Conceptual Habitat Suitability Index model for Swainson's hawk

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Habitat use information

The Swainson's hawk is a medium-sized buteo generally found in arid habitats throughout the western United States. In California, Swainson's hawks feed primarily on California voles and other small mammals (e.g., deer mice, pocket gophers, and ground squirrels), birds, and insects. Predominantly migratory, Swainson's hawks spend winter months (November to March) in South America. They return to their breeding grounds in March, and typically nest in large valley oaks or Freemont cottonwoods. Nests are frequently found near streams, perhaps because the larger cottonwood trees are mostly restricted to riparian habitats. Swainson's hawks are moderately tolerant of human disturbance, and occasionally nest in isolated trees, roadside trees, or near urban areas (Estep 1989). Swainson's hawks forage exclusively in open plains and grasslands, where visibility is good and reduced vegetative cover allows greater accessibility to prey (Bechard 1982). Estep (1989) reports Swainson's hawks use some agricultural lands, such as alfalfa cropland, and dry or fallow pasture.

Reasons for decline

The population decline in Swainson's hawks from historic levels is attributed to the loss of native nesting and foraging habitat, and changes in land uses from agricultural to urban. Although complex species-habitat relationships suggest many factors may contribute to a population decline, losses of suitable nesting trees within preferred riparian habitat may be the most important factor in the decline of Swainson's hawks in California (California Dept. of Fish & Game 1988).

Model applicability

This conceptual Habitat Suitability Index (HSI) model was developed for use in the Central Valley region of California and specifically in semi-urban and rural areas near Sacramento. In this region, Swainson's hawk habitat consists of large open areas with suitable foraging habitat associated with suitable nesting habitat. Suitable nesting habitat is comprised of mature riparian forest, single trees, oak groves, and mature roadside trees. Riparian forest habitats are critically important to Swainson's hawks successfully nesting in this area (California Dept. of Fish & Game 1988).

Season. This model will produce HSI values based upon foraging and nesting needs of Swainson's hawks in the Central Valley of California. In the Central Valley, Swainson's hawks are migratory, generally arriving in the area from early to mid March and departing from late August to October. Therefore, the HSI model is applicable during the period of residence (March to October) in California's Central Valley.

Cover types. Swainson's hawks depend on open cover types for foraging and the presence of larger trees near the foraging area for nesting. Suitable foraging habitats include cropland (alfalfa and other hay crops), grassland, lightly grazed pasture, old field, and other combinations of hay, grain, and row crops (Bechard 1982, Bloom 1980, Estep 1989). Unsuitable foraging habitats include crop types in which prey are less available due to vegetation structure (Bechard 1982), or vineyards, orchards, rice, and cotton which support low prey populations.

Minimum habitat area. Swainson's hawks may forage over an area of 15,000 acres. The average male home range is about 2300 acres (Bechard 1982), and the minimum foraging area necessary to meet the food requirements of a single nesting pair is between 2000 and 3000 acres. The California Department of Fish and Game mitigation guidelines require a minimum of 1280 contiguous or semi-contiguous acres of suitable habitat for Swainson's hawks. This model considers habitat to be unsuitable if less than 1280 acres of suitable foraging habitat is identified within a 10-mile radius of a suitable nest tree.

Model description

This conceptual model assumes that the requirements for reproduction and foraging may be adequately defined in terms of four variables. Suitable habitat is defined as the appropriate cover types with contiguous foraging areas with high density and available prey within 10 miles (16 km) of suitable nesting substrate. The presence of nesting trees within riparian forested habitat greatly enhances the suitability of the habitat for Swainson's hawks.

Variables

Prey density component (SIV_1). This corresponds to the population density of small mammals which comprise the major food base for Swainson's hawks. Of particular importance is California vole and valley pocket gopher but other small mammals, avians, and even some larger insects may serve as alternative prey for Swainson's hawks. Estep (1989) reports the following species as major prey for Swainson's hawks in California: California vole, valley pocket gopher, California ground squirrel, deer mouse, whitetail antelope squirrel, San Joaquin antelope squirrel, San Joaquin pocket mouse, western harvest mouse, Ring-necked pheasant, western meadowlark, mourning dove, grasshopper, and cricket.

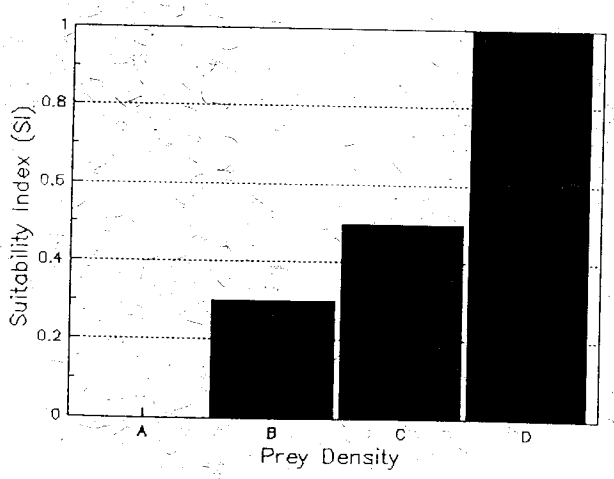

Figure 1. Prey density (SIV_1) – estimated density of rodent species.

Table 1. Prey density component (SIV_1).

Category	Description
A	**Zero density** - Pavement, disked field, or other unsuitable habitat.
B	**Low density** - Heavily grazed pasture, wheat, sunflower, corn, or irrigated pasture.
C	**Medium density** - Alfalfa, dryland pasture, and fallow field.
D	**High density** - Tomato, beet, and field edge.

Prey availability component (SIV2). This variable corresponds to the propensity of different cover types and different stages of cropping practices to provide various levels of success rates for Swainson's hawks to acquire prey. This follows Bechard (1982) and accounts for the amount of prey exposure in the cover type. The variable combines the height and density of the herbaceous cover as well as the temporal effects of the harvesting practices for agricultural crops. Based on these guidelines, prey availability follows the descending order listed below.

Prey available

- Native grassland
- Agricultural cropland (grain, hay, and row crops) – within four weeks of disking
- Alfalfa or other hay cropland
- Fallow field
- Lightly grazed native or cultivated pasture
- Hay, grain, or row crops
- Fallow field with some thistle
- Rice cropland before flooding or after draining
- Heavily grazed pasture

Prey unavailable

- Vineyards
- Mature orchards
- Flooded rice cropland
- Fallow fields with dense thistle
- Cropland with unharvested crops greater than 4 inches tall.

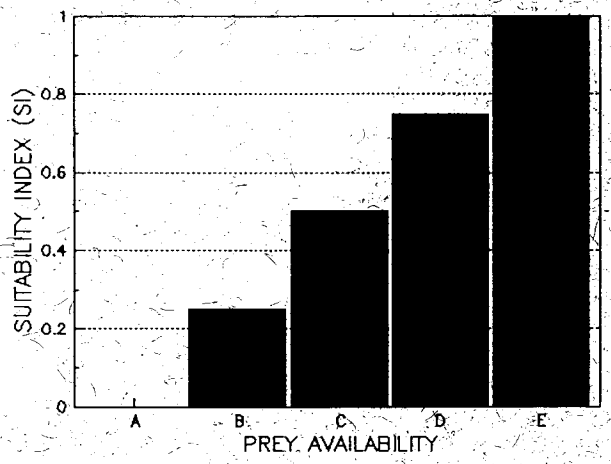

Figure 2. Prey availability (SIV_2) – estimated by the amount of cover in various habitat types.

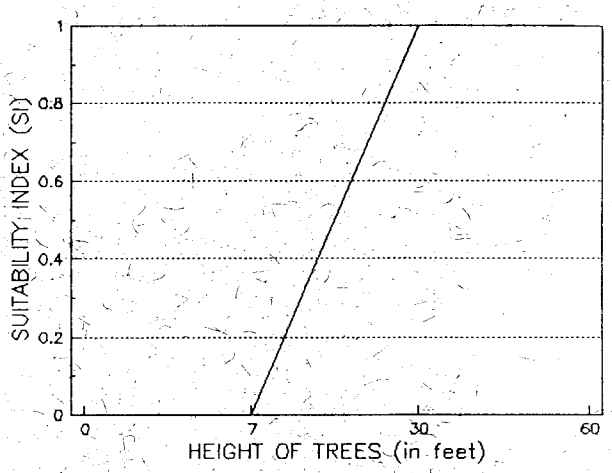

Figure 3. Nesting site component (SIV_3) – height (in feet) of trees. Species should be one of the preferred species.

Table 2. Prey availability component (SIV_2).

Category	Description
A	**Prey unavailable** - Lake, flooded rice, orchard, and vineyard.
B	**Some protection** - Fallow fields with dense vegetation, vegetation with extensive stands of bull thistle or shrubs.
C	**Escape cover** - Row crops, grain crops, or dry pasture.
D	**Sparse escape cover** - Alfalfa (early), fallow fields.
E	**No escape cover** - Native grassland and agricultural fields immediately after disking or during flooding.

Nesting site component (SIV_3). Reproductive success and forage site suitability are directly related to the presence of suitable nesting trees. Suitable nesting trees follow the general guidelines provided by Gilmer and Stewart (1984), and for the California Central Valley, are trees greater than 30 feet in height. Trees between 30 and 50 feet are preferred for nesting. In the Sacramento Valley, oak, Freemont's cottonwood, willow, sycamore, and walnut trees are used frequently by Swainson's hawks as nest trees.

Interspersion component (SIV_4). Suitable nesting sites must generally be within easy flying distance of suitable foraging habitat. This component recognizes that Swainson's hawks forage predominantly within 5 miles of the nest site. As prey availability decreases, the distance may increase but not above 18 miles. Foraging habitats more than 18 miles from a nest site are unavailable to Swainson's hawks during nesting season.

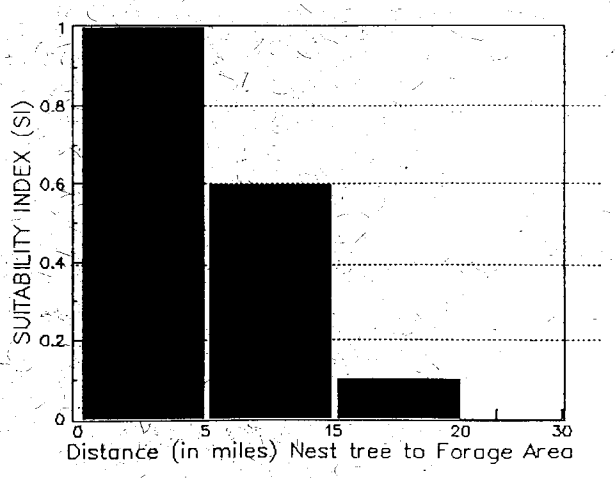

Figure 4. Interspersion component (SIV_4) – distance (in miles) between suitable foraging habitat and suitable nest trees within the study boundary.

Variable aggregation

The available literature indicates that prey density (SIV_1) and prey availability (SIV_2) collectively define the attributes of a foraging habitat. The presence of large nesting trees (SIV_4) within 10 miles of a foraging area (SIV_3) comprise the most important attributes of nesting habitat. As both variables must be present for acceptable foraging to occur, the life requisite suitability index for foraging ($LRSI_{foraging}$) is the geometric mean of SIV_1 and SIV_2.

$$LRSI_{foraging} = (SIV_1 * SIV_2)^{1/2}$$

Likewise, the life requisite suitability index for nesting ($LRSI_{nesting}$) is the geometric mean of SIV_3 and SIV_4.

$$LRSI_{nesting} = (SIV_3 * SIV_4)^{1/2}$$

The overall habitat suitability is the geometric mean of all four variables.

$$HSI = (SIV_1 * SIV_2 * SIV_3 * SIV_4)^{1/4}$$

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