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White-tailed Kite Movement and Nesting Patterns in an Agricultural Landscape

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Abstract – We examined patterns of white-tailed kite habitat use and nesting success in the agricultural landscape of the Sacramento Valley, California. Road surveys covering 320 km were conducted from 1990–93. The number of kites observed per km of transect decreased through the years. White-tailed kites preferred areas of natural vegetation, which constituted a small percentage of the landscape along the transect. Seasonal and local changes in land use also affected kite habitat use. Kites preferred rice stubble in spring as the few remaining fields were being tilled. A nest survey covering 625 km^2 was conducted in 1993. Nine of 22 nests successfully fledged young. Nesting habitat was characterized using Atlas™ Geographic Information System. Significant differences in land uses were found using 0.8 km radii around successful and failed nests. Successful nests contained more natural vegetation and more human development (abandoned farms, vacant lots, a cemetery), but none were in urban areas. Differences in land uses were not significant when radii were increased to 1.6 km around successful and failed nests. Forty-one percent ($N = 22$) of nests were located in riparian corridors, but only one of these nests was successful. The successful nests shared in common: adjacent low-lying medium density natural vegetation (>50 m × 30 m), water <1.5 km from nest, placement of nest on edge of the vegetation, nest located >100 m from roads.

Key words: white-tailed kites; Sacramento Valley California; Geographic Information System; habitat use analysis.

The white-tailed kite was nearly extinct in California early in this century. Whereas the successful recovery of the species has demonstrated its resilience in adapting to human-caused disturbances (Pruett-Jones *et al.* 1980), land uses within its range are always changing, and could present future threats to its existence.

The white-tailed kite is a small rodentivore raptor found in California, Arizona, southern Texas, and the Gulf Coast, with recent expansions occurring into Oregon and Washington (Eisenman 1971, Henny and Annear 1978, Harrington-Tweit 1980, Larson, 1980). In California the white-tailed kite is found in the Central Valley, the north coast of Del Norte County, and south to

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San Diego County (Fry 1966, Eisenman 1971, Pruett-Jones *et al.* 1980). Within its California range the kite is primarily non-migratory, inhabiting moist lowland areas, grasslands, and cultivated fields (Eisenman 1971, Warner and Rudd 1974, Pruett-Jones *et al.* 1980). The white-tailed kite's range in the Central Valley includes lands dominated by intensive agriculture with heavy use of pesticides.

The spatial scale of our research reflects the importance of conserving raptors as an assemblage, not as individual species, in a human-modified ecosystem. Conservation of the kite, and other raptors in California, depends on understanding how these raptors use the present landscape, especially those elements that are managed intensively. Land-use practices that stress wildlife species inhabiting agricultural landscapes include annual till, chemical use, introduction of exotic species (both plant and animal), and loss of natural habitat, especially riparian forests. Today, less than 8% of the original natural wetlands and riparian forests of the Sacramento Valley remain (Katibah 1984, Griggs 1993). Raptors must use agricultural lands for space and food resources, especially when densities are highest during annual migration (Bloom 1985, Smallwood *et al.* 1996).

In this paper, we incorporate results from a 4-yr road survey (1990–94) and a nesting success survey (1993). The goal of our research is to elucidate temporal and spatial patterns of white-tailed kite habitat use and nesting success in an agricultural landscape, as part of a study of the actions of multiple stresses on wildlife.

STUDY AREA AND METHODS

The study site (15–25 m elevation) was located in the southern portion of the Sacramento Valley 20 km west of Sacramento, California (Fig. 1). The climate of the region is mediterranean with annual precipitation averaging 43.5 cm (Koppen and Geiger 1954).

Road Survey

One of the authors (KSS) initiated wildlife surveys in January 1990 along a 58-km road transect through Sacramento Valley farmland. The white-tailed kite was added to the survey on 11 March 1990. The transect was enlarged in late 1990 to 200 km along a 320-km loop (Fig. 1). The survey was conducted from a car travelling 55 km hr^{-1} with one passenger who served as principal observer. The frequency of surveys varied from once per week to once per month. Observations of birds and mammals were tape-recorded, and included number, location, activity and association with a landscape element.

White-tailed kite observations were analyzed for association with landscape elements, using typical percentages of landscape elements along the transect

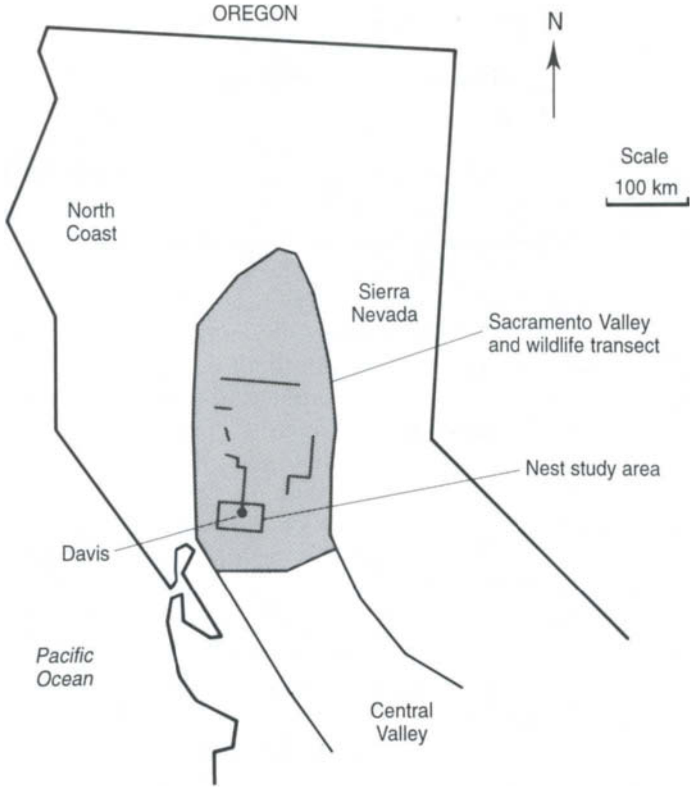

Figure 1. Locations of the white-tailed kite nesting study and wildlife survey in the Sacramento Valley, California.

during winter (November–February) and during spring (March–July). The majority of kite observations occurred in these two seasons.

A measure of association between kites and land-use elements was derived by dividing the land-use percentage value into the proportion of the wildlife observations that occurred on or above that landscape element. The resulting ratio is a measure of association, which is interpreted as the number of species *A* at landscape element *i* as a multiple of that to be expected by chance. The parameters of this ratio can be rearranged to equal the observed divided by expected values of χ^2 analysis (Smallwood 1993). Hence, the observed and expected values can be rearranged again to obtain a probability value for a χ^2 test. Landscape associations and number of observations were compared between cumulative distances of transect, years and seasons.

Nesting Habitat

Nesting white-tailed kites were studied in a 625-km^2 area surrounding Davis, California (38° 33′N, 121° 45′W), during the breeding season of 1993 (January–September).

Pairs of white-tailed kites were located during road surveys. Nest sites were located by observing breeding displays such as soaring, flutter flight, twig carrying, nest building and copulation (Palmer 1988). Courting pairs were first observed during late January. The last observed nesting pair was courting in mid-August.

Nesting pairs were monitored at least twice weekly to locate nests and to record the nesting stage (courtship, incubation, post-hatch). To minimize the risk of nest abandonment, we climbed to nests and measured habitat only after chicks hatched (Fyfe and Olendorff 1976). Pole-mounted mirrors were used for eight nests which were in the inaccessible top meter of the tree canopies.

Nest habitat land use was characterized within 0.8 and 1.6 km radii from the nest. Hawbecker (1940) reported that breeding male kites (which feed the females during incubation) rarely hunt more than 1 km from the nest. Our nest observations indicated that nesting kites frequently used hunting areas immediately adjacent to the nest (<0.5 km) and out to approximately 1.6 km of the nest. The immediate nest territory was the area where all aggressive interactions between white-tailed kites and other raptors occurred. Therefore, we generated both 0.8 and 1.6 km radii to include immediate nest surroundings and adjacent land uses which might affect nest success. Land-use maps, obtained from the California Department of Environmental Quality, were ground-truthed against current land uses (Division of Water Resources Sacramento, California). Subsequently, the maps were digitized into Atlas GIS™, a Geographic Information System (Strategic Mapping, Inc., Santa Clara, California). With Atlas GIS, 0.8 and 1.6 km radii buffers were generated around all nests (Fig. 2). A "buffer" is a circular area generated by the program around a central point (in this case the nest). Land-use variables analyzed within each buffer included field crops (sugar beet, safflower, corn, beans), grains (wheat, barley), natural and idle grass vegetation, riparian vegetation, pasture (alfalfa), tomato, water, human development (including rural homes, abandoned buildings, vacant lots, livestock facilities, cemeteries, cities, and highways), vineyard, and orchard. Areas of land uses and their diversities (Simpson's Diversity Index) were measured and compared within the 0.8 km and 1.6 km radii for differences between nest successes and failures using logistic regression and the Mann-Whitney Test (Afifi and Clark 1984, Daniel 1990).

RESULTS

Road Survey

The number of white-tailed kite observations per km during winter declined from 1990/91 to 1992/93 (Fig. 3). Nearly all winter-time observations of white-tailed kites were of single birds. Only 9 of 213 observations included 2 individuals. The numbers of kites observed during spring also declined, but not

Figure 2. A simplified GIS map demonstrating a 1.6 km "buffer" used to analyze land-use composition around a successful white-tailed kite nest. The legend displays selected land uses. Note the three failed nests which are in close proximity to each other and the successful nest on this riparian corridor. The closeness of these nests was atypical.

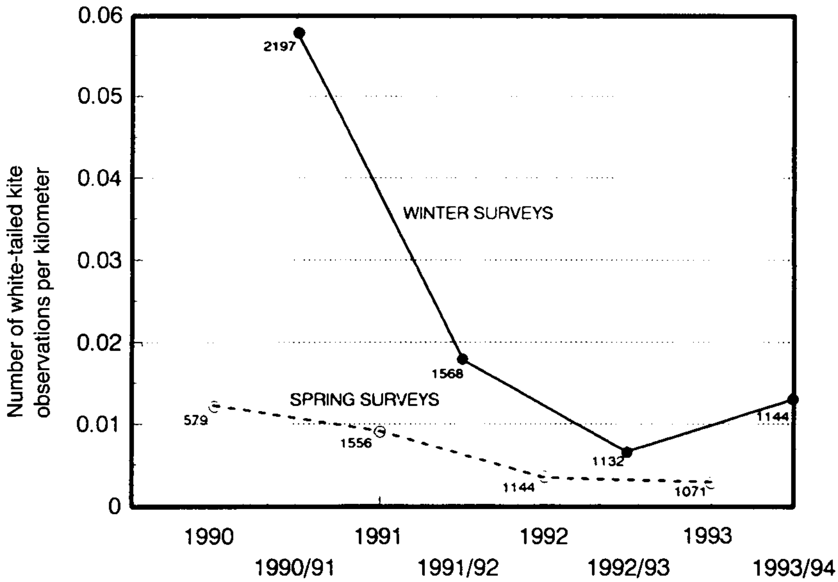

Figure 3. Winter- and spring-time trends in total number of white-tailed kite observations divided by the total distances of road survey in the Sacramento Valley from 1990–93. Cumulative survey distances are indicated at each data point.

as dramatically. The population of white-tailed kites was less concentrated during spring than during winter (Fig. 3).

Based on cumulative survey distance, use of the landscape was non-homogeneous during both seasons ($P < 0.001$ for all χ^2 tests, d.f. = 12, Fig. 4). For example, white-tailed kites occurred in sugarbeets 7.7 times more than expected by chance, which was the cumulative number of kite observations on the transect multiplied by 0.5%, the percentage of sugarbeets on the transect. White-tailed kites also preferentially used natural vegetation, which included riparian, wetland, and upland habitats. Land-use preferences changed with season. In spring kites maintained a strong preference for riparian habitat but increased preference for rice, alfalfa, dry pasture and orchards. Small areas of rice stubble, which have not been burned in the winter, are disked in early spring. Plowed fields, rural areas and irrigated pastures were avoided by kites throughout the survey.

The perch types used by white-tailed kites varied with season. Fewer white-tailed kites were seen on the ground during winter, and they avoided trees and utility poles during spring and fall ($\chi^2 = 18.2$, d.f. = 6, $P = 0.006$). Overall, 39 kites (19%) were on trees, 12 (6%) were observed on utility poles, 11 (5%) on the ground, three (1.4%) were on artificial hawk poles, and one (0.5%) on a cattail (*Typha* spp.).

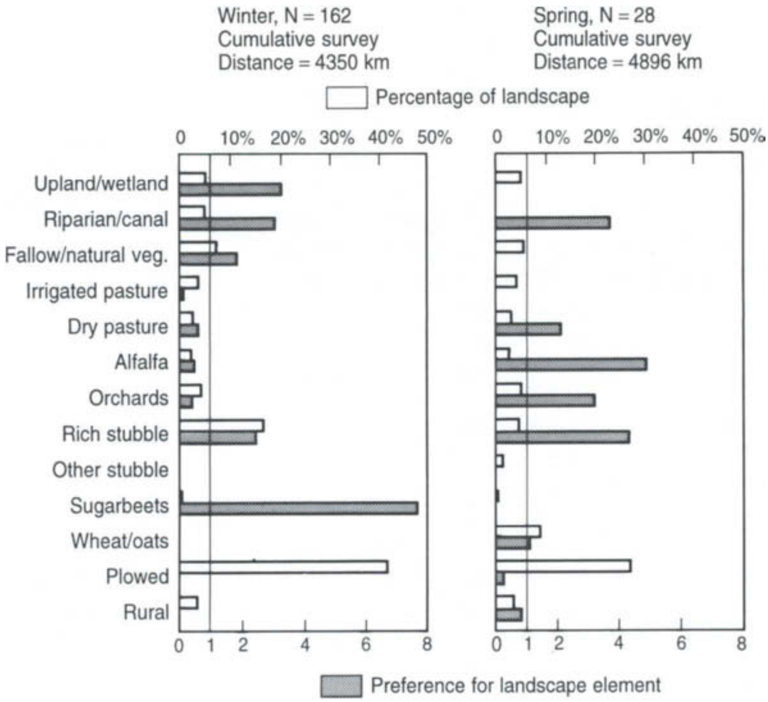

Figure 4. The character of the landscape along the survey transect and white-tailed kite preferences for landscape elements. The top horizontal axes correspond with incidence of landscape elements, and the lower axes correspond with the measure of ecological association, M_i, or selection "preference". The solid vertical lines at $M_i = 1.0$ correspond with the selection to be expected based on chance.

On road surveys 68% ($N = 128$) of sightings were of kites flying, with nearly half of these (34%, $N = 128$) being hovering flight. The proportion of kites seen hovering did not change with season ($\chi^2 = 3.28$, d.f. = 2, $P = 0.19$).

Nesting Habitat

Twenty-two nests were located within the 625-km^2 study area between late February and mid-September 1993. Nine of 22 pairs (40.9%) successfully fledged young. The 13 nest failures occurred prior to or during incubation by the female.

Six of the 13 white-tailed kite nest failures (46%) were due to displacement by Swainson's hawks in mid-March and early April. All of the kite nest territories displaced by Swainson's hawks were located along riparian corridors. Aggressive interactions, in which physical contact was made when white-tailed kites stooped on Swainson's hawks, were common. Red-tailed hawks and northern harriers and other kites were also chased by white-tailed kites in nesting territories. One kite nest was successful along a riparian corridor and was unusually close to three failed nests (Fig. 2). All were within a 1.6-km stretch of the riparian corridor. Two nests, within 1 km of each other, failed when one of the mates was killed. The remaining five nests (38%) failed for undetermined reasons.

Features common to successful nest sites were:

(1) nests were in rows (hedgerows between fields) or patches of trees (including riparian corridors, and unmanaged vegetation around buildings) overlooking low-lying natural vegetation, fallow fields, wet pasture and alfalfa;
(2) low-lying vegetation contiguous with the nest tree was at least 50 m × 30 m;
(3) nests were <1.5 km from water, whether man-made or natural;
(4) nests were >100 m from roads.

Eight failed nests (66%) located along riparian corridors shared the above characteristics. Five failed nests were in single trees ($N = 2$), in patches less than 50 m × 30 m, or >1.5 km from water.

Successful nests had more natural, fallow, and riparian vegetation as well as more human development within 0.8 km buffers than failed nests (One-sided Mann-Whitney $T = 77$, $P < 0.025$). The human development was characteristically low use, abandoned, or maintained private property. Analysis of 1.6 km buffers also showed that successful nests tended to have more natural vegetation, although not significantly so (Mann-Whitney $T = 70$, $0.10 > P > 0.05$). No significant differences were found between 0.8 and 1.6 km buffers using logistic regression.

Successful nests were distributed as follows: 2 in *Cupressacaea* spp.; 3 in *Quercus* spp.; 1 in *Eucalyptus* spp.; 1 in *Pinus* spp.; 1 in *Populus* spp.; and 1 in *Podocarpus* spp. Average nest height was 14 m, located within 1 m of the crown. Snags were consistently part of the nest tree or adjacent to the nest and were favored as perches by adults and offspring.

DISCUSSION

In their analysis of Christmas Bird Counts, Pruett-Jones *et al.* (1980) stated that it is "critical" to monitor California's white-tailed kite population. They noted that the kite population of the Central Valley, which was the center of California's kite population, had declined significantly since 1975 (Eisenman 1971, Larson 1980). Other than Christmas Bird Count analysis, there are few records of kite populations and historical nest locations in the Sacramento Valley.

The decreasing frequency of white-tailed kite observations along the survey transect probably indicates a decreasing population trend rather than a shift in location. The white-tailed kite population is probably decreasing in the Sacramento Valley as suggested by the decrease occurring on every stretch of the transect, which sampled populations in a large area of the valley. The population decrease might be attributed to land-use changes such as urban development of agricultural lands, loss of natural habitats, drought, prey cycles, and shifts in agricultural crops grown in the area. Competition between the white-tailed kite and Swainson's hawk and other tree nesting raptors is also a potential factor.

Seasonal changes in agricultural activities have direct impacts on white-tailed kites. Changing agricultural practices in the middle part of the century drastically increased rodent abundance and altered species composition, particularly in irrigated crops such as sugarbeets and alfalfa (Warner and Rudd 1974, Pruett-Jones *et al.* 1980). These changes in prey availability had a positive effect on recovering white-tailed kite populations (Stendell and Meyers 1973; Warner and Rudd 1974). The expansion of irrigation, along with federal and state protection, also assisted the kites' recovery (Eisenman 1971).

Association analysis values support findings of Stendell and Meyers (1973) and Warner and Rudd (1974) that kites selectively use sugarbeet and alfalfa crops. Rice stubble is another important foraging habitat for the white-tailed kite, especially in the spring. Most of the rice stubble is burned during the winter, and in spring, the remainder is plowed under. Subsequently, white-tailed kites begin to increase foraging in alfalfa and orchards.

The California vole is the primary prey of the white-tailed kite (Stendell and Meyers 1973, Mendelson and Jaksic 1989). This vole depends upon natural vegetation and standing water for breeding and dispersal (Stendell and Meyers 1973, Lidicker 1980). In general, California vole densities are low and their distribution is patchy in agricultural habitats (Ostfeld and Klosterman 1986, Estep 1989). In terms of agricultural crops, sugarbeets and alfalfa generally contain the highest densities of voles (Lidicker 1980, Ostfeld and Klosterman 1986, Estep 1989). The hunting success of white-tailed kites is directly proportional to the abundance and composition of prey species (Stendell and Meyers 1973, Warner and Rudd 1974). Therefore, it is likely that transect populations and habitat selection measurements reflect, in a large part, the abundance of California voles.

We found Atlas GIS to be a user-friendly, effective tool for analyzing the spatial use of habitat by kites. However, there were limitations. The land-use maps, which serve as templates for GIS-based analyses, are out-dated and lack resolution. Specifically, the land-use coverages do not show small fallow strips of vegetation between fields, or along roads. These linear elements are important hunting areas for raptors in the Sacramento Valley (Smallwood *et al.* 1996).

In general, our analyses of nesting habitats demonstrate that kites in the study area exploit a highly heterogeneous landscape and select nest territories that are in patches and corridors of natural vegetation amidst agricultural fields and human development. Analysis using the 0.8-km buffers produced significant results whereas the 1.6-km buffers did not. Successful nests had more natural vegetation and human development within 0.8 km of the nest than unsuccessful nests. This suggests that the immediate nesting habitat might be a more important factor for nest success than the larger breeding territory. Furthermore, the aggressive interactions between kites and Swainson's hawks occurred in the areas within 0.8 km of the nest.

Indeed, land-use analysis of kite nesting habitat is perhaps confounded by the loss of territories to Swainson's hawks, which strongly prefer riparian corridors. Therefore, the use of fallow developed areas by kites may be secondary if Swainson's hawks avoid these areas. The selection of riparian corridors, by 41% of the pairs, one of which was successful, implies that nest success is influenced by factors other than nest habitat availability. Additionally, 88% of the successful nests were located in varied classes of human development such as unmanaged vegetation adjacent to developed lands, rural homes, ranches, abandoned buildings, and construction sites (One tailed Mann-Whitney $T = 77$, $P < 0.025$). White-tailed kites might be able to adapt to the pressures of competition for primary nest sites, such as riparian corridors, if suitable alternatives are available. Still, the availability of alternatives is waning as urban development continues spreading across the Sacramento Valley. The habitats of two successful 1993 nests, that were located in urban coverages, are not available this year due to the commencement of construction and removal of existing trees and fallow vegetation.

In the 1993 breeding season, 41% of white-tailed kites in our study area (625 km^2) had one or more fledglings per pair. White-tailed kites occupied nesting territories from late January through late September 1993 and there is potential for kites to lay second clutches, or to establish a second nesting territory, if they fail in one location. However, we do not know whether failed breeding pairs renested. A telemetry study is underway to track changes in the nesting, hunting, and communal roosting habitats of a breeding pair of white-tailed kites. As of 1 May 1994 the pair had remained together within the 1.6 km buffer area along a riparian corridor throughout the winter, renested in the riparian area once, failed in late March (aggression by kites was frequently observed towards a pair Swainson's hawks <100 m to the west), and renested in riparian habitat within 0.2 km of the first nest. We found no references to past levels of reproductive success for local populations of this species.

Almost half of the failed nests were caused by kites losing nest territories to other hawks, namely Swainson's hawks. Swainson's hawks have also been documented to usurp the high-quality territories of red-tailed hawks (Janes 1994). At this time Swainson's hawks are threatened in California. Research on the Swainson's hawk is focusing on interspecific interactions for nest territories between tree-nesting raptors in the Central Valley (P. Moreno pers. comm.). The primary nesting and foraging habitats that remain in California for the Swainson's hawk are riparian corridors (Estep 1989, Risebrough *et al.* 1989). We propose that the same trend applies to white-tailed kites and that future studies will be necessary on the comparative habitat uses of both species.

The prey of the two species are similar as well. Swainson's hawks also prefer California voles and hunt in crops that are associated with vole abundance such as fallow fields, alfalfa, sugarbeet, and tomato fields. Estep (1989) reported that all Swainson's hawk nests were adjacent to primary foraging areas. It is possible that white-tailed kites and Swainson's hawks in our study area preferentially hunt the same prey and thus select very similar foraging and nesting territories.

Cooperative efforts between researchers and farmers are underway to create farm habitat for wildlife. Native grasses and trees have been planted along roadsides, ditches, and fields. In contrast, conventional farming practices involve maintaining roadsides, ditches, and field edges as bare dirt strips using herbicides (J. Anderson pers. comm.). This practice is expensive and provides no habitat for wildlife dispersal, hunting, or breeding.

The white-tailed kite, like the Swainson's hawk and other raptors inhabiting the Sacramento Valley, needs habitats which are rapidly disappearing from the landscape. Certainly the white-tailed kite has adapted in many ways to human-altered landscapes. It is unlikely, however, that its population will remain stable if riparian habitats, natural and fallow lands continue to be fragmented and developed.

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