/NCCP.

The HCP/NCCP plan area is primarily productive agricultural land. The Swainson's hawk population is largely dependent upon these lands to hunt and successfully nest. After significant effort to incorporate the value, use, and management of agricultural lands into the conservation strategy, a biologically sound and workable solution to Swainson's hawk conservation remains incomplete due mainly to the diverse agricultural lands and the wide range of habitat values and use they receive by covered species. Unlike natural lands, which do not undergo similar seasonal and annual changes, agricultural lands are subject to a variety of other factors, including soil conditions, weather, water availability, market forces, and landowner interests. Because it is essential to Yolo County to maintain a productive, economically viable agricultural landscape, attempting to manage agricultural lands in order to meet NCCP requirements has proven to be problematic. Because the Swainson's hawk is the covered species most associated with agricultural landscapes, developing a workable conservation strategy for this species must consider the realities of maintaining an economically viable agricultural landscape that also benefits the species.

This report was prepared to provide a more detailed analysis of the Swainson's hawk population and habitat availability in the plan area in order to provide biological rationale for the elements of a conservation strategy. The report also uses species and land use data for determining a reasonable and biologically-based estimate of land required to maintain and protect the Swainson's hawk population in the plan area, and to the extent possible within the constraints and complexities of agricultural land management, meet NCCP requirements.

Due to the limitations of available data and its application to the diverse and dynamic agricultural landscape in Yolo County, there are uncertainties with regard to the assumptions used to formulate the baseline estimations and outcomes used in the strategy. In light of these uncertainties and the desire to develop a biologically-sound, albeit generalized, approach to a conservation strategy, my professional judgment was also used in the example modeling framework and assumptions. So this is not intended to be a definitive, science-based approach to a conservation strategy, but rather uses the species biology and land use information to assess the status and habitat requirements of the population and to formulate a strategy that is feasible in the context of a working agricultural landscape while protecting the Swainson's hawk population.

### **General Biological and Land Use Framework**

The following is a brief summary of pertinent issues related to the biology of the Swainson's hawk and land uses that support the species' requisite needs.

- With the exception of the Yolo Basin Wildlife Area and several smaller preserves, the majority of the low elevation land in Yolo County east of the Coast Ranges is privately-owned agricultural land. This area also provides habitat for the state-threatened Swainson's hawk. The Swainson's hawk nests in trees along riparian corridors and in a variety of other settings within the agricultural landscape and hunts for small rodents in the surrounding cultivated lands. In Yolo County and elsewhere in the Central Valley, this species relies almost entirely on privately-owned, productive, cultivated land to meet its foraging needs (Estep 1989, 2007, Estep and Dinsdale 2013).
- There are approximately 300 pairs of nesting Swainson's hawks in Yolo County distributed fairly evenly throughout the interior lowland portions of the county (Estep 2007). This is a very dense and broadly-distributed nesting population, and so for purposes of land management or conservation, this population is considered at or near carrying capacity.
- The nesting distribution is generally associated with annually rotated irrigated croplands. Areas that are dominated by rice or orchards, and to a lesser extent annual grassland, support fewer nesting territories and receive substantially less foraging use (Anderson et al. 2007).

- The nesting distribution is also associated with the availability of suitable nest trees. Suitable nesting habitat includes riparian woodland, remnant patches of oak woodland, and other trees found in cultivated landscapes such as tree rows along roads and field borders, isolated trees, and trees around farmyards and farmsteads.
- Foraging studies indicate a positive association with alfalfa, tomato, wheat, oat, and other annually rotated crops that maintain a relatively low vegetation profile and that are harvested during the breeding season. Availability of these suitable crop types to foraging Swainson's hawks is a function of their height and density, which changes during the course of the breeding season as crops mature and are then harvested. As a result, these types and others provide value at different times of the breeding season. Alfalfa has been shown to provide particularly high value habitat due to its consistently low profile, and along with oat fields and tilled fields, are used at a significantly greater rate relative to their availability (Bechard 1982, Estep 1989, 2009, 2013, Babcock 1995, Swolgaard et al. 2008).
- Much of the agricultural landscape in Yolo County consists of annually rotated irrigated cropland interspersed with alfalfa fields, which typically remain uncultivated for 3 to 5 years. Due to seasonal and annual rotations, this results in a very dynamic, ever-changing foraging landscape. Swainson's hawks respond to these changes with highly elastic foraging ranges as they seek out suitable sites to hunt (Estep 1989, Babcock 1995).
- High densities of nesting Swainson's hawks, as we have in Yolo County, are generally associated with a very diverse agricultural landscape. They respond to a variety of farming activities such as cultivating, disking, mowing, harvesting, and irrigating. A less diverse landscape, such as those that are dominated by pasturelands or less crop diversity, generally support fewer nesting Swainson's hawks (Anderson et al. 2007).
- Defending a relatively small area around the nest, individual Swainson's hawks range widely during foraging bouts. Foraging ranges are large (average 6,800 acres in the Sacramento Valley) due to the continually changing amount and location of available foraging habitat as crops mature and then are harvested. Overlap between individual foraging ranges is extensive depending on the density of nests. Throughout the majority of the breeding season, male foraging ranges are much larger than female foraging ranges (Estep 1989, Babcock 1995).

## **Estimating the Land Base Required by the Nesting Population**

Key to the development of a conservation strategy for the Swainson's hawk in the plan area is an estimate of how much agricultural land is required to meet the foraging needs of the population. To do this, I initially describe the following elements that will provide the framework for a simple model to estimate the extent of the plan area landscape that is required to maintain this population:

- Size and distribution of the nesting population
- Land cover types/crop types used as foraging habitat
- The extent of the available foraging landscape
- The proportion of the landscape used for foraging

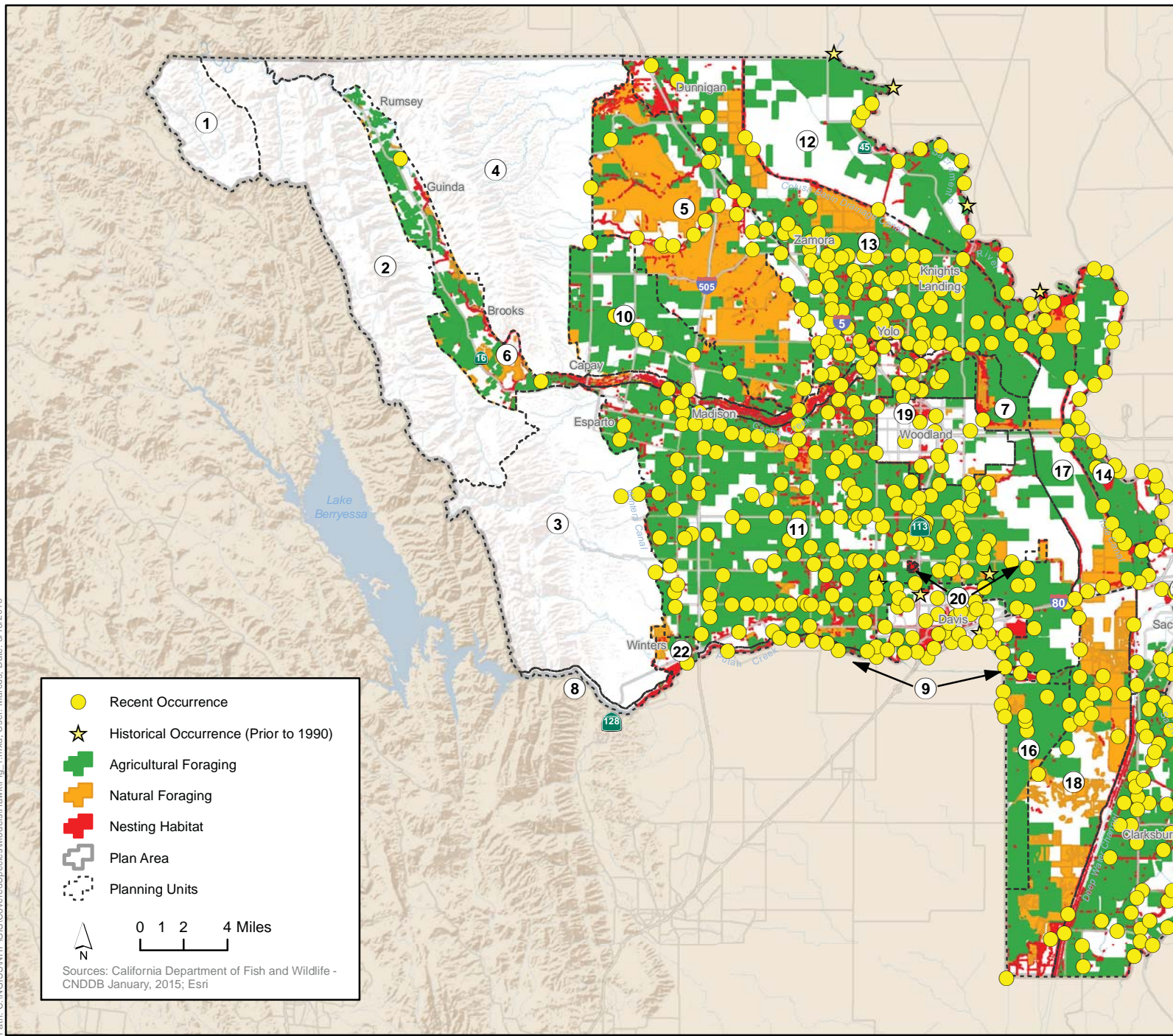
### **Population Size and Distribution**

As noted above, there are an estimated 300 nesting territories in Yolo County. This estimate is based on a 2007 census-level survey conducted in the county (Estep 2007), supplemented with focused surveys conducted in 2012, and with long-term monitoring activities throughout a large portion of the county (Estep in progress). The estimate is also generally consistent with the results of a state-wide survey conducted in 2005 and 2006 (Anderson et al. 2007). Monitoring data indicate an increasing population during the 1980s and early 1990s followed by a relatively stable, and perhaps slightly increasing population to present (Estep in progress). The population is distributed throughout the low elevation agricultural lands in the plan area from the base of the Coast Ranges to the Sacramento River. The highest nesting densities occur within planning units 11, 13, 15, and 16 (Figure 1).

### **Foraging Habitat Use**

Swainson's hawks are highly mobile and opportunistic hunters and, as noted above, hunt for rodent and insect prey in a variety of cultivated and other agricultural cover types. The suitability of individual cover types is largely a function of two factors, 1) prey availability, and 2) vegetation structure, which influences visibility and the accessibility of prey (Bechard 1982, Estep 2009). The seasonal and annual changes in Swainson's hawk home range size and configuration is primarily a function of the changes in vegetation structure resulting from field preparation, planting, growth, and harvest regimes of each crop type. Annually rotated irrigated cropland provides the bulk of the suitable foraging landscape in the plan area, which includes a variety of field and vegetable crops subject to these seasonal changes in structure and value to foraging Swainson's hawks. For example, among these crop types are tomatoes and wheat, both historically important crop types in Yolo County, which together comprise an average of approximately 95,000 acres, or 24% of the available habitat in the plan area each year (Table 1). These types are particularly important to foraging Swainson's hawks because of their time of harvest, which increases prey accessibility. Most wheat is harvested in June during the late incubation/early fledging period, and most tomatoes are harvested in August just prior to migration.





Swainson's Hawk Modeled Habitat

**Table 1. Agricultural cover/crop type acres**

Crop Type	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Alfalfa Hay	31,000	30,500	36,000	41,638	30,500	30,350	31,775	24,584	28,193	33,983	42,430	43,802
Other Hays	7,100	7,000	6,000	11,700	8,489	5,094	5,534	8,695	6,296	6,018	8,802	9,100
Barley	6,000	4,100	4,100	4,540	5,948	1,931	1,280	739 **	**	**	**	**
Tomatoes	43,350	50,000	59,500	59,600	45,600	61,500	69,700	73,137	67,700	49,200	56,600	61,500
Sugar Beets	17,963	9,650	6,860	8,483	6,963	11,398	7,357	4,027	2,018	4,526	1,570	1,570
Wheat	51,254	80,800	70,247	59,681	69,277	53,676	59,031	42,857	54,172	54,836	39,014	33,983
Field Corn	16,700	18,200	15,000	12,900	21,200	16,380	21,650	24,536	31,371	36,915	18,518	13,000
Safflower	13,500	20,900	27,710	21,380	31,203	47,938	40,005	33,231	23,937	27,040	24,278	29,200
Sunflower	5,280	4,828	4,590	3,818	5,417	5,721	8,755	8,118	5,075	5,679	5,831	10,000
Melons	3,038	3,189	5,300	3,702	2,683	3,565	4,930	2,544	3,128	5,324	2,333	4,000
Rice	28,940	24,200	25,000	13,646	21,680	21,909	20,917	25,012	25,999	25,800	17,816	24,000
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
Dry Pasture	136,000	103,000	132,000	126,872	130,711	123,870	126,612	119,543	145,854	144,950	136,368	119,000
Cotton	0	0	0	0 **	**	**	**	**	1,405	4,418	2,857	3,000
Orchard***	17,617	17,663	18,001	17,447	17,469	17,694	19,026	17,814	16,596	18,368	18,039	17,000
Vineyard***	1,362	1,374	1,581	1,366	1,667	1,770	2,092	4,219	4,540	6,833	8,410	8,000
Misc. field	39,300	41,800	36,264	43,661	52,368	49,359	42,062	36,425	25,715	20,925	21,273	22,000
Misc. veg	1,945	1,566	1,344	1,088	605	894	1,310	785	1,531	1,800	1,440	1,000
Organic veg	0	455	570	643	444	1,242	1,501	1,460	1,719	1,556	2,425	2,000
Nursery crops	358	568	506	454	441	430	443	453	338	524	293	300
Seed crops	10,373	10,827	12,964	8,459	10,087	11,301	13,878	9,987	14,740	18,464	16,768	14,000
Total available	444,080	443,620	476,537	454,078	475,752	479,022	490,858	451,166	473,327	480,159	438,065	438,000
Total suitable	395,803	399,815	431,450	421,465	434,495	437,219	448,380	403,668	425,854	435,602	393,507	387,000
Highest value	31,000	30,500	36,000	41,638	30,500	30,350	31,775	24,584	28,193	33,983	42,430	43,802
Moderate value	313,967	309,350	327,972	327,837	332,356	319,828	324,576	298,423	314,764	300,423	276,627	266,000
Low value	50,836	59,965	67,478	51,990	71,639	87,041	92,029	80,661	82,897	101,196	74,450	78,000

Average annual agricultural acres = 463,759 acres  
 Average annual acres suitable for foraging (excludes rice, orchards, vineyards, nursery = 405,625 acres  
 Average annual highest value (alfalfa) acres = 41,692 acres  
 Average annual moderate value (tomatoes, wheat, beets, barley, other hays, pastures, misc field = 293,267 acres  
 Average annual low value (corn, saff, sunfl, melons, cotton, misc veg, seed, organic = 70,665 acres

\*summarized from Yolo County Annual Crop Reports

\*\*included under Misc. field crops

\*\*\*These totals reflect harvested acreage and therefore do not include vineyards and orchards that are too young to produce fruit. The total acres for these land

High Value
Moderate Value
Low Value
No Value



Alfalfa is considered the highest value crop type due to its more consistent vegetation structure, its semi-perennial regime (typically 3-5 years between cultivation events), and its management (mowing and irrigating) that enhances prey accessibility (Estep 1989, 2009, Anderson in preparation). Other types, including irrigated pastures and dry pastures or grasslands, are also moderately suitable habitats for foraging. Perennial crop types, such as vineyards, orchards, and rice that do not support accessible prey receive significantly less use (Estep 1989, Anderson in preparation, Swolgaard et al. 2008) and are considered unsuitable.

### **Available Foraging Landscape**

Table 1 summarizes the agricultural crop/cover types in Yolo County between 1988 and 2012. Using data from the Yolo County Department of Agriculture, I calculated an annual average of 463,759 acres of active agricultural land, 405,625 acres (87 percent) of which is considered suitable as foraging habitat for the Swainson's hawk (Table 1). This was further subdivided into high, moderate, and low value habitats as follows:

- High value = 41,692 acres (10.3 percent)
- Moderate value = 293,267 acres (72.3 percent)
- Low value = 70,665 acres (17.4 percent)

For purposes of this report, high value habitat consists entirely of alfalfa hay. Refer to Table 1 for types in the moderate and low value categories.

While low value crops may be used occasionally, the majority of use occurs on high and moderate value lands, which together on average comprise nearly 83 percent of the agricultural landscape.

Note that these estimates do not account for lands that were double-cropped (i.e., where two plantings and harvests occurred in the same field during the same year). While not a particularly common practice in Yolo County, this means that the overall annual average and the totals for moderate and low value types (which includes all of the seasonally and annually rotated crop types subject to double cropping) presented here are considered over-estimates of the available foraging acres. They do, however, represent a reasonable estimation of the proportions of high, moderate, and low value foraging habitats across the landscape.

### **The Proportion of the Landscape Used for Foraging**

Telemetry studies have shown that Swainson's hawks in the Central Valley forage widely over a large landscape (Babcock 1995, Estep 1989). Reported home ranges in the Sacramento Valley range from 830 to 21,000 acres depending on the land cover types available, with an average estimated home range of 6,800 acres (Estep 1989). This is the average area that individual hawks occupy during the course of the breeding season. Within this area, actual hunting occurs only where conditions provide available and accessible prey. In other words, some portion of this area is either unsuitable or is

seasonally or annually unavailable. Where nests are located in the immediate vicinity of high value foraging habitat, home ranges are substantially smaller (as low as a reported 830 acres). Where crop diversity is greater and includes a greater proportion of unsuitable or low suitability types, home ranges can be substantially larger as hawks range more widely in search of prey. With an estimated 300 nesting territories within the plan area, this suggests that a large proportion of the available foraging landscape is used by Swainson's hawks.

### **Estimating the Extent of Suitable Foraging Habitat Needed to Maintain the Population**

Using the information in the preceding section, I constructed a simple model to estimate the extent of suitable foraging habitat required to maintain the population. The resulting total number of acres represents the minimum baseline acres of suitable foraging habitat that should be maintained annually within the plan area.

While it is clear that a reasonably large proportion of the agricultural landscape is used for foraging, the estimated total number of agricultural acres available for foraging in the plan area (405,625 acres) does not necessarily represent the number of acres that are required to maintain the breeding population. Many habitat areas are not used or underused during the course of a breeding season. Table 1 indicates that the average annual low value habitat (e.g., corn, sunflower, safflower) exceeds 70,000 acres, or 17.4 percent of the total available acres. These acres are not used or used infrequently for foraging. Some moderately suitable habitats, such as annual grasslands, are also used less frequently than many moderately suitable cultivated habitats. Annual grasslands, or dry pastures, comprise an average of 129,000 acres (32%) of the available foraging habitat in the plan area. Totalling the annual estimates of low value habitat and annual grasslands, approximately 50% of the available foraging landscape in the plan area may be infrequently used.

So while Swainson's hawks occupying diverse and dynamic agricultural landscapes may forage widely, actual prey capture attempts likely occur in a smaller proportion of the fields that are included in most individual home ranges. Other factors (e.g., prey availability and density, vegetation structure and density, etc.) influence what proportion of the landscape is actually used and needed to provide sufficient foraging habitat (Bechard 1982, Estep 2009). But because home ranges are different each year due to seasonal and annual changes in the crop matrix, it is difficult to predict or model the extent of the area likely to be used. However, using the average home range size as our initial baseline, one simple way to calculate a rough estimate of required suitable habitat is to apply correction factors to the estimated available habitat. I use three correction factors in the following example, 1) the extent of overlap between the nesting territories, 2) the proportion of at least moderately suitable habitat within foraging ranges, and 3) the extent of foraging that occurs outside of the plan area. By applying these factors as adjustments to the home range estimates, I calculated an estimated acreage of suitable habitat required to maintain the population.



**Correction Factor 1: Adjusting for Home Range Overlap.** By simply multiplying the number of nesting territories by the estimated average home range size, the number would be much greater than the available habitat (See Table 2, column D). But by estimating the extent of home range overlap, the adjusted acreage is reduced to a more reasonable estimate of the overall foraging range of the population within the plan area. With an average of only 405,625 acres of suitable habitat available, this suggests the extent of overlap among foraging ranges is substantial. Home range overlap is highly variable depending on land use and the density of nests. In Yolo County, nesting territories are in close proximity to each other resulting in a very high nesting density (Estep 2007). Individuals defend a relatively small area, usually in the immediate vicinity of the nest, and often forage communally with other Swainson's hawks (Estep 1989). Within the plan area, overlap of foraging ranges are therefore expected to be extensive and is assumed in this example to be 75 percent (Table 2, column E).

**Correction Factor 2: Adjusting for Habitat Suitability.** Then, by calculating the number of acres of at least moderately suitable foraging habitat within home ranges (from the sample of hawks used in the home range estimate [Estep 1989]), I determined that approximately 75% of the total home range area was at least moderately suitable and 25 percent was either unsuitable (e.g., rice, orchard, vineyard, urban) or had low suitability (e.g., corn, safflower, sunflower). Using this as the second correction factor, I further adjusted the estimate of required suitable habitat (Table 2, Column F).

**Correction Factor 3: Adjusting for Foraging Outside of the Plan Area.** Finally, because of their large home ranges and because 17.6% of reported nests (Estep 2007) occur along the plan area border and over 36% of reported nests occur within 2 miles of the plan area border, I also assumed that some proportion of foraging occurred outside of the plan area in Sacramento, Solano, and Sutter Counties. For this example, I arbitrarily selected a correction factor of 30% to estimate the extent of foraging that occurs outside of the plan area (Table 2, Column G).

Using these correction factors, the total suitable acres required to support the population can then be estimated using the formula:

$Y = n \times a \times b \times c \times d$ , where

- $n$  is the number of nesting territories
- $a$  is the average home range size
- $b$  adjusts for the overlap in foraging ranges
- $c$  adjusts for the proportion of at least moderately suitable foraging habitat
- $d$  adjusts for the proportion of foraging that occurs outside of the plan area
- $Y$  is the total suitable acres required to maintain the population

$Y = 300 \text{ pairs} \times 6,800 \text{ acres} \times 0.25 \times 0.75 \times 0.70 = 267,750 \text{ acres}$  (Table 2).

**Table 2. Estimating required foraging habitat**

A	B	C	D	E	F	G
Available* foraging habitat (ac)	Estimated number of nesting territories	Average home range size (ac)	Unadjusted foraging habitat required to support 300 nesting territories (B x C) (ac)	Adjusted for 75% overlap of home ranges (ac)	Adjusted for proportion of at least moderately suitable habitat (75%) (ac)	Adjusted for proportion of foraging occurring outside of Plan Area (30%) (ac)
405,625	300	6,800	2,040,000	510,000	382,500	267,750

\*as previously noted, this estimate, which is derived from a 25-year average using data from the Yolo County Department of Agriculture does not address double-cropping and therefore should be considered an overestimate of the available foraging habitat in the Plan Area. In addition, because it is an average over a 25-year period, it also does not necessarily represent the current total available foraging habitat present within the Plan Area. However, also note that the estimated acres required to maintain the population (Column G) is based on the number of breeding territories and the average home range size and then applying the three correction factors (Columns B through F), and so is independent of the available foraging habitat (Column A).

In this example, 267,750 acres of suitable foraging habitat are required to support the population each year, which equates to 66 percent of the total suitable habitat in the plan area. Because the model is very simplistic, Y can change substantially with little change in the proportions. For example, if we increase the home range overlap to 80 percent, Y is calculated as  $Y = 214,200$  acres, or approximately 53 percent of the total suitable habitat in the plan area. Conversely, if we decrease the home range overlap to 70%,  $Y = 321,300$  acres, or nearly 80% of the total suitable habitat in the plan area.

While there are many uncertainties using such a simple model, in my opinion it nonetheless results in a range of values that seem to be a reasonable estimate of suitable agricultural foraging habitat needed to support the population. So, for purposes of this exercise, I assume that approximately 267,750 acres of suitable foraging habitat are required each year to support this population.

### **Estimating the Extent of High Value Foraging Habitat Needed to Maintain the Population**

In addition to maintaining sufficient suitable habitat, maintaining some proportion of the landscape in high value foraging habitat is also essential to maintain the population. As noted, for the purposes of this exercise, alfalfa is the only crop type identified as having high value. However, as with other crop types, it is not expected that all alfalfa acreage is used similarly and that there is a point at which the extent of alfalfa no longer influences use or abundance of nesting Swainson's hawks.

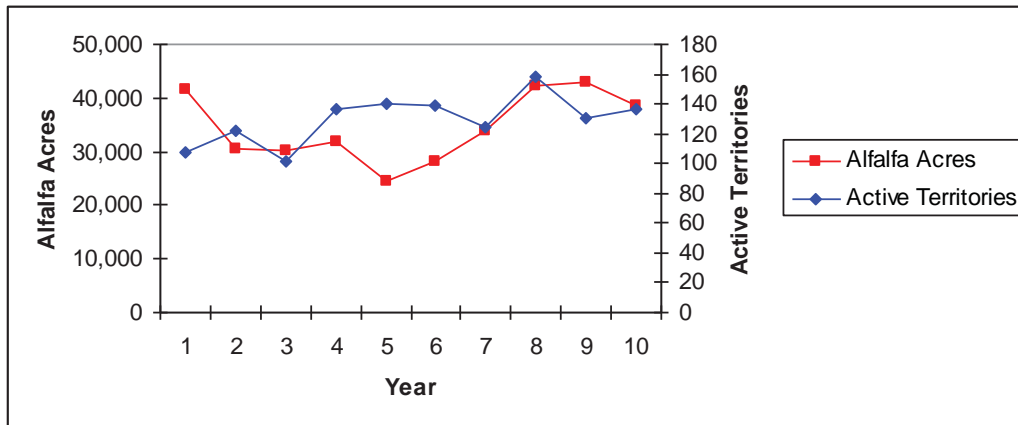
To estimate this threshold acreage, I compared alfalfa acreage with the number of active nesting territories in my Yolo County study area between 1991 and 2000 (Table 3). Figure 2 indicates that during this 10-year period there was not a clear correlation between alfalfa acreage and the nesting population within the study area. This pattern has continued through 2012 as alfalfa acreage increased during some years and is currently back at approximately 1991 levels (Table 1) while the nesting population within the study area remained relatively stable (Estep in progress).

Because changes in the number of active territories do not correlate well with changes in alfalfa acreage (note in particular that active territories increased during years when alfalfa acreage was lowest [1995-96], and decreased when alfalfa acreage increased [1999]) suggest that other factors are regulating the nesting population and that the threshold for alfalfa acres lies within these values. So, for purposes of this exercise I use the average value from Table 3 of 34,500 acres to represent the minimum number of acres of alfalfa required to maintain the population.

**Table 3. Acres of alfalfa and corresponding number of active Swainson's hawk territories in Yolo County.**

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Acres of Alfalfa	41,638	30,500	30,350	31,775	24,584	28,193	33,983	42,430	43,024	38,720
Active Territories	108	122	101	137	140	139	125	158	131	136

**Figure 2. Acres of alfalfa and active territories between 1991 and 2000.**



## Summary

Using the model parameters and assumptions described above, for purposes of this exercise I estimate that a minimum of 267,750 acres of suitable foraging habitat, 34,500 acres of which is high value habitat, is required to maintain the current Swainson's hawk nesting population in the plan area.

## Applying the Habitat Estimations to a Conservation Strategy

The preceding section provides a biological baseline upon which a strategy can be developed. However, in addition to applying biological information and assumptions, the strategy must also consider and not be inconsistent with the continued economic viability of agriculture in Yolo County. Therefore, the goal of the strategy can be generally stated as follows:

*Develop and implement a strategy that preserves sufficient agricultural and natural landscapes to protect the Swainson's hawk nesting population and that is not inconsistent with maintaining an economically viable agricultural landscape in Yolo County.*

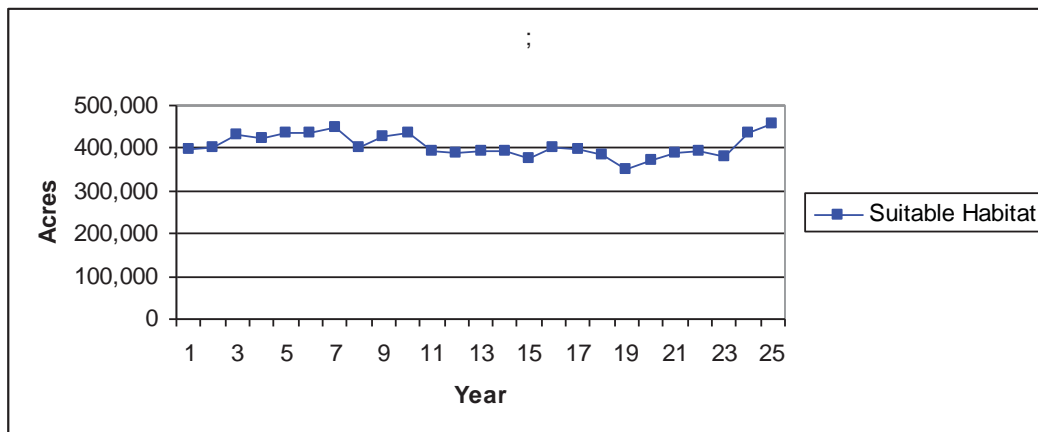
### **Status of the Population**

Monitoring in the plan area indicates the population may have increased between the mid-1980s and early 1990s and has remained stable through 2012 (Estep in progress). The estimate of 300 nesting territories in the county was determined through a county-wide census in 2007 (Estep 2008), supplemented with focused surveys in 2012 (Estep 2012), and is consistent with estimates from a state-wide survey conducted in 2005-06 (Anderson et al. 2007). Continued monitoring has not detected substantial changes to this estimate. This is considered a very dense nesting population and the most dense nesting population reported within the range of the species (Bechard et al. 2010). This suggests that the agricultural land uses and diversity of crop/cover types in Yolo County have historically provided and currently provides a high value nesting and foraging landscape for the Swainson's hawk.

### **Status of Available Habitat**

From Table 1 it is evident that agricultural patterns in the plan have provided sufficient suitable and high value foraging habitat for Swainson's hawks over at least the last 25 years. While there have been increases in unsuitable crop types (i.e., rice, orchard, vineyard) over that time period, as well as a slight decrease in moderately suitable habitat, total suitable habitat has remained relatively stable over this time period (Figure 3). Due to the large geographic area and the extent of suitable habitat throughout the plan area, to date these changes appear to have been inconsequential relative to changes in the Swainson's hawk population. However, more recent and ongoing conversions of suitable agricultural habitats to orchards are reducing available habitat at a more rapid rate than was reported during the period of 1988 to 2012 (Yolo County 2013).

**Figure 3. Acres of suitable Swainson's hawk foraging habitat in Yolo County between 1988 and 2012\*.**



\*from Yolo County Department of Agriculture annual crop reports. As noted earlier, estimates do not account for double-cropping, and therefore they are considered overestimates of the total suitable acres in the Plan Area.



## **Impacts of Implementing the HCP/NCCP**

Impacts to Swainson's hawk foraging habitat from implementing the HCP/NCCP can be derived from examining the footprint of proposed covered activities (Figure 4).

Participating agencies propose development, infrastructure, and other projects that may occur over the permit term. Many of these will remove habitat used by the Swainson's hawk and other covered species. Assuming a full build-out of all covered activities results in an agricultural landscape that can then provide the available land base for conservation actions. The administrative draft HCP/NCCP indicates impacts to Swainson's hawk foraging habitat as follows:

- agricultural foraging habitat = 9,203 acres
- natural foraging habitat (grasslands primarily) = 1,769 acres

A total of 10,972 acres of foraging habitat is estimated to be removed by covered activities. This equates to approximately 3 percent of the total suitable habitat in the plan area. This relatively small amount of loss is distributed throughout the county (Figure 4) and is unlikely to have a substantial affect on the nesting population. Consistent with the current interim mitigation program administered by Yolo County and cities participating in the NHP, I assume for purposes of this exercise that these acres would be subject to mitigation at a 1:1 replacement ratio. In other words, for each acre of suitable agricultural land removed, a replacement acre would be acquired, protected, and managed to consistently provide suitable conditions for Swainson's hawk foraging.

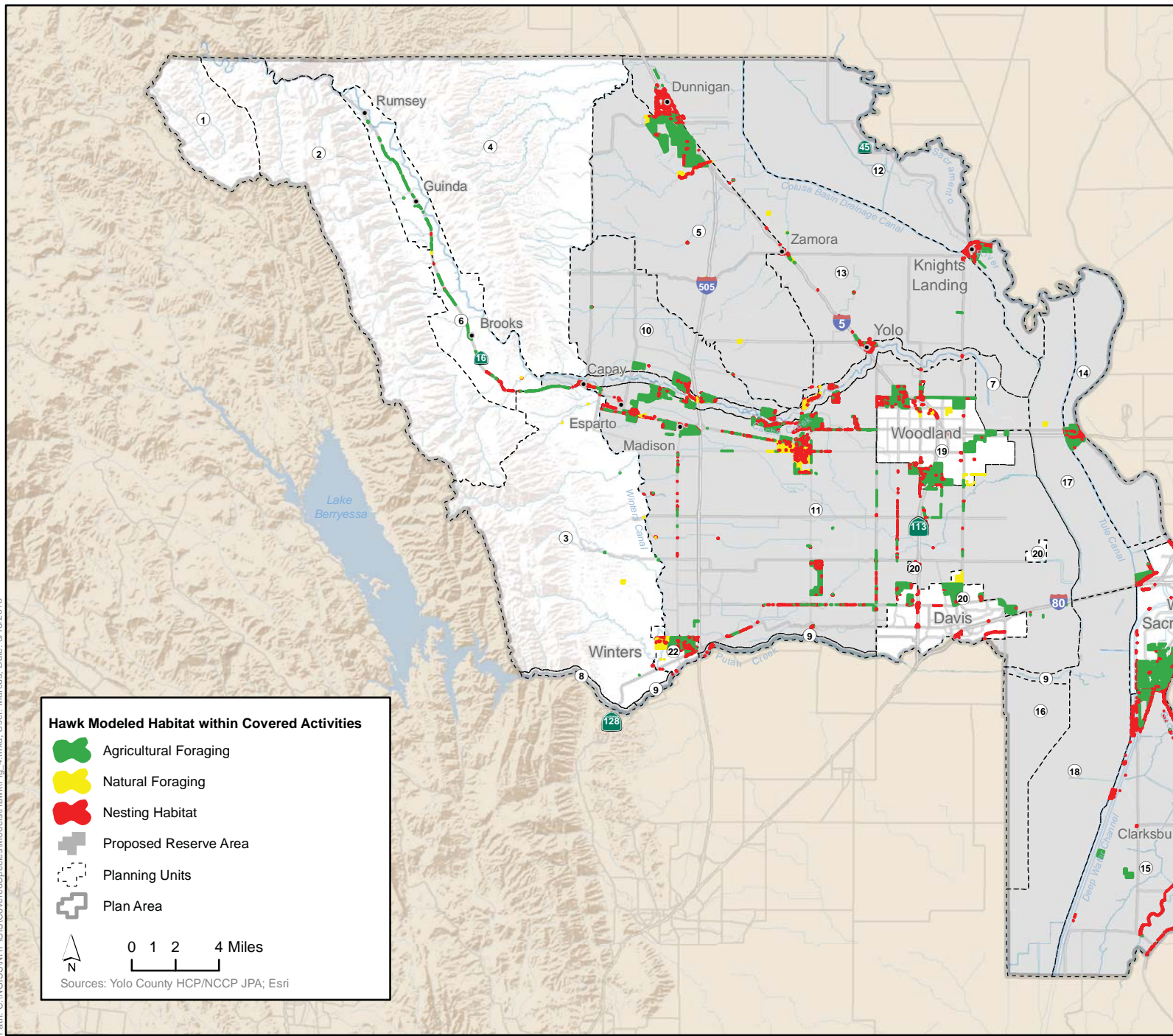
Thus, the impacts of implementing the HCP/NCCP would have a relatively minor effect on the Swainson's hawk population. Much more difficult to predict or quantify is long-term agricultural land use. While conditions (i.e., the types and distribution of crop/cover types) in the plan area have and continue to provide highly suitable habitat conditions for the Swainson's hawk, the extent to which these conditions will persist throughout the permit period is unknown. Converting agricultural land uses to unsuitable foraging cover types can be as detrimental to the nesting population as urbanization. For example, expanding acreages of orchards in the plan area reduces the total available acres of suitable foraging habitat. Areas in the Central Valley that are dominated by orchard- or vineyard-based agriculture such as portions of Butte County and Fresno County, support much smaller nesting populations (Anderson et al. 2007, Estep and Dinsdale 2013).

## **Elements of the Strategy**

The following strategy is presented as a series of assumptions, concepts, and actions.

### **Required Land Base**

In the preceding section I estimated that 267,750 acres of suitable foraging habitat were required to support a population of 300 breeding pairs of Swainson's hawk in Yolo County. This equates to approximately 66 percent of the estimated available foraging landscape in the plan area. Figure 3 indicates that this estimated threshold acreage has



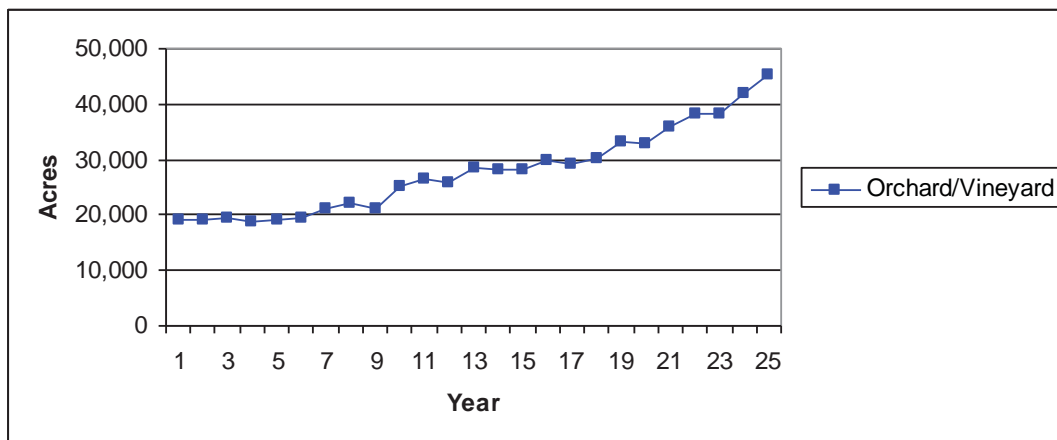
Location of Covered Activities and

been exceeded each year since 1988. Using this estimate, 137,875 acres of the total suitable habitat can be farmed in an unsuitable crop type before the threshold is reached that would have a detrimental affect on the nesting population.

Assuming that rice acreage will remain stable over the permit period due to its more specific soil requirements, orchards and vineyards are the two unsuitable crop types that are expected to reduce available suitable habitat. Table 1 indicates that both have increased since 1988 and by 2012 together total approximately 45,000 acres of land within the plan area. Therefore, a further increase of 92,875 acres would be necessary before the estimated maximum acreage threshold of unsuitable habitat (137,875 acres) is reached.

Together, orchard and vineyard acreage has increased in the plan area by approximately 9% per year over the last 10 years, a period of relatively rapid expansion compared with a 2.5% per year increase over the previous 15 years (Table 1) (Figure 5). Over a 30-year period, a similar 9% annual increase in these types would total approximately 95,000 acres. While increases in orchard and vineyard acreage may continue in Yolo County, given the highly productive farmland, history of agricultural land uses, and the market value of alfalfa hay and many annually rotated irrigated crops (Richter 2009, Yolo County Crop Reports 1988-2012), I assume that the pace of expansion will remain on a similar trajectory as it has since 2003. Under this assumption, further expansion of orchard and vineyard acreage would not result in a substantial increase above the threshold acreage. Therefore, while there are numerous uncertainties inherent in predicting future agricultural patterns in Yolo County, for purposes of this exercise I assume that the agricultural landscape in the plan area will maintain the estimated minimum of 267,750 acres of suitable foraging habitat throughout much of the permit period.

**Figure 5. Acres of orchard/vineyard between 1988 and 2012\*.**



\*Note that between 2012 and 2013 the increase in orchards was 15%, exceeding the estimated annual increase of 9%. Further increases at the current rate of conversion will result in reaching the threshold acres sooner than estimated here.

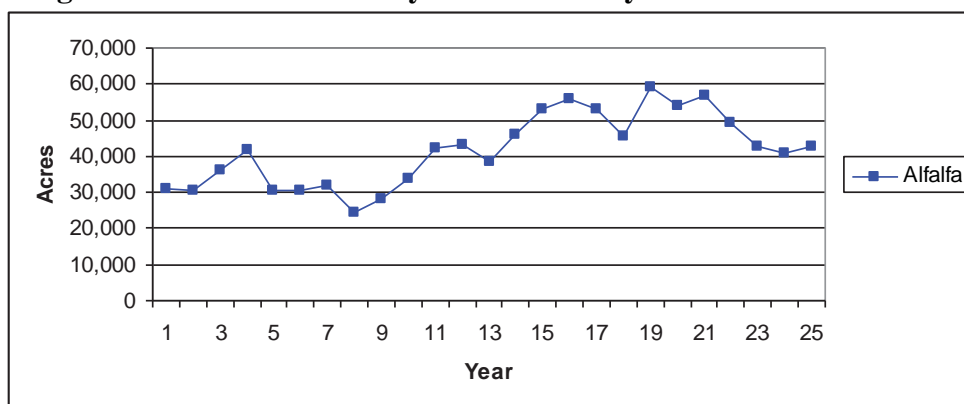
Therefore, assumption number 1 is: sufficient suitable agricultural foraging habitat (267,750 acres) will be consistently available during much of the permit period to maintain the population.

### Required High Value Foraging Habitat

While maintaining a suitable foraging landscape is essential, in order to maintain the population, managing some proportion of this landscape in high value foraging habitat is equally essential. Table 3 indicates that an average of approximately 34,500 acres of high value alfalfa hay occurred within the plan area between 1991 and 2000. During this period the nesting population fluctuated but remained relatively stable, suggesting that this is a reasonable number of high value habitat acres to be maintained as a component of the suitable foraging landscape.

Therefore, assumption number 2 is: 34,500 acres of agricultural foraging habitat that emphasizes high value cover types is required as a component of the overall suitable foraging landscape in order to maintain the nesting population. Figure 6 indicates that alfalfa hay has exceeded this target acreage 18 of the last 25 years and each year since 1998.

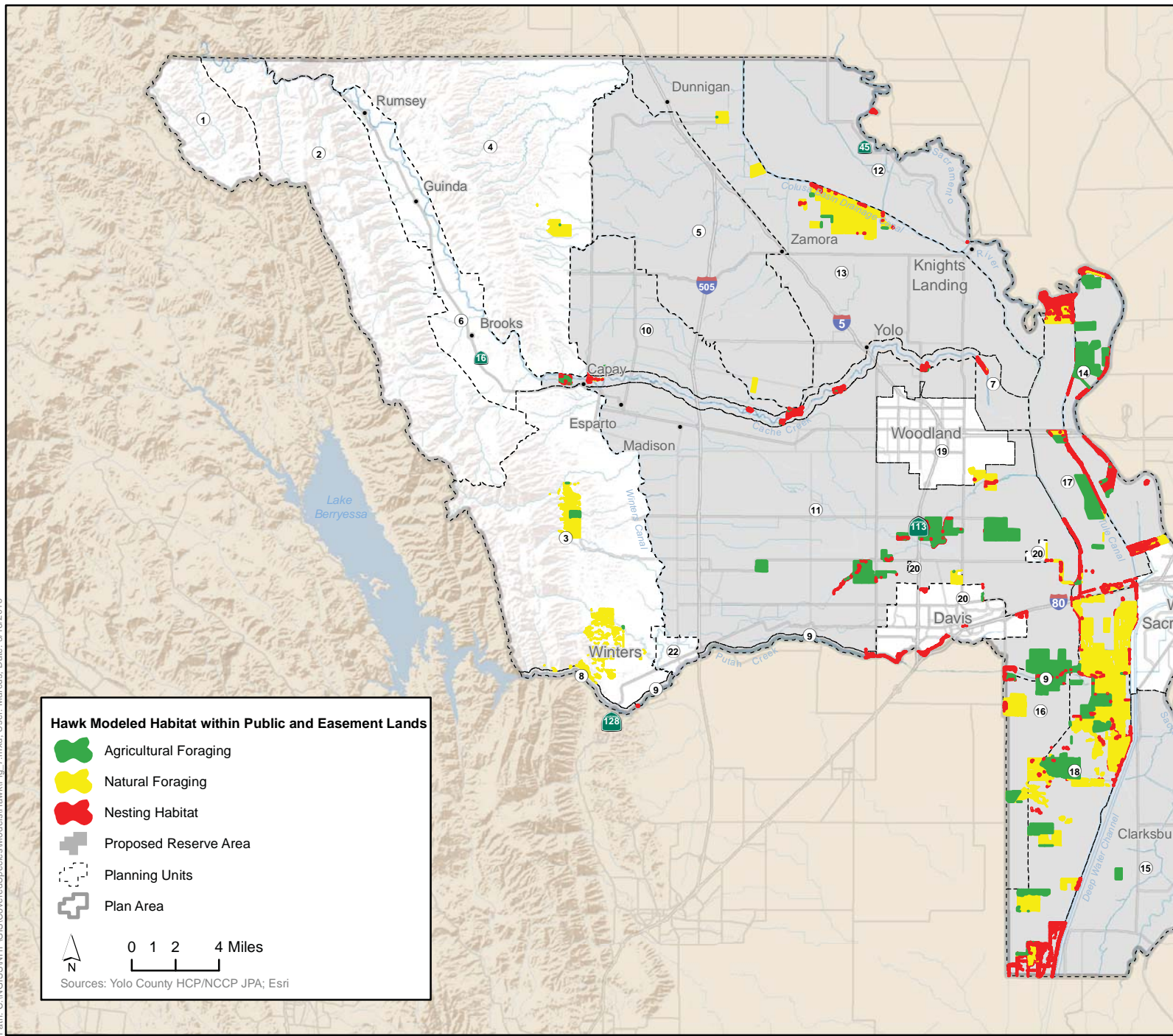
**Figure 6. Acres of alfalfa hay in Yolo County between 1988 and 2012.**



### Existing Protected Habitats

Over 65,000 acres that support suitable Swainson's hawk foraging habitat are currently protected under existing conservation easements or are owned and managed by private or public land management entities. Of this, 23,108 acres (14,900 acres of natural lands and 8,208 acres of cultivated lands) meet the definition of Category 1 Baseline Protected Lands (covered by an irrevocable conservation mandate) (Figure 7). (An additional 1,960 acres of riparian nesting habitat is also considered Baseline Protected Land). So, while the entire 65,000 acres likely provide value to foraging Swainson's hawks, for purposes of this strategy, I assume that a minimum of 23,108 acres are sufficiently protected and support at least moderate value foraging habitat. Through participation in





Current Public and Easement Lands that Support Suitable Sw

the proposed landowner incentive program (see below) much of the 23,108 acres of cultivated land may be potentially available to being managed with high value habitat.

Therefore, assumption number 3 is: at least 23,108 acres of suitable foraging habitat is currently protected in the plan area.

### **Newly Protected Habitat**

Implementation of the HCP/NCCP will impact 10,972 acres of suitable foraging habitat that will require mitigation. These acres are expected to be managed in the rotational regime typical to the plan area, which emphasizes primarily moderate value foraging cover types, but may periodically rotate to either high or low value types. These lands are also potentially available, through agreement with individual landowners participating in the proposed landowner incentive program, to be managed as high value foraging cover types.

To further contribute toward meeting NCCP goals, an additional 5,448 acres will also be conserved for a total of 16,310 newly protected habitat acres.

Therefore, assumption number 4 is: Mitigation and other conservation will provide 16,310 acres of newly protected suitable foraging habitat in the plan area.

### **Summary of Protected Lands.**

A total of 39,418 acres of suitable foraging habitat would be protected as a result of existing protected lands (23,108 acres), and newly acquired conservation easements (16,310 acres). Up to approximately 80,000 acres would be protected if all existing protected habitats (65,000 acres) were included (including Category 2 and 3 lands). This represents between 11% and 30% of the total suitable habitat acreage required to maintain the population.

Therefore, assumption number 5 is: between 11 and 30 percent of the suitable foraging habitat acreage required to sustain the population (267,750 acres) will be met by implementing the conservation program. The remaining 70 to 89 percent is expected to be met through ongoing compatible farming practices on non-reserve lands.

### **Meeting the High Value Habitat Target**

Our objective is to maintain at least 34,500 acres of high value foraging habitat in the plan area. Table 1 indicates that this objective has been met and exceeded each year since 1998. Due to the historic trend in alfalfa acreage (Table 1, Figure 5) and the current (Richter 2009) and assumed future market value of alfalfa, this objective is expected to be met for at least the near future without implementation of other management measures.

## Landowner Incentive Program

To address future deficiencies in alfalfa acreage, a landowner incentive program could be established for the purpose of increasing high value foraging habitat in the event it falls below the threshold of 34,500 acres. Activation of the incentive program should be based on maintaining the target threshold acres but also should account for annual fluctuations and trends. For example, if the acreage of alfalfa declines by more than 10 percent below the threshold over a 5-year period or by more than 25 percent in any single year, then the incentive program could activate. The incentive program could then remain active until the acreage of alfalfa exceeds 10 percent above the threshold acreage. The program would be based on a formula that exceeds current market values sufficient to provide an incentive to farmers to grow alfalfa hay or other high value cover types on a short-term basis (1 to 2 alfalfa rotations). Participation in the program should initially focus on farmers with existing conservation easements acquired as Swainson's hawk foraging habitat, then expand to other locations as needed.

## Distribution and Management of Protected Lands

Existing conservation lands occur throughout the plan area. Mitigation acres and other conservation acres should be strategically placed within the plan area. For example, dividing the 16,310 newly protected acres into 300 acre blocks, there are 54 individual reserves that can be placed strategically throughout the agricultural landscape. The concept is to provide moderate to high value habitat reserves scattered throughout the portion of the conservation reserve area that supports the bulk of the nesting population. These newly protected reserves can be consolidated and form larger contiguous blocks or can be a series of separate, smaller reserves scattered throughout each Planning Unit. Acquisition of newly protected reserves for the Swainson's hawk should focus on planning units 10, 11, 13, 15, and 16, but can include others as determined by the Science and Technical Advisory Committee. For example, Table 4 shows an example of how 54 reserves could be distributed among the planning units based on their size and the distribution and abundance of Swainson's hawk nesting territories.

**Table 4. Example distribution of 54 reserves among 5 planning units.**

Planning Unit	Reserves
11	18 (5,400 acres)
13	16 (4,800 acres)
15	8 (2,400 acres)
16	6 (1,800 acres)
10	6 (1,800 acres)

Because the majority of the nesting population and available nesting habitat occurs within these planning units, strategically placing reserves as described will also maintain or enhance habitats nearest the majority of nesting habitats in the plan area. However, the reserve design strategy must also be developed in close coordination with the conservation objectives for other Covered Species in order to meet the overall habitat

objectives required under the HCP/NCCP. So the size, location, and configuration of reserves will be closely linked with the overall conservation objectives for Covered Species and natural communities.

## **Reserve Land Management**

### **Crop/cover Types**

Reserves will continue to be part of the working agricultural landscape. It is anticipated that most reserves will be managed and farmed according to the provisions of conservation easements agreed to by landowners. Conservation easements would require the landowner avoid unsuitable crop types. This is expected to result in reserves that emphasize at least moderately suitable types, although periodic rotation to low suitability crops is possible. The proposed incentive program would be available to these landowners to use high value crop types if necessary based on the overall abundance of high value crop types within the plan area. At least 34,500 acres of high value habitat are needed annually in order to meet the high value habitat objective. As long as at least 34,500 acres of high value habitat are present within the plan area, then reserves can continue to farm with moderate value crop types and the incentive program would not activate. The incentive program activates only when the plan-area-wide total is reduced to less than the target acreage, as described above.

While for purposes of this strategy high value habitat is defined solely as alfalfa hay, this should not discourage the use or experimentation of other crop types that have been demonstrated to provide high value including oats, burseem, grass hay, or ryegrass, or crops that provide high value at key times of the breeding season, such as tomatoes.

### **Trees and Hedgerows**

Establishing strategically placed reserves also provides the land base for tree restoration required to mitigate the loss of potential nest trees, and the establishment of hedgerows along field borders to serve as habitat for prey species and to provide source populations for reestablishment into fields following harvest. Tree planting to mitigate losses of suitable Swainson's hawk nest trees and hedgerow development should initially focus on using mitigation lands since these lands would be strategically placed throughout the plan area as described above. Provisions for these habitat elements can be included along with crop restrictions in the agricultural-based conservation easements.

## **Monitoring**

This strategy is meant to be adaptive to changes in the landscape as well as new information regarding the status of the species and agricultural habitat use. Monitoring is essential for three purposes, 1) review annual changes in crop types, 2) review changes in the distribution of crops and land use patterns, and 3) review the Swainson's hawk nesting population within the plan area.



- Monitoring changes in crops and other agricultural land uses can be done through an annual review of Yolo County Department of Agriculture Crop Reports.
- Monitoring the distribution of crops and crop patterns should be conducted on a 5-year basis by building on the existing GIS mapping program that uses available aerial photos of the plan area.
- Monitoring of the Swainson's hawk population should be monitored on a 5-year basis using a census-based approach similar to that conducted in 2007.

## Summary

The conceptual strategy described above outlines the process and assumptions through which two key thresholds are derived: suitable foraging habitat acres in the Plan Area (267,750 acres) and high value foraging habitat acres in the Plan Area (34,500 acres). The estimates and assumptions used in the conceptual strategy indicate that in order to maintain a population of 300 nesting pairs in the Plan Area, foraging habitat acres should consistently exceed these thresholds. Reducing available habitat below these thresholds would presumably trigger actions to initially evaluate the effect on the nesting population, and then if necessary implement other actions to increase available habitat above the threshold acreages. In the meantime, monitoring of available habitat and the nesting population will provide opportunities to test the assumptions used to establish the threshold acreages, which should be considered only a baseline through which additional data are applied and through which adjustments of the threshold acreages can be made. Continued monitoring of land uses, the nesting population, and reserve design and management is essential to provide data to assess the overall effectiveness of the strategy and the reliability of threshold acreages, and to meet the goal of maintaining the current population of nesting Swainson's hawks in the Plan Area.

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