California Partners in Flight Riparian Bird Conservation Plan

Swainson's Hawk (*Buteo swainsoni*)

Photo by James Gallagher, Sea and Sage Audubon

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RECOMMENDED CITATION

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SHORTCUTS

range map

references

SPECIES STATUS:

The Swainson's Hawk occurs as a breeding species in open habitats throughout much of the western United States and Canada, and in northern Mexico. In California, breeding populations of Swainson's Hawks occur in desert, shrubsteppe, grassland and agricultural habitats, however the overwhelming majority of the state's breeding sites are in two disjunct populations in the Great Basin and Central Valley. **The Swainson's hawk is not an obligate riparian species; it's relationship with riparian habitats is variable and largely dependant on the availability and distribution of suitable nesting trees in proximity to high-quality foraging habitats. In the Central Valley, nest sites are strongly associated with riparian forest vegetation, whereas in the Great Basin nest sites are widely distributed in upland habitats. The primary habitat requisite provided by riparian systems is nesting substrate, typically large trees.**

MANAGEMENT STATUS: Threatened, California Department of Fish and Game

DISTRIBUTION

HISTORICAL BREEDING DISTRIBUTION

Bloom (1980) reviewed historical records and egg collections to estimate the historical distribution of Swainson's Hawks in California, and found that the current range of this species has been reduced dramatically. Historical records indicate the existence of breeding populations (or at least scattered nest sites) in most of California's bioregions, including the Southern Transverse Ranges, Central Coast Ranges, Central Valley, Great Basin, and Mojave-Colorado Desert. Swainson's Hawks occupied large grassland and shrubsteppe habitats, as well as canyons, foothills, and smaller interior valleys in otherwise mountainous regions. Few historical records exist for bioregions dominated by mountainous, forested terrain (North Sierra Nevada-Cascade Range, North Coast-Klamath Mountains, and Southern Sierra Nevada-White Mountains) that would not typically be considered suitable habitat. However, within these regions some small populations were documented in unforested habitats such as Owens Valley, Shasta Valley, and grassy foothills in Sonoma County. Unfortunately, historical records typically describe single nest sites, and rarely support conclusions about the size of local populations. Bloom (1980) addressed this problem by extrapolating known densities per area of suitable habitat to larger unsurveyed areas. Using this method, he estimated a total statewide population of 4,284 to 17,136 pairs.

CURRENT BREEDING DISTRIBUTION

Swainson's Hawks are locally common to rare breeders in California, with the majority of known territories located in the Central Valley and Great Basin bioregions. The largest population in the state is located in the midsection of the Central Valley in the area between Sacramento and Modesto, and in the northern San Joaquin Valley. Estimates of the size of the Central Valley population vary from 280 (Bloom 1980) to 420 (CDFG 1988); however recent surveys have increased this estimate to as high as 1000 pairs (Estep pers. comm).

ECOLOGY

AVERAGE TERRITORY SIZE

Swainson's Hawks are a highly mobile, wide-ranging species with large home ranges. Home range size is highly variable, and affected by a number of factors including distribution and juxtaposition of nesting habitat and high-quality foraging habitat, amount of foraging habitat, and temporal fluctuations in availability of prey (Bechard 1982, Estep 1989, Woodbridge 1991). Based on radio telemetry studies, the size of home ranges

varies from 69 to 8,718 hectares (Table 1); this wide variation makes estimation of average home range size somewhat meaningless. However, variation in home range size within study areas was often attributable to habitat quality and nest site distribution. In California's Central Valley, home range sizes were dependant on the distance to foraging sites, which in turn was dependant on the distribution of high-quality foraging habitat such as alfalfa fields, and crop mowing or harvesting schedules. In general, nest sites in riparian forest habitat in close proximity to alfalfa or recently-harvested row crops corresponded to smaller home ranges (Estep 1989). Similar relationships were found in studies in upland habitats and agricultural areas without riparian nesting habitat.

Table 1. Home range sizes of Swainson's Hawks in various habitats in the western United States.

Location	***n***	**Home Range (ha)**	**Nesting/ Foraging Habitat**	**Source**
Central Valley, CA	12	2,760 - 2,553 (336-8,718)	Riparian/ Agriculture	Estep 1989
Central Valley, CA	5	4,038 - 2,663 (724-7,659)	Riparian/ Agriculture	Babcock 1995
NE California	12	(69-2,884)	Upland/ Agriculture, steppe	Woodbridge 1991
SE Washington	8	621 - 214 (263-2,032)	Upland/ Agriculture	Fitzner 1978
SE Washington	5	886 - 243 (602-1,282)	Upland/ Agriculture	Bechard 1982
SE Colorado	8	2,429 - 1,050 (680-4,130)	Upland/ Grassland	Andersen 1995

TIME OF OCCURRENCE AND SEASONAL MOVEMENTS

With rare exceptions, Swainson's Hawks are complete migrants, breeding in North America and wintering in the pampas of southern South America; a round trip journey of over 20,000 km. Data from recent studies employing satellite telemetry have greatly improved our knowledge of timing, migratory routes, and destination of migration. Regional differences exist in the timing of migration. In NE California, Swainson's hawks arrive at nesting areas in early to mid-April and begin to depart in early September, with a few individuals remaining on territory in early October (Woodbridge unpub.). In the Central Valley, Swainson's hawks arrive in late February and early March, 4-6 weeks earlier than at sites <350km away in NE California. Early arrival dates of Central Valley hawks are likely related to their shorter migration distance to wintering sites in Mexico (Bradbury unpub.). Throughout the remainder of the hawk's range in North America, arrival on southern breeding areas (Arizona, Texas) occurs in late March - early April, extending into late April and early May to the north in Alberta and Saskatchewan (England et al. 1997).

MIGRATION STOPOVER CHARACTERISTICS

Migration stopover sites may be characterized into two categories; night roosts and prolonged stopover sites. Night roosts described in Mexico, Costa Rica (Woodbridge unpub.), Panama, (Smith 1980), and Colombia (Bildstein et al. 1993) were located on forested hillsides or (in coastal Mexico) riparian gallery forest (J. Montejo-Diaz pers. comm.).

Prolonged stopover sites are used by flocks of Swainson's hawks for longer periods of time, from a few days to weeks. Although in general the migration through Central and South America is very rapid, data from satellite telemetry reveal a small number of specific locations where radio-marked hawks settled. Two important areas identified in 1995 and 1996 are the agricultural plain south of Lago de Nicaragua in

Nicaragua, and the valley of the Beni River in southern Bolivia. At these locations, radio-tracked hawks stopped for periods of several days to over a week.

FOOD HABITS

FORAGING STRATEGY

Swainson's Hawks are morphologically adapted for aerial foraging, and spend a large proportion of foraging time soaring, or coursing over open habitats. Over much of range often hunts from perches such as power poles and fenceposts, although this is rarely observed in the Central Valley of California (Estep pers. comm.). During the breeding season, Swainson's Hawks travel long distances (up to 29km) in search of habitats with abundant prey (Estep 1989, Woodbridge 1991). In agricultural habitats, foraging activity is closely associated with harvest or cultivation activities that expose prey to aerial predation (ibid.).

DIET

Diets of Swainson's Hawks differ markedly between the breeding and nonbreeding periods. Over most of the species' range, breeding Swainson's Hawks show a strong dependence on ground squirrels, voles, or other abundant small mammal prey. Territory density appears to be positively associated with the availability of specific regional prey such as Richardson's ground squirrel in w. Canada (Houston unpub.), montane vole in NE California (Woodbridge 1991), and California vole in central California (Estep 1989). Following the breeding season, this species shifts from small mammals to insects, especially grasshoppers and crickets.

Swainson's hawks in the Central Valley of California preyed on a wide variety of species, ranging from small mammals and birds to toads, crayfish and insects. About 45% of non-insect prey items taken were California voles, with pocket gophers, deer mice and other small mammals accounting for another 20%. Birds, most notably mourning doves, ring-necked pheasants, and meadowlarks, made up an additional 32% of prey items identified (Estep 1989). Insects comprised a large proportion of total individuals, but a negligible proportion of prey biomass during the breeding season. In NE California, montane voles and Belding's ground squirrels contributed over 70% of prey items identified by Woodbridge (1991). After the young fledge and begin to attain independence, diets begin to shift to insect prey. In NE California, pellets regurgitated by both adult and fledgling Swainson's Hawks in August consisted almost entirely of grasshopper (Dichroplus sp.) parts.

Although Swainson's Hawks prey on a wide variety of mammalian, avian and insect prey, annual reproductive success appears to be driven by availability of particular small mammal species. Many areas of apparently suitable' habitat support few Swainson's Hawks, suggesting that although small mammals may be abundant, they are not among the preferred or optimal species. An example of this is the situation in the northern Central Valley (Shasta and Tehama Counties), where well-distributed trees and open grassy habitats support extremely low densities of Swainson's Hawks (Detrich 1986). The (largely exotic) annual grassland habitats typical of this area support high densities of nocturnal Heteromyid rodents, and low densities of Microtines and pocket gophers preferred by Swainson's Hawks, relative to perennial grasslands and certain agricultural crops (Woodbridge 1991). Considering the close correlation between prey base and reproduction seen elsewhere in California (Estep 1989, Woodbridge 1991) this factor alone may explain the scarcity of Swainson's Hawks in the upper Central Valley. Restoration of riparian nest site' habitat alone will be unlikely to benefit Swainson's hawks in this situation.

DRINKING

Little information available. Swainson's hawks inhabit desert and dry shrubsteppe habitats where surface water is unavailable, suggesting that drinking water is not required for survival.

BREEDING HABITAT

Swainson's Hawks inhabit a wide variety of open habitats, ranging from prairie and shrubsteppe to desert and intensive agricultural systems. For the purposes of this Conservation Plan, habitat use in California, particularly riparian systems of the Central Valley, will be discussed.

Swainson's Hawks are a highly mobile, opportunistic species. Habitat use by breeding birds occurs at the landscape scale, rather than microsite as may be the case for many nesting songbirds. Placement of nests is dependant on proximity to foraging habitats that are entirely different from the vegetation selected for nest

sites. In Central California, about 85% of Swainson's hawk nests are within riparian forest or remnant riparian trees (Estep pers. comm.). However, the vast majority of home ranges consist of treeless agricultural lands used for foraging. The abundance and spatial distribution of riparian forest as well as high-quality foraging habitat such as fallow fields and alfalfa fields are both critical determinants of territory suitability. Presence and quality of riparian habitat alone cannot be used as an indicator of habitat quality for this species.

NEST SITE

Swainson's Hawks construct their nests in a wide variety of trees species, existing as riparian forest, remnant riparian trees, planted windbreaks, shade trees at residences and along roadsides, and solitary upland oaks. In the Great Basin area of northeastern California, expansion of western juniper into lowland habitats has created vast areas of potential nesting habitat where nesting was formerly limited to riparian willow habitats (Woodbridge 1991). In the Central Valley, trees most commonly used for nesting include Fremont's cottonwood *(Populus fremonti*), willows (*Salix* sp.), sycamores (*Platanus* sp.), valley oaks (*Quercus lobata*), and walnut (*Juglans* sp.). Introduced species such as *eucalyptus* sp., pines, and redwoods also are used occasionally.

Nests in the Central Valley are typically built in a semi-exposed position in the upper canopy or lateral branches of tall (mean ' 17.6m, SD'3.0m: Estep 1989) trees affording a panoramic view of the territory. Central Valley tree and nest heights are higher than any reported in the literature for other areas (Estep 1989). In the Butte Valley in northeastern California, nests are typically placed in western junipers from 4 to 10m tall, and occasionally in sagebrush plants 2.5 m tall (Woodbridge unpub.).

VEGETATION SURROUNDING THE NEST

Nest site selection by Swainson's Hawks does not appear to be strongly influenced by the characteristics of the vegetation immediately surrounding the nest tree. They will use trees in dense riparian forest, scattered trees, or solitary trees along roadsides or field edges, with understories of native shrubs, cultivated crops, or mowed lawns. There appears to be some selection for trees in small groups affording screening from the nest from disturbance, however many nests are in solitary trees (Estep 1989, Woodbridge 1991).

NEST TYPE

Swainson's Hawks construct open platform nests typical of Buteos. Materials commonly include sticks, plant parts such as sagebrush, Russian thistle, and other weeds (Fitzner 1980). In NE California, nests are frequently constructed largely of tumble-mustard (Symbrissum sp.) stems. Nest construction less dense than that of Red-tailed Hawk, nests often appear flimsy and do not persist overwinter. Nests are semi-exposed, typically built below the canopy and towards the outer ends of limbs. Occasionally nests in large shrubs in sagesteppe habitats (Woodbridge unpub.).

BREEDING BIOLOGY

TYPICAL BREEDING DENSITIES

Density of breeding territories is strongly affected by land use type and availability of nest trees. Agricultural habitats in Central California supported a mean of 30.23 pairs/100km^2 (range 21.39-39.31) (England et al. 1995, Estep 1989), similar high densities are reported in areas dominated by alfalfa production in NE California (36.8 pairs/100km^2; Woodbridge 1991). In NE California, lower densities are associated with areas of irrigated pasture, weedy abandoned fields/ grains, wetlands, juniper woodland, and sagesteppe (2.3, 16.5, 1.9, 16.5 and 10.7 pairs/100km2, respectively) (Woodbridge 1991).

SOCIAL ORGANIZATION

Social behavior of Swainson's hawks differs markedly between the breeding and nonbreeding periods. During the breeding season, forms monogamous pairs (rarely polyandrous: Woodbridge unpub.) that defend large areas against conspecifics. Under conditions of limited or patchy nesting habitat, pairs may tolerate adjacent pairs as close as 60 m. (Estep 1989) to 0.4 km (Woodbridge 1991) away. In Central California, nonbreeding birds may form flocks of over 100 birds that forage and roost communally during the breeding season.

DISPLAYS

Courtship displays usually occur above or near nest site, and consist of circling by the pair, followed by steep dives by the male hawk. Dive may terminate in exaggerated ascent to an elevated perch (Woodbridge unpub.), or steep open-winged ascent to elevation of initial soar (Fitzner 1980).

MATING SYSTEM

Monogamous. Polyandry (2 males mated to same female) reported at small percentage of territories in NE California (Woodbridge unpub.); one territory supported a polyandrous breeding unit for 8 consecutive years.

CLUTCH SIZE

Typically 1-4 eggs (Brown and Amadon 1968). Clutches in NE California usually contained 2-3 eggs (Woodbridge 1991).

INCUBATION

The female performs nearly all incubation; relieved by the male during brief periods for feeding and stretching during the day.

INCUBATION PERIOD

34-35 days (Fitzner 1980)

DEVELOPMENT AT HATCHING

Altricial, nidicolous.

NESTLING PERIOD

Age at fledging is variable. Young may venture out onto branches at 27-33 days, and take first flight at 38-46 days (Fitzner 1980). May return to nest to be fed by parents or roost for up to 10 days following fledging. At some nests in NE California, smaller nestlings sometimes exhibited retarded development and fledged up to 13 days later than normal nestmates (Woodbridge unpub.).

PARENTAL CARE

Female performs most brooding and shading of nestlings, fed by male for first 2-3 weeks of nestling period.

POST-FLEDGING BIOLOGY OF OFFSPRING

Immediately after fledging, juveniles remain within the parental territory for 2-4 weeks and are dependant on adults for food (Fitzner 1980, Estep 1989). Length of post-fledging dependency period may be correlated with food supply; in agricultural areas juveniles may depart parental territories earlier and congregate at insect concentrations or agricultural harvest operations where food is abundant (Estep 1989, Woodbridge). Recently-fledged hawks in NE California were observed soaring in small groups, hawking grasshoppers in strong thermals (Woodbridge 1991).

POST-BREEDING SOCIAL BEHAVIOR

Post-breeding behavior of adult Swainson's Hawks is dependant on availability and distribution of prey resources. Following dispersal of young in late July and August, adults in NE California remained on their breeding territories until initiation of migration in September (Woodbridge 1991). Adults in central California began gathering in flocks and roosting communally as early as August, foraging on insects in recently disked fields (Estep pers. comm.).

DELAYED BREEDING

Not reported. One case of a extra bird (a helper) tending young at a nest was of a male in subadult plumage (Woodbridge unpub.). Unknown if extra birds at nests reported by Cash (1989) were polygamous or nonbreeding adults delaying breeding while cooperating with established pairs.

NUMBER OF BROODS

Typically one. Adults may (rarely) attempt to renest if first attempt fails early.

BROOD PARASITISM

None reported

LANDSCAPE FACTORS

ELEVATION

Nesting Swainson's Hawks occupy relatively level terrain to gently rolling hills, and typically avoid mountainous terrain or steep canyons. Elevation of occupied areas in California vary from nearly sea level in the Central Valley to 1500m in the Butte Valley.

FRAGMENTATION AND PATCH SIZE

Spatial characteristics of patches of nesting trees are relatively unimportant to Swainson's Hawks. Nest sites may be located in isolated trees, natural or planted groups of trees, or riparian gallery forest. Although this species typically does not occupy large tracts of forest or woodland, they may nest at margins where woodlands meet grassland or agricultural habitats (Woodbridge 1991, England et al. 1997).

DISTURBANCE

Nesting Swainson's Hawks are somewhat tolerant of human activity, particularly in areas where activity is regular and individual pairs are able to habituate to it. Nest sites are sometimes located near roads and houses, and frequently near field edges where crop cultivation activities regularly occur. However, changes in activity regime (construction in previously open areas, human intrusion at nest site) frequently causes nest abandonment, particularly during the pre-nesting, egg-laying, and incubation stages of the reproductive cycle (Bent 1937, Houston 1974, Estep 1989).

ADJACENT LAND USES

Swainson's Hawks occupy large home ranges that are primarily composed of foraging habitats. The amount and intensity of land uses within home ranges are the primary factors determining habitat quality (largely a function of prey abundance and availability) for a given territory or subpopulation (Table 2). In the Central Valley, most home ranges consist of agricultural crops, and often have insignificant area of nesting (trees) habitat (Estep 1989). The amount and distribution of different crop types and the small mammal populations associated with them, creates a shifting mosaic of foraging habitat in Central Valley landscapes. Estep (1989) found that each crop type supported a different level of prey abundance, and that the timing of tilling and harvest activities strongly affected the availability of prey within each crop type. Alfalfa fields exhibited low prey abundance but steady prey accessibility, whereas beet and tomato fields supported high prey density, but dense cover limited prey accessibility until harvest time when Swainson's hawks would forage almost exclusively in those crops. Fallow fields, dry land pasture, and irrigated pasture were also important foraging habitats. Vineyards, mature orchards, and cotton fields supported low prey populations or excessive vegetation density and were not used.

Table 2. Ranking of various habitats as foraging habitat for Swainson's hawks in California, based on studies in Central Valley (Estep 1989) and Great Basin (Woodbridge 1991).

vegetation type	rank	variability	factors influencing rank
perennial grassland	1,2	consistent - high	high prey - high availability
alfalfa	1,2	consistent - high	high prey - high availability

fallow fields	3,5	consistent - moderate	moderate prey - high avail.
dryland pasture	4	consistent - moderate	low prey - high availability
beets	4,5	variable - at harvest	mod. prey - high avail at harvest
tomatoes	5,6	variable - at harvest	mod. prey - high avail at harvest
weedy/ ruderal field	5-11	highly variable	moderate prey - avail. variable
irrigated pasture	7	consistent - low	very low prey - high avail.
shrub/ sage	7-12	highly variable	low prey - moderate availability
grains	8	consistent - low	low prey - low availability
other row crops	9-12	consistent - low	low prey - low availability
orchard/ vineyard	10-12	consistent - low	low prey - low availability

Under natural conditions, Swainson's Hawks likely foraged in upland and seasonally flooded perennial grasslands. These habitats are largely extirpated from the Central Valley today, replaced by annual grasslands with low prey populations, and agricultural crops. These changes have resulted in Swainson's hawks being dependant on landscape elements almost entirely controlled by human activities, with frequent shifts in agricultural practices and habitat quality.

CLIMATE

Annual variation in climate may have a dramatic effect on territory occupancy and reproductive success of Swainson's hawks. Direct effects caused by spring rains and windstorms include mortality of eggs and nestlings, and destruction of occupied nests (England et al. 1997). Widespread indirect effects are caused by climate's effects on prey abundance. In northeastern California, abundance of montane voles, a primary prey species, is strongly linked to winter precipitation and snow depth. Likewise, abundance of grasshoppers is negatively affected by heavy spring rains (Woodbridge 1991).

PESTICIDE USE

Until recently, speculation concerning the effects of pesticide use and other environmental contaminants on Swainson's Hawks were little supported by empirical data, and reports of direct mortality were limited to occasional individual hawks. Analyses of eggshell thinning and organochlorine residues in eggs suggested that this species was not adversely affected by organochlorine use (Henny and Kaiser 1979, Bechard 1981, White et al. 1989). Records from USFWS describe mortality events involving single birds to up to 40 birds killed by applications of organophosphate and carbamate insecticides in agricultural fields, particularly in fall when flocks feed on insects in harvested fields (Mineau unpub.).

Significant effects of pesticide use on Swainson's Hawks wintering in the pampas of Argentina were reported by Woodbridge et al. (1995) and Goldstein et al. (1997). Direct mortality of large numbers of hawks was attributed to poisoning by organophosphate insecticides monocrotophos and dimethoate used to control grasshopper outbreaks in sunflower, corn and alfalfa fields. In 1996, approximately 5,000 dead Swainson's Hawks were counted in La Pampa province, with an estimated total kill of 16,000 to 20,000 birds. Additional mortality events of lower magnitude were reported in 1997 and 1998. Farmer education programs and

restrictions on use of highly toxic organophosphate pesticides implemented by government and industry appear to have dramatically reduced the impacts of these compounds on wintering Swainson's Hawks, however continued monitoring will be required to assess the long-term effectiveness of these measures.

PREDATORS

Predation does not appear to be an influential factor affecting Swainson's Hawk populations. Great Horned Owls are the most commonly reported predator of nestlings and occasionally, adult hawks (England et al. 1997). Other predators (rarely reported) include coyotes, Golden Eagles, and bobcat (England et al. 1997). Swainson's Hawks exhibit highly aggressive nest defense, and are often able to drive off diurnal predation attempts by other raptors.

DEMOGRAPHY AND POPULATION TRENDS

DEMOGRAPHICS

Demographic processes do not appear to constitute a special factor in Swainson's Hawk conservation. Swainson's Hawks are long-lived (15-20 years), exhibit high breeding site fidelity, and are capable of producing 2-4 offspring/year if prey resources are adequate. Intensively monitored populations in northeastern California (Woodbridge et al. 1995) and the Central Valley (Estep unpub.) exhibit relatively high stability in the short-term (5-15 years), despite wide variation in annual reproductive success.

POPULATION TREND

Declines in Swainson's Hawk populations have been reported across much of the species' range, particularly in the Canadian prairies (England et al. 1997), California (Bloom 1980), Oregon (Littlefield et al. 1984), and Nevada (Herron et al. 1985). In California, Swainson's Hawks are currently absent from much of their historic breeding range in the central and southern portions of the state, and overall may have declined by as much as 90% (Bloom 1980). Current population trends in California are less clear. In the Butte Valley, the population has been stable at 65-80 pairs since the mid-1980's, however reproductive success has declined post-1992 (Woodbridge unpub.). During the same time period, the adjacent Klamath Basin population declined by approximately 90%; from 40 pairs to <5 pairs (Risebrough et al. 1989). Large numbers of Swainson's Hawks still occupy the Central Valley (est. 420-1,000 pairs), but annual losses of territories to residential development and riparian habitat removal, and agricultural intensification are reported (CDFG 1988, Estep 1989). Conversely, Bloom (unpub.) reports apparent recolonization of historic habitats in Los Angeles Co. (Antelope Valley), and population increases in Owens valley, suggesting that the species' populations can respond to improved habitat conditions. Likewise, modest increases in small populations in Lassen Co. and the east side of the Sierra Nevada are likely linked to expansion of alfalfa cultivation (Bloom unpub.).

MANAGEMENT ISSUES AND OPTIONS

EXOTIC SPECIES INVASION/ENCROACHMENT

The primary effect of exotic species on Swainson's Hawks are reductions in prey availability in habitats dominated by weedy exotic plant species. In northeastern California, weedy ruderal fields and cheatgrass-dominated grazing lands supported low prey populations and received little use by foraging Swainson's Hawks (Woodbridge 1991); similar patterns were reported by Estep (1989) in the central Valley. Invasion by Russian thistle, cheatgrass and tumble-mustard (*Symbrissum* sp.) Also result in increased fire potential, further reducing cover of less fire-resistant native perennial grasses and shrubs.

The primary management issues currently facing Swainson's Hawks in California are:

1) loss of preferred nesting habitat in mature riparian forest.

2) loss or adverse modification of high-quality foraging habitat to development or conversion to incompatible crop types.

3) high mortality due to pesticide use on migration route and wintering areas.

Loss of nesting and foraging habitat is currently a contentious issue between conservationists and developers in the California's Central Valley. Although not an obligate riparian species, the availability of nesting habitat is strongly tied to the distribution of riparian forest or riparian trees in much of the Central Valley portion of the species' range in California (Bloom 1980, Estep 1989). Loss of small areas of remnant riparian forest within areas of highly suitable foraging habitat can result in permanent losses of Swainson's hawk territories. Similarly, loss of patches of high-quality foraging habitat to development or conversion to high-intensity crop types adjacent to riparian forest or other patches of trees may eliminate territories.

Current management strategies for Swainson's Hawks in the Central Valley are focused on mitigation of habitat losses at known hawk territories (CDFG Mitigation guidelines), and habitat conservation under the USFWS Habitat Conservation Planning (HCP) process. Under CDFG draft mitigation guidelines, losses of suitable foraging habitats within 10 miles of a Swainson's Hawk nest site must be mitigated by protection or creation of equally suitable foraging habitat elsewhere within the territory's 10-mile radius. The ratio of loss/replaced habitat changes from 1:1 within 1 mile of a nest, to 1:.5 over 5 miles from the nest. These guidelines have been thoroughly reviewed by the Swainson's Hawk Technical Advisory Committee (SWTAC), an independent group of agency and private biologists with experience with Swainson's Hawks. The SWTAC has pointed out several flaws in the guidelines, and has judged them to be inadequate to conserve or recover the species in the Central valley (Estep, pers. comm.). The guidelines generally allow for losses of foraging habitat to occur throughout the remaining area populated by the species, and do not consider the potential habitat needs of additional territories with population recovery. The guidelines also fail to consider the cumulative effects of agricultural intensification and conversion to incompatible crop types, which occur independantly from residential development. Development of "final" mitigation guidelines by CDFG has been in progress since 1993 and continues today.

Habitat Conservation Planning efforts under section 10 of the Endangered Species Act (Yolo County and Natomas Basin HCPs are examples) have been based primarily on the draft CDFG mitigation guidelines.

Potential loss of large numbers of Swainson's Hawks during the nonbreeding period in Latin America may, over time, affect the species' ability to respond to management of breeding habitat. Current efforts to reduce this source of mortality may result from international agreements among governments and industry to modify patterns of pesticide use, however these efforts are presently limited to Argentina and will require years of monitoring to determine their effectiveness. Assessment of the Mexican wintering grounds of the Central Valley Swainson's Hawk population is needed to determine if similar mortality effects are occurring there.

Management options for Swainson's Hawks in the Central Valley are strongly influenced by the pattern of land ownership in the areas supporting the majority of the remaining population. Over 95% of the known nest sites are on private lands and are vulnerable to changes in the agricultural environment and development (Estep 1989). Management of the two primary factors affecting Swainson's Hawk populations in the valley; availability of nest trees and suitable foraging habitat, must be integrated to optimize adjacency of these two elements.

Protection and Restoration of Riparian Habitats:

Although Swainson's Hawks will nest in trees located in upland areas, their strong association with riparian forests suggests that protection and restoration of these habitats may provide nesting habitat superior to other sources of trees such as roadsides and field margins. Landscape-level assessment of tree availability as well as distribution of suitable foraging habitat should allow identification of areas where trees are the primary limiting factor for the hawks. Many areas of the Central valley are devoid of trees and restoration of even small stretches of riparian forest can provide habitat and mitigate for losses elsewhere (Estep 1989). In particular, protection and restoration of riparian systems along smaller drainages such as Willow Slough (Woodland area) and Red Bridge Slough (Vernalis area) would provide numerous nesting opportunities for Swainson's Hawks. Conversely, restoration of riparian habitats surrounded by intensive monocultural agriculture systems (ex. Merced and southern San Joaquin Rivers) will be unlikely to improve habitat for Swainson's Hawks unless areas with compatible crop types are targeted.

Maintaining and Increasing Availability of Suitable Foraging Habitat:

Loss of agricultural lands to development is an issue that effects many aspects of local human and natural communities, and should be addressed with a broader approach than single-species protection. State and Federal incentives to maintain a diverse, productive agricultural community in highly productive areas such as the Central Valley, coupled with regional and local planning efforts, may be the only effective long-term

habitat conservation tool for Swainson's Hawks and other wide-ranging species. Provisions in the USDA Farm Bill currently contain Conservation Reserve Programs (CRP) that provide incentives for farmers to maintain fallow lands or grow specific crops for soil protection or waterfowl foraging habitats; these provisions may be valuable for conserving suitable foraging habitats in specified areas. However, the high value of land for development or intensive agriculture in many portions of the Central Valley will be difficult to compensate for with agricultural subsidies.

ASSOCIATED BIRD SPECIES

Bird species that occupy the mature tree and gallery forest component of riparian systems will also benefit from conservation or restoration of nesting habitat for Swainson's Hawk. Examples are Yellow-billed Cuckoo, Yellow-billed Magpie, Long-eared Owl, Great Horned Owl, Red-tailed Hawk, White-tailed Kite, Cooper's Hawk, Great Blue Heron, and Black-crowned Night Heron. An additional suite of grassland or open habitat-associated species such as Western Meadowlark, Northern Harrier, White-tailed Kite, Barn Owl and Short-eared Owl would benefit from management of high-quality foraging habitats such as perennial grasslands, alfalfa, fallow fields, and pastures.

HABITAT AND POPULATION OBJECTIVES

Establishing habitat and population objectives for the Swainson's Hawk in riparian-associated regions of California will be difficult. Population size, density per unit of suitable habitat, survival rates, and metapopulation structure are not well known outside of a few small intensive study areas. In addition, this species may be significantly affected by conditions outside of the breeding range (pesticide use, shooting) that mask the effects of breeding habitat conditions.

A logical starting point from which to establish population and habitat objectives is the Central Valley population (possibly metapopulation) where association with riparian habitats is greatest. Migratory patterns, overwintering areas, and relative isolation of breeding grounds all suggest that this area may support a distinct metapopulation with relatively limited interaction with other populations. A concerted effort to inventory this area for Swainson's Hawk territories and to map distributions of nesting and foraging habitat could form the basis for estimates of potential population size given differing levels of habitat restoration.

At a finer scale of resolution, habitat objectives could be established for smaller areas that currently support higher densities of territories. Assessment of current and projected availability of riparian forest habitat, and current territory distribution, would allow identification of high-priority areas for acquisition, protection, or restoration. Integration of spatial information on habitat and territory distribution presently maintained by CDFG, Army Corps of Engineers, USFWS, and Soil Conservation Service will be critical to the development of landscape-level plans for this wide-ranging species.

MONITORING METHODS AND RESEARCH NEEDS

Inventory and monitoring of Swainson's Hawks are facilitated by this species' large size and conspicuous nesting behavior. Roadside transects that permit investigation of a high proportion of the trees in a survey area are adequate for inventory of large areas. Large stick nests are readily visible in winter when trees are leafless; mapped potential nests can be revisited in spring to determine occupancy. Some riparian forest distant from roads may require survey from boats or canoe, or on foot. Annual site fidelity of this species is high, therefore annual visits to samples of previously-identified nest sites is effective for monitoring an inventoried area. Reproductive monitoring can be accomplished remotely with spotting scopes or binoculars.

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