SWAINSON'S HAWK POPULATION AND HABITAT USE ASSESSMENT

SOLANO HCP/NCCP

LSA

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INTRODUCTION

The Swainson's hawk (*Buteo swainsoni*) is listed as threatened by the State of California and a Species of Special Concern by the U.S. Fish and Wildlife Service (USFWS). As a result, the Habitat Conservation Plan (HCP) being developed for Solano County includes Swainson's hawk as a "covered" species. The HCP Swainson's hawk conservation strategy is currently being developed and will include appropriate mitigation measures and recommendations to minimize impacts to individual Swainson's hawks, as well as to minimize the degradation or loss of nesting and foraging habitat.

The historic range of nesting Swainson's hawks in California included the Southern Transverse Ranges, Central Coast Ranges, Central Valley, Great Basin, and Mojave-Colorado Desert (Bloom 1980). These regions included desert, shrubsteppe, grassland, agricultural, canyon, foothill, and interior valley habitats. Few historical records exist for mountainous and forested terrain in the North Sierra Nevada-Cascade Range, North Coast-Klamath Mountains, or Southern Sierra Nevada-White Mountains. However, small populations were recorded in non-forested habitats in Owens Valley, Shasta Valley, and Sonoma County. During historical times (circa 1900), an excess of 17,000 pairs of Swainson's hawks may have bred in California (CDFG 2000; Bloom 1980); however, the species population declined by approximately 90% between the 1940's and early 1980s, presumably due primarily to the loss of habitat (Brown 1996) although other factors such as mortality in wintering areas in South America may also have played a major role in the population decline.

Nesting Swainson's hawks are still locally common to rare in the Central Valley and Great Basin (Woodbridge 1998). Recent Central Valley population estimates indicate up to as many as 1000 nesting pairs (Woodbridge 1998), with the densest nesting densities centered in Sacramento, San Joaquin, Solano, and Yolo counties.

Within the Central Valley, Swainson's hawks are closely tied to and appear dependent on the high abundance and/or availability of prey such as pocket gophers and microtine rodents associated irrigated agricultural areas. The highest densities of Swainson's hawks appear to be present in areas with substantial alfalfa production and pasture intermixed with other row crops (Estep 1989, Woodbridge 1991).

Swainson's hawk nests in the Central Valley are typically built in the semi-exposed sections of the upper canopy or lateral branches of tall trees. Nesting territories occur in relatively level terrain to gently rolling hills and rarely in mountainous or steep terrain (CDFG 2000).

The loss of agricultural lands to residential and commercial developments is considered to be a major threat to nesting Swainson's hawks in California. Additional identified concerns/threats include: loss or reduction in the availability of nest sites due to loss of riparian habitats through riverbank flood control protection projects; decline or loss of trees in agricultural areas through direct removal or limited recruitment; the conversion from certain agricultural crops that provide abundant prey to crops such as vineyards and orchards that provide limited prey; exotic species invasion and encroachment; shooting; competition from other raptors; human disturbance at nest sites; and potential affects of pesticides (CDFG 2000, Woodbridge 1998).

In the past, analyses of eggshell thinning and organochlorine residues in eggs suggested that Swainson's hawks were not adversely affected by organochlorine use (Henny and Kaiser 1979, Bechard 1981, White *et al.* 1989). However, USFWS have recorded instances when 1-40 hawks were killed by organophosphate and carbamate insecticide contamination in agricultural fields, particularly in fall when the hawks feed on insects in harvested fields (Mineau unpub.).

Woodbridge *et al.* (1995) and Goldstein *et al.* (1997) reported significant effects of pesticide use on wintering Swainson's hawks in Argentina. Several hawks died due to poisoning by organophosphate insecticides, monocrotophos, and dimethoate that were used to control grasshoppers in sunflower, corn, and alfalfa fields. In 1996, approximately 5,000 Swainson's hawks were found dead in La Pampa province, with an estimated total kill of 16,000 to 20,000 birds. Other hawk insecticide-induced deaths were reported in 1997 and 1998. Farmer education programs and toxic organophosphate pesticides restrictions implemented by the government and industry appear to have reduced these impacts.

The increase of exotic plant species has reduced prey abundance in the Swainson's hawks foraging habitat. In northeastern California and the Central Valley, the increase of fallow fields dominated by weedy ruderal species and the increase of cheatgrass-dominated grazing lands provided limited foraging opportunities for Swainson's hawks (Woodbridge 1991, Estep 1989).

The following report has been developed to assist in the development of the HCP Swainson's hawk conservation strategy by summarizing the current population status and distribution of Swainson's hawks in Solano County and addressing habitat use, habitat availability and the assessing the potential impacts of pesticide use on Swainson's hawks within the County.

METHODS

Swainson's hawk distribution and nest records for Solano County were compiled from California Department of Fish and Game survey data (CDFG 2000, 2001), California Natural Diversity Database records (CNDDB 2003), and HCP/NCCP surveys (LSA 2003). All records from these data sets were used to map the distribution of Swainson's hawks in Solano County. Since many of these records probably represent multiple records of the same individual or pair within and across years, breeding population and density, site fidelity, and estimates of reproductive performance were developed based on confirmed breeding records from the 2001 breeding season, when extensive surveys were carried out in Solano County.

Habitat use and availability was analyzed using GIS map layers of Swainson's hawk distribution, as described above, vegetation cover (LSA 2003), potential nest trees (LSA 2003), and California Department of Water Resources land-use maps (DWR 1994). analysis of habitat suitability and use by Swainson's hawks in Solano County included analysis of the following factors:

1) Tree species used for nesting;
2) Suitable foraging habitat within 2-miles of known 2001 nests;
3) Foraging habitat composition within the home range of known Swainson's hawk nests versus availability within the County overall;
4) Overall availability of suitable foraging habitat in the County; and
5) Parcel size of properties surrounding known nest sites.

The potential impact of pesticides on Swainson's hawks in Solano County was examined by identifying those chemicals that are known to be the most toxic to birds (American Bird Conservancy Pesticide Program 2003, Canadian Wildlife Service Pesticides and Wild Birds website 2002, Mineau et al 1999) and pesticide use in Solano County based on Annual Pesticide Use Reports provided by the California Department of Pesticide Regulation (CDPR 2003). The most recent year for which pesticide use data was available was 2001. In addition, the trend in total usage of selected pesticides in Solano County was examined using pesticide application records from 1990 through 2001.

RESULTS

CURRENT POPULATION STATUS AND DISTRIBUTION

Systematic surveys of Solano County for Swainson's hawks have not been completed; however, extensive surveys have been carried out by the California Department of Fish and Game and others in recent years (CDFG 2000, 2001, CNDDB 2003), with a total of 167 records between 1988 and 2002 (Figure 1). CDFG surveys in Solano County are part of a larger survey effort that began in 2000 focusing on the Central Valley population of Swainson's hawks, of which the Solano County sub-population is a part. These surveys are based on a random sampling design under which randomly selected 25 km^2 cells within a grid of cells covering the Central Valley are thoroughly surveyed each year. These surveys have focused primarily on the northern half of the County where the density of Swainson's hawks is greatest (see distribution discussion and Habitat Availability below).

Solano County Population

Based on 2001 Swainson's hawk records from the CNDDB, which include records from the CDFG surveys, there were 112 Swainson's hawk records in Solano County for 2001 and, of these, 83 were recorded as confirmed nests and another 23 records were indicated as likely nest locations. As a result, 83 nesting pairs is a conservative estimate of the breeding population in Solano County. In addition to these nest records, there are 17 other nest records that were not accounted for in the CDFG study. These nests include older CNDDB nest records with a long history of use and nests confirmed from other sources. If all of these additional nest records are included, a reasonable estimate for the breeding population in the County is the range of 123 breeding pairs. Additional nests locations are also probable as many of the remaining 71 CNDDB records are from areas such as along Putah Creek that do not appear to been formally surveyed since the 1990s.

Figure 2 displays the 83 confirmed nests from 2001 and the additional 40 likely nests/territories based on records from other years/sources.

Breeding Density

Within the irrigated agricultural areas in the northeastern portion of the County in what the Working Draft HCP/NCCP has defined as the core Swainson's hawk habitat area (approximately 315 square miles defined by a 2 mile radius around nest records, Figure 2), the estimated Swainson's hawk nesting density is between 2.6 to 3.9 nests per 10 square miles.

Other studies in agricultural habitats in Central California have identified a mean nesting density of approximately 3 pairs per 10 square miles (England *et al.* 1997, Estep 1989). Similar densities of 3.7 pairs per 10 square miles were also found in the alfalfa production areas in northeast California (Woodbridge 1991).

Site Fidelity

Swainson's hawks are known to return to nest sites used in previous years (Estep pers. comm., England *et al.* 1997) and the Solano County breeding records indicate confirm a high level of site fidelity. Thirty-three of the 83 (40%) confirmed 2001 breeding sites were used in previous years. However, high site fidelity may increase the vulnerability of Swainson's hawks to the loss of nesting and foraging habitat, particularly the loss of traditional nest trees and conversion of foraging habitat around traditional nesting sites.

Reproductive Success

Another indication of population stability and health is reproductive success. Among the 83 confirmed Swainson's hawk breeding records in Solano County for 2001, 73 (88%) of these nests fledged at least one chick. This is comparable to the results from previous studies across the North American range of Swainson's hawks for which the average was 62% (England *et al.* 1997). England *et al.* (1995) found that 75% of nests in central California were successful on average. For the 2001 Solano County breeding records, there was an average of 1.12 fledglings/nesting attempt and 1.19 fledglings/successful nest. This reproductive success is lower than that documented in other studies, for which the average success was 1.35 fledglings/nest attempt and 1.84 fledglings/successful nest (England *et al.* 1997). However, the reproductive success calculated for Solano County in 2001 is more comparable to that observed for in Yolo County in recent years (1.0 - 1.3 fledglings/nest attempt and 1.4 - 1.8 fledglings/successful nest; Jim Estep pers comm.). It is important to note that the reproductive success reported here for Solano County in 2001 is based on the information reported in the CNDDB (2003) and that these values represent rough estimates since the reproductive success was not recorded for all nests and there were almost certainly other nests that were not observed at all. Nevertheless, these values provide a reasonable estimate of how the reproductive success of Swainson's hawks in Solano County.

Breeding Range

All but 4 of the 167 Swainson's hawk CNDDB records are located in the northern portion of the County, north of Travis Air Force Base (Figure 1). The other 4 records are located in the central eastern portion of Solano County, in the Rio Vista area (Figure 1; CNDDB 2003, Dan Gifford pers comm), and one recent record of an adult and juvenile located south of Highway along Shiloh Road, south of Highway 12 (Figure 2, LSA 2003). The lack of extensive surveys in the western, central, and southern portions of Solano County may explain the paucity of Swainson's hawk records in these areas. However, the availability of irrigated agricultural land and nest trees in the northern parts of the County are probable reasons for the high density of Swainson's hawks in these areas. Swainson's hawks are known to be attracted to irrigated agricultural land and may even abandon other, more natural habitats in favor of adjacent agricultural areas. Habitat use and availability are addressed below.

HABITAT USE AND AVAILABILITY

There are two critical elements to suitable Swainson's hawk habitat: nest trees and suitable foraging areas. Swainson's hawks in the Central Valley, including Solano County, naturally nest in medium to large riparian trees and valley oaks surrounded by open grasslands that provide foraging habitat (Bloom 1980, Estep 1989, England *et al.* 1997). The affiliation of Swainson's hawks with riparian areas is most likely due to the natural availability of trees in riparian corridors, rather than a specific habitat preference as has frequently been suggested. Because Swainson's hawks naturally use open open habitats with scattered trees, they have been able to adapt to widespread agricultural conversion within the Central Valley and elsewhere. However, even though certain agricultural areas can provide suitable habitat, Swainson's hawks are detrimentally affected by the loss of nest trees and the conversion to crops that are not suitable for foraging. The following is an analysis of nest tree and foraging habitat use and availability within Solano County including comparisons to other Central Valley populations.

Nest Trees

Both Bloom (1980) and Estep (1989) reported that Swainson's hawks in the Central Valley frequently nest in or near riparian areas, with 78% of nests found within riparian systems and only 22% in roadside trees or isolated trees in agricultural areas. The most commonly used nest tree in Estep's study (1989) was valley oak. Estep's continuing study of Swainson's hawks in Yolo County has more recently demonstrated that Swainson's hawks nest in many different tree species and that their nest site selection does not appear to be focused around riparian areas (Estep pers comm). This is similar to the pattern seen in Solano County. Recent nest records for Solano County show that Swainson's hawks most frequently nest in isolated individual trees and groves of non-native trees planted for landscaping or as windbreaks, with only a few nests occurring in the few remaining riparian areas and scattered oak trees on the valley floor. An analysis of 137 CNDDB records (2003) for Swainson's hawks in which nest tree was identified, showed that 37% of the nests were in eucalyptus trees, 31% were in walnut trees, and 17% were in other non-native trees. Only 12% of the Swainson's hawk nests occurred in riparian trees (cottonwoods and willows) and 4% in native oaks. These results suggest that Swainson's hawks are opportunistic in terms of nest tree selection and probably do not require specific tree species. This is supported by the numerous tree species used for nesting within the Central Valley, including Solano County, and in the wide variety of trees used across the range of Swainson's hawks in North America (England et al 1997).

Since Swainson's hawks are willing to use many different tree species, the greater threat in terms of their persistence is the loss of trees overall. Local population declines in Canada have been attributed to the gradual decline in trees due to tree removal, neglect, and impacts from cattle (England *et al.* 1997). In Solano County, Swainson's hawks probably historically nested in valley oaks in the grassland areas and willows or cottonwoods along the riparian drainages. The historic extent of nest trees in the County is unknown and so it is difficult to assess the historical distribution of Swainson's hawk breeding sites in Solano County. Figure 3 shows the current distribution of individual trees, groves, windbreaks, oak savannah, and riparian areas in Solano County in relation to all Swainson hawk records in the County. The overall density of trees in the northern part of the County, where the Swainson's hawk population is concentrated, is not substantially different than the rest of the County. This suggests that nest trees are not a limiting factor in the distribution and population size of

Swainson's hawks in Solano County. Although there has been a dramatic decline in riparian woodland and valley oak savannah in Solano County, the planting of trees for various purposes may have compensated for this loss and prevented the widespread loss of nesting habitat.

Foraging Habitat

Since Swainson's hawks are quite adaptable in their use of different tree species for nesting and trees are available throughout the County, a more important limiting factor may be the availability of suitable foraging habitat around potential nest trees. Swainson's hawks naturally forage in grasslands and open shrublands, but frequently utilize agricultural areas. Across their range, there is considerable variation in preference for particular vegetation types for foraging. In Alberta, Swainson's hawk nesting territories included a disproportionate amount of cultivated land (Schmutz 1984, 1987, 1989 as cited in Dechant *et al.* 2000). On the other hand, in Saskatchewan, Swainson's hawks nested in areas with more grasslands and fewer cultivated fields within close proximity to the nest (Groskorth 1995 as cited in Dechant *et al.* 2000). Swainson's hawks of the Central Valley often nest in high densities within agricultural areas and prefer areas with substantial alfalfa, irrigated pasture, and low row crops, but nest at lower densities in areas surrounded by dryland pasture, vineyards, and orchards (LSA 2003, Estep pers. comm., Estep and Teresa 1991, Woodbridge 1991). This variation may be related to the distribution or availability of nest sites, but could also depend on the local abundance and availability of prey. Irrigated crops, such as alfalfa and certain row crops, often support dense prey (rodent and insect) populations and are open enough for Swainson's hawks to successfully forage. In contrast, crops such as vineyards, orchards, certain row crops, rice, corn, and cotton may support abundant prey, but they are unsuitable for Swainson's hawks due to the taller canopy that prevents them from foraging effectively.

Swainson's hawk habitat use in Solano County reflect the general patterns observed in other portions of the Central Valley, with all of the known nest sites surrounded by agricultural land (Figure 3). While this may be largely a by-product of converting most of the natural habitat for Swainson's hawks to agriculture, it is probably that this also reflects their attraction to cultivated areas. As observed in Yolo County (Estep pers. comm.), Swainson's hawk home ranges in Solano County are centered within the most agricultural portions of the County. Intensively cultivated crops (field crops, grain, and hay) and pasture comprise approximately 66% of the total area located within the home range of known nests from 2001 (Table 1). In fact, the composition of cover types within the home ranges of known nests is considerably different than it is for the County as a whole, suggesting that Swainson's hawks are selecting agricultural areas (Table 1). It is also clear that the concentration of Swainson's hawks in the intensively cultivated areas of northern Solano County is not the result of nest availability since trees surrounded by pasture and grasslands are widely available in other parts of the County (see Nest Trees above). The suitability of different crops and other cover types, is dependent on the prey species available, as well as their abundance and availability. Swainson's hawks have a broad diet that includes many small mammals, birds, reptiles, and insects. The degree to which they forage on this different prey varies seasonally and there are specific prey that make up a large portion of their diet.

Table 1. Swainson's Hawk Home Range Habitat Composition Versus Relative Availability in the Solano County (Source: DWR 1994 Solano County Land Use Map)

Cover Type	Relative Availability Within 2-miles of Known Nest	Relative Availability in County
Field Crops	34.23%	12.06%
Grain and Hay	16.38%	6.33%
Pasture	15.94%	6.56%
Grassland	11.21%	26.37%
Oak Savannah	0.31%	1.60%
Riparian	0.56%	0.85%
Orchards and Vineyards	3.67%	2.99%
Other Agriculture	2.01%	2.10%
Rice	0.13%	0.17%
Developed	14.47%	22.46%
Other Native Vegetation	1.09%	18.52%

Swainson's hawks are diurnal and so typically rely on prey that are active during the day. Estep (1989) found that voles, a diurnal rodent, made up 15% of total prey captured (23% of the total biomass) in one Central Valley population. This reliance on diurnal rodents during the breeding season may explain why Swainson's hawks seem to be uncommon in the non-native annual grasslands and vernal pool communities in the center of Solano County. The plant communities in this area support high densities of nocturnal Heteromyid rodents, but support low densities of voles and pocket gophers that are preferred by Swainson's hawks during the breeding season (Woodbridge 1991). In addition to small mammals, insects are the other major component of the Swainson's hawk diet in terms of total prey captured. Insects are the primary prey item following the breeding season and prior to migration, when Swainson's hawks forage almost exclusively on large insects, such as grasshoppers and crickets (Estep 1989, England *et al.* 1997).

The type of prey is not the only important factor in determining habitat suitability. Prey abundance and availability interact to influence the suitability of particular habitats. For example, one crop type can have high prey abundance, but its structure (e.g. tall row crops or orchards) may prevent Swainson's hawks from successfully hunting. For this reason, crops that are more accessible for foraging are the most important, even if they support lower prey abundance. Also, Swainson's hawks opportunistically take advantage of farming practices, such as harvesting and flood irrigation, that expose prey. In Yolo County Estep (1989) found Swainson's hawks foraged mostly in croplands during the summer when prey density was highest prior to harvesting and discing. Following harvest and discing, these areas no longer supported abundant prey and Swainson's hawks would only then begin foraging more extensively in pastures and grasslands where prey abundance is lower generally lower. Table 2 presents the results of trapping efforts in Estep's study (1989) showing the relative rodent prey densities in different cover types of the Central Valley. The importance of prey availability is provided by tomato and beet crops. Thse two crops accounted for over 40% of the total rodents captured in Estep's study (1989), however, they are inaccessible for foraging until harvest time, when Swainson's hawks are known to focus on these fields. During the rest of the year, low crops, especially alfalfa and dryland pasture are the most important foraging areas due to prey accessibility and the regular harvesting and irrigation (Estep 1989). Swainson's hawk habitat preferences based on home range composition reflect this variability in prey availability (Table 2).

Table 2. Rodent prey abundance within and Swainson's hawk preference for different cover types (adapted from Estep, 1989).

Cover Type	Number prey/100 trap nights	Percent of Total Prey Captured	Swainson's Hawk Habitat Preference*
Tomatoes	500	22.1	6
Beets	450	19.9	5
Edge	443	19.6	--
Fallow	233	10.3	3
Dryland pasture/grassland	200	10.3	4
Alfalfa	163	7.2	1
Riparian	83	3.7	--
Corn	67	2.9	--
Sunflower	67	2.9	9
Irrigated pasture	33	1.5	7
Wheat	25	1.1	8
Disced field	0	0	2

* Based on relative composition within foraging home range.

PESTICIDE IMPACTS

Many pesticides (insecticides and rodenticides in particular) are particularly toxic to birds, including Swainson's hawks. It is estimated that approximately 67 million birds die each year in the United States as a result of exposure to pesticides (ABC 2003). These deaths can be the result of poisoning due to long-term exposure or acute poisoning due to direct or secondary poisoning where death may occur within minutes or days.

The following discussion addresses those pesticides that are especially toxic for birds, summarizes pesticide use in Solano County, and provides some general guidelines for the use of alternatives.

Pesticides with High Toxicity for Birds

Many pesticides are toxic for wildlife, however, they vary in their degree of toxicity. Organochlorine pesticides, such as DDT, are well known to be highly toxic to wildlife and have largely been eliminated as a result of their implication in widespread impacts to wildlife that became clear in the 1960's and 1970s. Organophosphates and carbamates are two other classes of pesticide that are still commonly used and are known to be highly toxic to some animals, including birds. These two classes of pesticide, while acutely toxic to animals, do not persist in environment to the degree that organochlorines do. A total of 255 incidents of raptor mortality involving pesticides were reported in the U.S. between 1985 and 1995 resulting in the death of 734 raptors (Mineau *et al.* 1999). Most of these incidents involved the use of organophosphates or carbamates and approximately 50% of these raptor kills occurred as a result of applications in accordance with labeled instructions. The following is a list of pesticides that have been documented to have significant impacts to birds. This list is not exhaustive and any other organophospate or carbamate pesticides should also be considered highly toxic since they all have similar impacts when ingested by birds. Also, many of these compounds are

frequently sold under a brand name and so the active ingredients of pesticides to be used should be reviewed to determine if they include one of the following.

Carbamates: Carbofuran, Oxamyl, Aldicarb, Methiocarb

Organophosphates: Chlorpyrifos, Diazinon, Dicrotophos,Dimethoate, Disulfoton, Ethoprop, Famphur, Fenamiphos, Fensulfothion, Fenthion, Fonofos, Malathion, Methamidiphos, Monocrotophos, Parathion, Phorate, Phosphamidon, and Terbufos

Organochlorines: Endosulfan

Other: Brodifacoum (anti-coagulant rodenticide)

Most of these compounds are used as insecticides during insect outbreaks that have the potential to cause considerable crop damage. Since many birds, including Swainson's hawks, consume insects as a major portion of their diet, widespread applications of insecticides poses a significant threat. The impact of insecticide applications can be either indirect or direct. Swainson's hawks and other predators are indirectly exposed when they consume freshly sprayed insects. Also, small mammals and birds are known to occasionally consume granular insecticides such as carbofuran when they mistake it for grit that they naturally consume and there have been documented cases of small birds drinking irrigation water treated with carbofuran from drip irrigation lines in vineyards. The small mammals and birds can then be captured or scavenged, resulting in secondary poisoning of various predators like Swainson's hawks (Mineau *et al.* 1999). Direct exposure occurs when Swainson's hawks and other birds of prey are sprayed themselves. This happens when they follow farm equipment so that they can forage on small mammals and insects that are flushed as the equipment moves through the field.

In the case of Swainson's hawks, the timing of applications is an important consideration for the likelihood of causing impacts. This is because Swainson's hawks vary their diet during the year, feeding on small rodents while breeding and insects later in the summer and fall, prior to migration south.

Most herbicides and fungicides are not acutely toxic to birds and mammals.

Pesticide Usage in Solano County

A total of 1,118,160 pounds of pesticides were applied in Solano County in 2001 and the majority of these were used for agricultural purposes. Most of the pesticides used are not documented to be highly toxic to animals and many are utilized in areas where the potential for exposure to non-target wildlife is low. The potential impacts to Swainson's hawks in particular, are dependent on the pesticides used, the location of applications relative to Swainson's hawk foraging areas, and the timing of applications.

The following lists the pesticides that are known to be highly toxic for birds and that were used on crops in Solano County that are frequently used for foraging by Swainson's hawks. This list of crops and pesticides is not exhaustive.

Alfalfa: carbofuran, dimethoate, malathion, and chlorpyrifos.
Beans: dimethoate and methomyl.
Corn: carbaryl, chlorpyrifos, methomyl, and methyl parathion.
Cucumber: carbaryl and methomyl.
Melons: diazinon
Sugar beets: carbaryl, chlorpyrifos, diazinon, dimethoate, and methamidophos.
Tomatoes: carbaryl, diazinon, dimethoate, methamidophos, and methomyl.

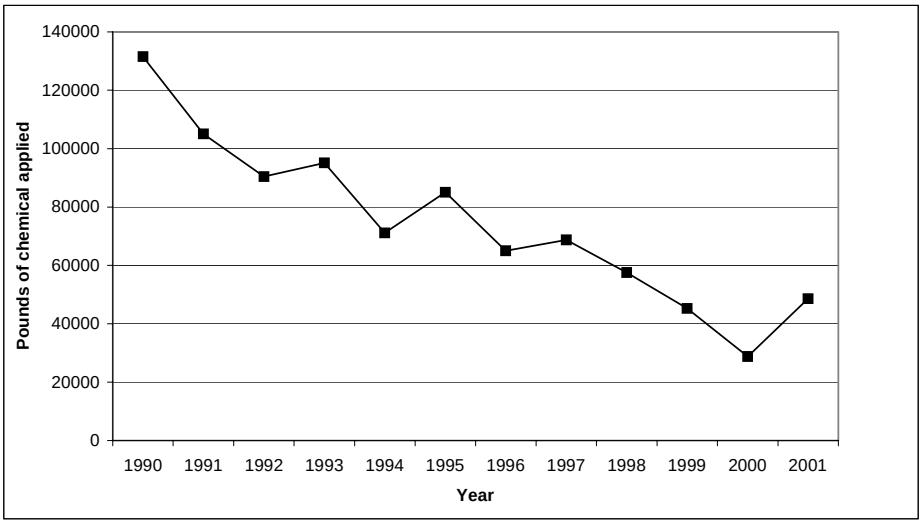
Chlorpyrifos, dimethoate, diazinon, methomyl, and carbaryl were among the top 50 pesticides used in Solano County in 2001 in terms of total quantity applied. Out of the total quantity of pesticides applied, approximately 48,600 pounds (4.3%) were either organophosphates or carbamates. This is a relatively low percentage, however, a disproportionate quantity of these classes of pesticides were applied to agricultural crops that are suitable foraging habitat for Swainson's hawks. Approximately 35% of the total organophosphate and carbamate pesticides used were applied to alfalfa and field crops that are important foraging habitat. Fortunately, the use of these classes of pesticides has declined in Solano County. Their application between 1990 and 2001 varied, but has steadily declined in that time (Figure 4).

Tables 3 lists the pesticides that are considered to result the most poisoning events.

Potential Pesticide Impacts to Swainson's Hawks

The potential for Swainson's hawks to be directly or indirectly poisoned by pesticides is dependent on the crop, the target pest, and the time of year. Swainson=s hawks typically arrive on the breeding grounds in central California in late March through early April and begin laying eggs by early April. The nesting season - up until young birds fledge - lasts until approximately August 15.

Figure 4. Organophospate and Carbamate Use in Solano County, 1990 – 2001



(Based on reported figures from the California Department of Pesticide Regulation, 2003)

Following fledging, juvenile birds and adults form flocks and forage extensively from late August through early September in preparation for migration to their southern wintering grounds. Most birds are gone (including those migrating through from the north) by early October.

The timing of pesticide use within the breeding season is important because Swainson's hawks change their diet after the young fledge. Swainson=s hawk diet during the breeding season in central California consists mostly of rodents (57%) and birds (25%), with insects only making up about 14% of their diet. This changes once the young have fledged and flocks are preparing for migration. During this time (August 15 - October 1), Swainson=s hawks feed largely on insects, mostly grasshoppers, to fatten up for migration. Insects will constitute as much as 95% of their diet at this stage and they will eat as many as 100 grasshoppers per day (England *et al.* 1997). As a result, the application of insecticides in the late summer and early fall is most likely to cause secondary poisoning due to Swainson's hawks eating insects that have been sprayed. However, it is important to note that Swainson's hawks have also been killed as a result of direct exposure to pesticides. Swainson's hawks are well known for following farming equipment through the field to prey on exposed prey, at which time they may be sprayed directly by a pesticide rig. So, the application of pesticides to control pests that are not an important part of the Swainson's hawks diet at the time can also result in significant impacts.

Table 3. Leading Pesticides Causing Avian Mortality In the United States

Active ingredient	Number of avian incidents in EIIS		Aggregate number of carcasses	Uses associated with majority of Incidents
	total	probable		
cabofuran	352	241	12,341	grapes, corn, alfalfa (most granular uses cancelled in 1991)
diazinon	267	165	4,434	lawns and turf (golf courses canceled in 1989)
chlordane	70			termiticide (use canceled in 1987)
fenthion***	58	47	5,545	avicide use, mosquito control
chlorpyrifos	57	37		termiticide, lawn and turf
brodifacoum	47**	47		rodent control
parathion	45		2,457	small grains, sunflower, alfalfa
famphur	31			livestock
Total	**927**			

Source: Adapted from American Bird Conservancy Pesticides website. Data collected from Ecological Incident Information System (EIIS)

* probably includes incidents that were convincingly linked to pesticide use and not linked to pesticide misuse.
** total includes recently received incidents not yet entered into EIIS.
*** avicide use voluntarily canceled on 3/1/1999. Aerial adult mosquito spray uses continue.

With the exception of chlordane, fenthion and most uses of granular carbofuran (which were canceled in 1987, 1999, and 1991 respectively), all of the pesticides listed above are still registered and used in the same manner that caused these incidents. The use of azinphos-methyl on sugarcane has all hut disappeared due to a prescription labeling mitigation program and the registration of effective alternatives.

RECOMMENDATIONS

Swainson's hawks are doing reasonably well in Solano County, with a substantial breeding population and reproductive success that is comparable to that observed in other populations within natural and agricultural settings. However, continued urban development, loss of trees, and the conversion to unsuitable agricultural crops threaten this population. Swainson's hawks habitually return to the same area (perhaps the same trees) to breed. As result, individuals may use marginal sites in the same area when better habitat is lost to development, resulting in reduced reproductive success and, ultimately, population declines. In addition, Swainson's hawks are especially susceptible to impacts from the application of pesticides because they frequently forage in and nest in agricultural fields.

The following measures are recommended in order to protect the Swainson's hawk population in Solano County and also apply to other regions, particularly other areas within the Central Valley.

Habitat Protection

1. Protect existing oak savannah and riparian habitats that provide suitable nest trees and foraging habitats for Swainson's hawks.

2. Within agricultural areas, maintain a mix of suitable crops that provide good foraging habitat for Swainson's hawks. In particular, establish agricultural easements that protect a mix of alfalfa fields, dryland pasture, fallow fields, and certain row crops since all of these provide valuable foraging habitat for Swainson's hawks. In those areas where Swainson's hawks traditionally nest, minimize the conversion of agricultural land to vineyards, orchards, and urban development. Maintaining a mix of crops will also ensure that different prey are available at different times of year as prey populations fluctuate and/or become more accessible following harvest cycles.

3. Protect existing nest trees from removal. In cases where trees will be removed, ensure that new trees are planted in as nearby a location as possible to compensate for this loss. New trees should be planted in areas that are surrounded by suitable foraging habitat.

4. Avoid disturbance of nest sites. Swainson's hawks often become habituated to regular patterns of disturbance, such as cars along a road near a nest. However, unusual disturbance can result in nest abandonment. This is especially true during initial nest building, egg laying, and early incubation.

Pesticide Impacts

Protection of Swainson=s hawks can be greatly increased by employing best management practices in pest control operations. These would largely consist of modifying the timing of pesticide applications as follows:

- Avoid or minimize use of rodenticides between April 1 and August 15
- Avoid or minimize use of insecticides between August 1 and October 1

In addition, the use of less toxic alternatives should be encouraged and incentive-based systems to cover the costs of more costly alternatives could be implemented. Organophosphate and carbamate insecticides are particularly toxic to birds and their use should be avoided whenever possible. Natural and synthetic pyrethroid pesticides are registered for many of the same pests as organophosphates and carbamates and are generally far less acutely toxic to birds and mammals. (Note: many of them are highly toxic to fish, amphibians, and insects and these impacts should also be taken into account; also recent studies have indicated concern for potential biolaccumulation in certain bird species). Using a combination of pyrethroid compounds for pest control has been found to be very effective in many cases, depending on the degree of infestation and the target pest. In addition, a relatively new class of pesticides, neo-nicatinoids, are being developed and used in limited areas and these are reportably also less toxic to birds and mammals. Neo-nicatinoids are relatively new and typically more expensive, but they have been found to be extremely target specific and effective.

Use of rodenticides should follow practices designed to prevent secondary poisoning of raptors, including use of mechanical traps near nests and in foraging areas, and surveying for and disposing of poisoned rodents that are found on the surface.

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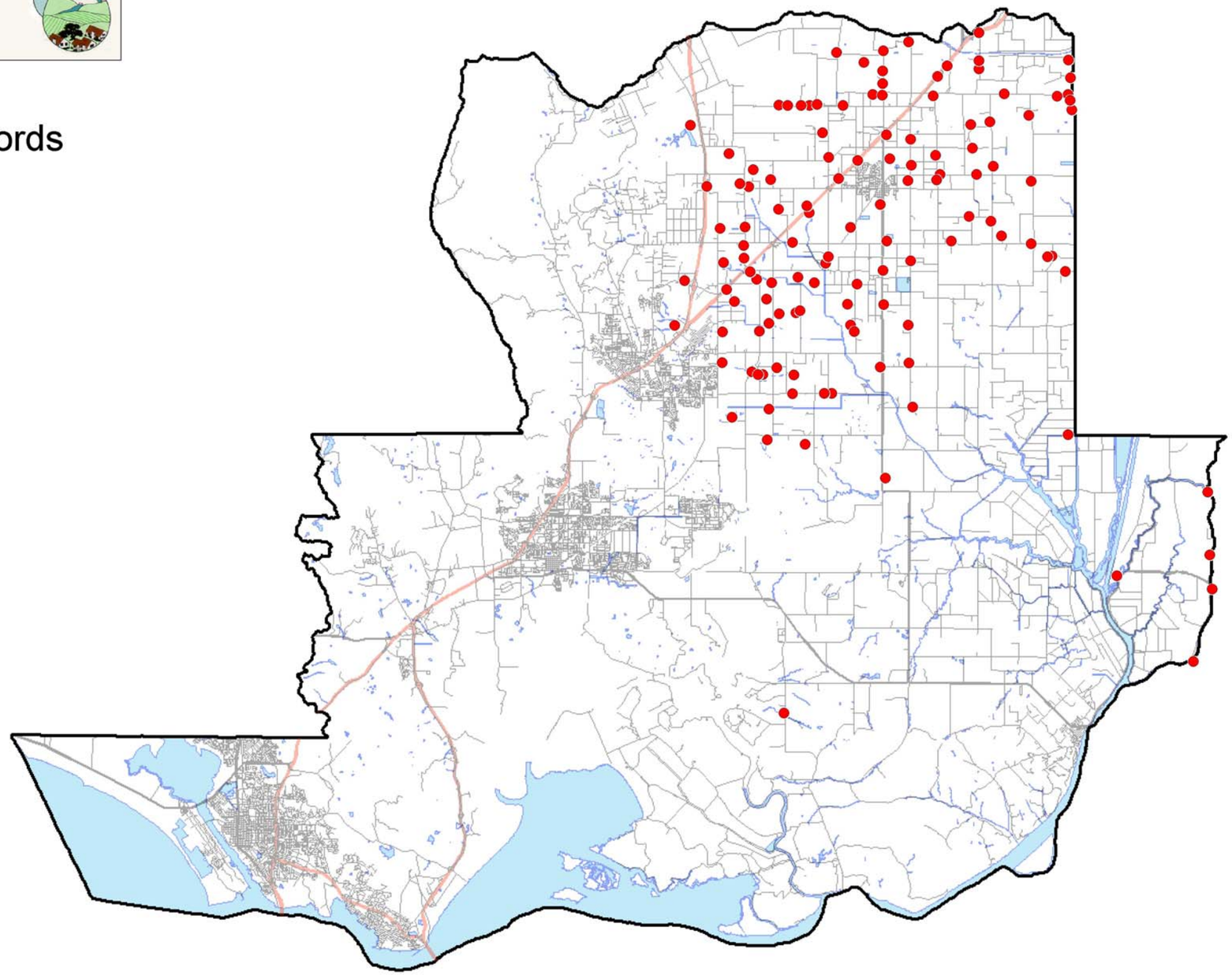
Figure 1
All Swainson's Hawk Records



N

0 1 2 4 6 8 Miles

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Figure 2
Estimated Swainson's Hawk
Nesting Population

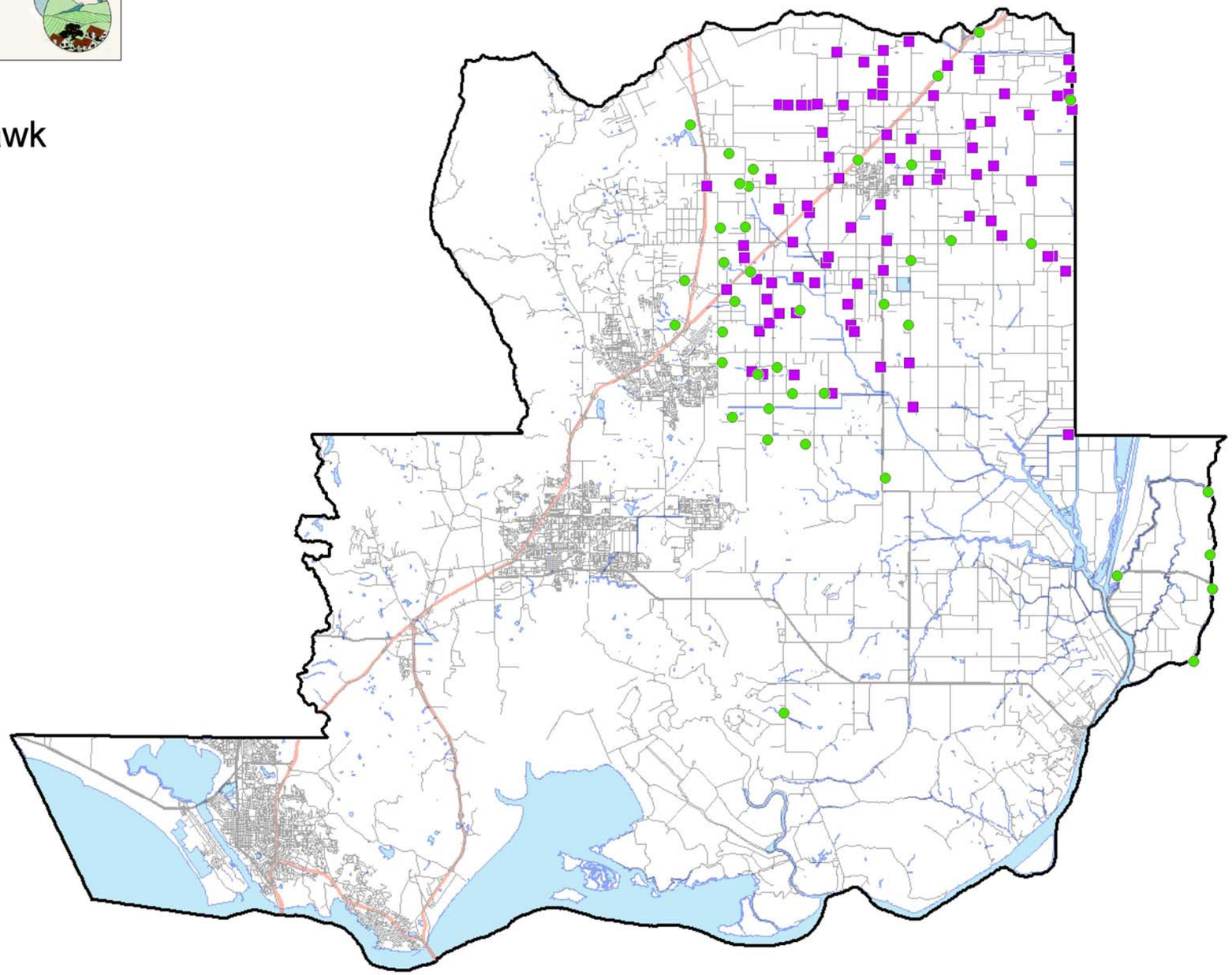

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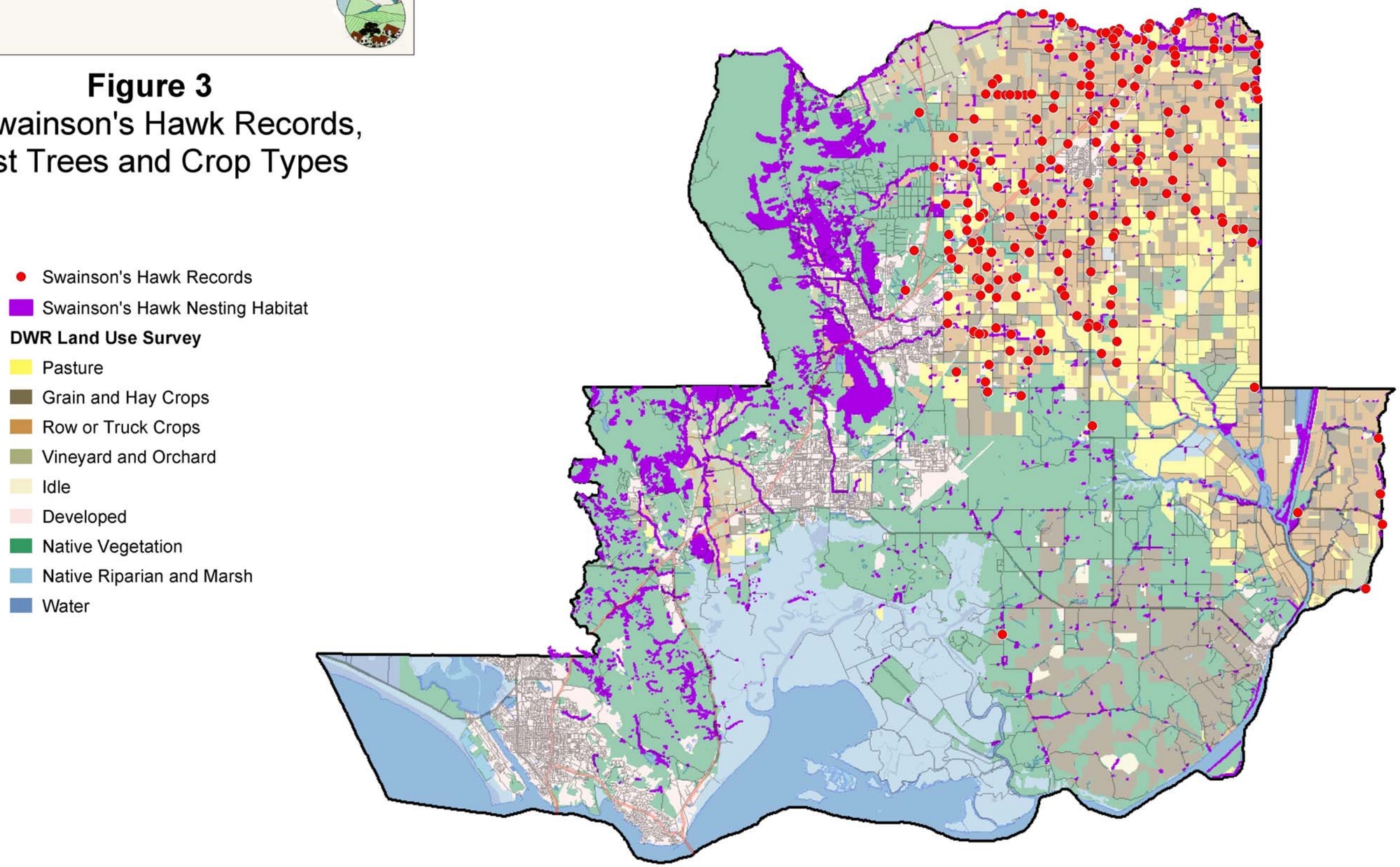
Figure 3
All Swainson's Hawk Records, Nest Trees and Crop Types



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