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RED-SHOULDERED HAWK HOME-RANGE AND HABITAT USE IN SOUTHERN CALIFORNIA

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Abstract: Space and habitat use patterns of adult red-shouldered hawks (*Buteo lineatus elegans*) in southern California are relevant to land-use planning and the conservation of this species. Thus, we determined average home-range size through radio telemetry to aid such planning. Average home-range size was 1.21 km² for 7 males and 1.01 km² for 6 females. A non-territorial male floater used a home range 30 times larger than the mean of 7 other males. Core areas averaged 7.5% and 4% of home-range size for males and females, respectively. Red-shouldered hawks used 4 woodland habitats more than expected due to chance, and 4 non-woodland habitats less than expected; the overall pattern of habitat use was the same for both sexes. Home ranges in mesic riparian habitats were smaller than those in more xeric oak (*Quercus* spp.) woodlands. Two pairs of red-shouldered hawks showed a high degree of adaptability to human-altered habitats and human disturbance. A mosaic of habitats in an area encompassing ≥1.21 km² of predominantly woodland habitats appeared adequate for 1 pair of red-shouldered hawks in southern California.

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A practical challenge for conservation biology is to provide recommendations to planners on how land development can be adjusted to minimize impacts on a broad range of wildlife. One cost efficient approach is to identify and maintain the habitat needs of a single species whose spatial and ecological requirements are likely to encompass those of many other species. Raptors have been suggested as candidate species in this approach because they often use relatively large areas and are at the top of many food chains (Burnham et al. 1989, Bednarz et al. 1990).

The red-shouldered hawk is likely to be affected by land development occurring throughout its distribution, particularly in California. Riparian woodland, an important habitat of this hawk in California (Bent 1937), is now reduced to a fragment of its former extent (Katibah 1984). For example, the amount of riparian habitat in the Sacramento Valley decreased 98% from 1850 (331,765 ha) to 1977 (4,858 ha) (Smith 1977). Furthermore, riparian vegetation occurs on <1% of the western North American landscape, yet it provides habitats for more species of birds than all other vegetation types combined (Knopf et al. 1988). It is essential, therefore, that guidelines be developed for preserving as many of the critical wildlife elements of riparian woodlands as possible.

Studies of the western subspecies of the red-shouldered hawk are limited chiefly to its breeding biology (Dixon 1928, Wiley 1975, McCrary and Bloom 1984*a*), status and distribution (Cohen 1970, Wilbur 1973, Harlow and Bloom 1989), and mortality factors (McCrary and Bloom 1984*b*). Only McCrary (1981*b*) and Bloom (1989) attempted to identify space and habitat requirements of this subspecies. Habitat conditions near the nest have been described for the eastern subspecies (*B. l. lineatus*) (Campbell 1975, Bednarz and Dinsmore 1981, Titus and Mosher 1981, Morris and Lemon 1983). However, aside from a study of unmarked individuals (Craighead and Craighead 1956), a limited radio-telemetry study in Iowa (Bednarz and Dinsmore 1981), a detailed study of 2 males in Missouri (Parker 1986), and data on which this paper is based (McCrary 1981*b*, Bloom 1989), little is known of the space or foraging habitat needs of either subspecies.

Herein, we examine habitat and spatial use of red-shouldered hawks in southern California. Specifically, we ascertained home-range sizes of males and females, and quantified the differential use by red-shouldered hawks of habitats within their home ranges; we believe this information is essential to enlightened land-use planning.

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STUDY AREA

Our general study area encompassed approximately 1,400 km² of coastal foothills extending from the San Luis Rey River in San Diego County north to the Santa Ana River in Orange County. We studied nesting pairs of red-shouldered hawks on Rancho Mission Viejo (Orange County), 90 km southeast of Los Angeles, and Camp Pendleton Marine Corps Base (San Diego County), 20 km southeast of Rancho Mission Viejo.

Principal land uses of the more natural Rancho Mission Viejo study area included cattle ranching and farming, whereas the Camp Pendleton study area was 50% urban with considerable human activity. The Camp Pendleton study area also included a small artificial lake (Lake O'Neill) and the Santa Margarita River, which flowed through the nesting territories. The 2 areas were similar in topography and weather, with low rolling hills divided by intermittent streams and, rarely, a perennial creek or river. Elevation varied between 30 and 300 m. Weather was typically Mediterranean with the bulk of precipitation during winter, with a peak in February. Average annual rainfall was 35.5 cm (Bloom 1989).

We categorized habitats as woodland (oak woodland, sycamore woodland, willow riparian, and urban woodland) or non-woodland (riparian scrub, coastal sage scrub, grassland, and agriculture) communities. Utility poles, wires, and at least 1 paved road were present within the home ranges of 13 of the 18 hawks studied.

Oak woodland was characterized by mature coastal live oaks (*Quercus agrifolia*) with a closed canopy; groves were found in bottoms and on north slopes of most canyons. Occasional sycamores (*Platanus racemosa*) protruded above the oak canopy. Sycamore woodland was dominated by this species usually in close association with oaks. This woodland type occurred more frequently in mesic canyon bottoms than did oak woodlands. Willow riparian habitat consisted of dense deciduous woodlands composed of arroyo willow (*Salix lasiolepis*), black willow (*S. gooddingii*), and mulefat (*Baccharis glutinosa*), in close proximity to water. Urban woodland was dominated by exotic trees, shrubs, and grasses including *Eucalyptus* sp., *Pinus* sp., and *Pittosporum* sp. It also included numerous buildings, roads, parking lots, utility poles, and lamp posts. Riparian scrub was located in stream bottoms and consisted mainly of mulefat and young willows. Coastal sage scrub was found on exposed hillside areas with several species of drought tolerant shrubs predominating. These shrubs included coastal sagebrush (*Artemisia californica*), black sage (*Salvia mellifera*), California buckwheat (*Eriogonum fasciculatum*), and several species of *Rhus*. Plant nomenclature follows Munz and Keck (1968).

Non-native and native grasslands occurred on the 2 study areas with the former predominating. Non-native annual grasses, including ripgut grass (*Bromus diandrus*) and foxtail brome (*B. rubens*), were ubiquitous. Prominent plant species occurring in native grasslands included perennial needle grass (*Stipa pulchra*) and shooting star (*Dodecatheon clevelandii*). These grasslands were occasionally interspersed with islands of cacti (*Opuntia* spp.), coastal sage scrub, or oak trees.

METHODS

We captured red-shouldered hawks with balchatri traps (Berger and Mueller 1959) baited with live house mice (*Mus musculus*), or a dhogaza with a live great horned owl (*Bubo virginianus*) as the lure (Hamerstrom 1963, Bloom 1987). Eighteen hawks were captured, and then banded with a U.S. Fish and Wildlife Service aluminum band. They also were affixed with a back-pack type transmitter via a 4-mm-wide Teflon strap harness (Dunstan 1972). We monitored 5 hawks (M1, M2, F1–F3 [M = male, F = female]) between 1979 and 1981 (McCrary 1981*b*) and the remaining 13 (M3–M8, F4–F10) between 1986 and 1988 (Bloom 1989).

All 18 hawks were in adult plumage, and their

sex was determined by the presence or absence of a brood patch, body size, and mass (P. H. Bloom and M. D. McCrary, unpubl. data). Transmitter masses were <5% (18–22 g) of the body mass of subject birds and had little or no apparent effect on hawk behavior (McCrary 1981*a*).

We ascertained hawk locations by triangulation (with a 3-element, hand-held yagi antenna) and visual sightings. Two to 3 bearings were taken sequentially while on foot or in a car, often within seconds of each other to ascertain the location of each hawk. Locations were plotted on U.S. Geological Survey 7.5-minute quadrangle maps.

Determination of hawk locations was facilitated by a road system within each home range that traversed canyon bottoms and ridges and paralleled woodland habitats. This, coupled with periods of relative inactivity by the hawks for many minutes, allowed for accurate triangulations.

Most bearings were taken from a distance of <150 m from the birds, and locations were recorded at 0.5-hour intervals or when a bird moved >25 m. When birds were out of view, we detected movements by a sharp change in signal strength, usually followed by a change in signal direction. Error polygons around triangulated locations (Springer 1979) were all <1 ha. Accuracy of locational data was enhanced by visual observations of birds (30.5% of locations) and the dispersed distribution of woodland areas used by hawks when hunting. We monitored hawks a total of 330 full days (no observation gaps ≥1 hr) from morning roosts (1 hr before sunrise) to night roosts (1 hr after sunset) and on 459 partial days.

We used the harmonic mean (HM) method to delineate size and shape of home range (Dixon and Chapman 1980). We identified the boundaries of the home range of each hawk with the isopleth encompassing 95% of all locations for that hawk (i.e., 95% HM contour); core areas were identified with the 50% HM contour (Kaufmann 1962, Anderson 1982, Andersen and Rongstad 1989). Grid size used in the HM calculations was 100 m for all birds. We also calculated home ranges with the minimum convex polygon (MCP) method (Mohr 1947) to allow comparisons with earlier studies that used this method.

We assessed the level of autocorrelation between location points with the index of autocorrelation (gamma) recommended by Swihart and Slade (1986). We assumed that significant autocorrelation existed when gamma was >0.3 (Ackerman et al. 1988). With the aid of the program HOME RANGE, we calculated the "time to independence" (Swihart and Slade 1986) for each bird. For most of the hawks the level of autocorrelation was reduced to an insignificant (gamma <0.3) amount at a sampling interval of 2 hours. However, a few birds (M3, M4, F7, and F9) still showed significant levels of autocorrelation at the 2-hour interval; these birds were analyzed at the 4-hour interval.

We estimated the boundaries of the 8 habitat types within the 95% HM home range of each hawk by plotting habitat boundaries in the field with the aid of aerial photos and U.S. Geological Survey 7.5-minute quadrangle maps. We used the geographic information system program CAMRIS (Ford 1988) to measure habitats and quantify habitat use. Relative use of habitat types, based on the number of hawk locations in each type, was compared with the amount of each type within a home range with a Chi-square goodness-of-fit test. The Bonferroni Z-test (Neu et al. 1974, Byers et al. 1984) was used to ascertain whether the use of different habitat types was more or less than expected, based on their availability. We used the 2-tailed Mann-Whitney test (*U*-statistic) to compare male and female home-range size and Spearman rank correlation (r_s) to analyze the relationship between home-range size and habitat quality. Significance levels were set at 0.05.

RESULTS

We observed hawks during time periods varying from 0.5 to 2.5 years, and monitored each hawk from 69 to 994 hours for a total of 6,691 hours for all 18 hawks. We recorded a total of 13,382 location points. Removal of location points to reduce statistical dependence resulted in 3,423 usable location points (Table 1). Due to variable transmitter life, the length of time a bird was monitored varied considerably (Table 1). Based on observed reproductive behavior, all hawks except for 1 male (see Male Home-Range Size) were territorial adult breeders. We simultaneously tracked both members of 6 breeding pairs (M1-F2, M2-F3, M4-F10, M6-F8, M7-F7, and M8-F9) for ≥6 months. Due to the distribution of monitored and unmonitored territories we were unable to assess overlap between pairs in most cases. However, in our southern

Table 1. Home range size (km²) of resident adult red-shouldered hawks in southern California, 1979–81 (M1–M2[a], F1–F3), 1986–88 (M3–M8, F4–F10).

Hawk no.	No. of locations	Days monitored	Harmonic mean		MCP[b]	
			50%	95%	95%	100%
M1[c]	226	55	0.04	0.45	0.40	0.45
M2[c]	185	46	0.10	0.59	0.51	0.69
M3	117	50	0.15	2.25	1.80	2.58
M4	378	119	0.20	2.54	1.84	4.43
M5[d]	141	20	0.83	35.65	23.83	28.23
M6	338	51	0.04	0.42	0.28	0.44
M7	320	53	0.06	0.48	0.42	1.21
M8[c]	102	23	0.04	1.72	1.08	2.01
F1[e]	67	23	0.004	0.22	0.06	0.13
F2[c]	201	47	0.05	0.53	0.38	0.52
F3[e]	142	26	0.01	0.42	0.36	0.41
F4[c]	68	31	0.04	1.16	0.48	1.19
F5[c]	198	44	0.10	1.29	1.13	1.76
F6[e]	78	16	0.06	0.38	0.20	0.24
F7	170	52	0.03	1.53	0.45	1.61
F8	406	69	0.01	0.34	0.17	0.55
F9[c]	159	41	0.01	1.18	0.69	1.25
F10[e]	127	23	0.003	0.15	0.08	0.22

[a] M = male, F = female.
[b] MCP = minimum convex polygon.
[c] Period of observation: M1 Feb 79–Apr 80, M2 Feb 79–May 79, M3 Jun 86–Jan 87, M4 Jul 86–Nov 88, M5 Jul 87–Sep 87, M6 Oct 87–Nov 88, M7 Dec 87–Nov 88, M8 Jan 88–Aug 88, F1 Feb 79–Jun 79, F2 Nov 79–May 80, F3 Jan 81–Jun 81, F4 Jul 86–Oct 86, F5 Dec 86–Jul 87, F6 Feb 87–Jun 87, F7 Jun 87–Feb 88, F8 Sep 87–Nov 88, F9 Feb 87–Jun 88, F10 Jan 88–Jun 88.
[d] Excluded from home-range statistical analysis because the bird was a non-territorial "floater."
[e] Excluded from analysis of home-range size because individuals were incubating or brooding females that rarely left the nest vicinity.

study area, which contained 3 adjacent home ranges, overlap of 5% occurred between pairs M1-F2 and M2-F3.

Female Home-Range Size

The 95% HM contour of 6 female red-shouldered hawks averaged 1.01 ± 0.19 (SE) km² (range = 0.34–1.53 km²; Table 1). Females had small home ranges relative to males during incubation and brooding periods (Mar–Apr) when it was not uncommon for females to move ≤100 m from the nest in the course of a full day's observations. We excluded 4 females (F1, F3, F6, and F10) from this analysis because they were sampled predominantly during incubation and brooding.

The female with the largest home range (1.53 km²) was F7. During most (89%) days of observation, F7 used a much smaller area (0.37 km²), similar to her mate, M7. However, during the postfledging period (Jun 1988), F7 began using the shore of a small reservoir 2 km from her nest, which increased her home range by 1.16 km². Although F7 used this reservoir during 11 of the next 18 days of tracking, we never observed her mate there.

The core area for the 6 females available for analysis averaged 0.04 ± 0.01 SE km² (range = 0.01–0.10 km²; Table 1) or only about 4% (range = 0.8–9.4%) of the size of the average female home range. All female core areas were centered around the nest.

Male Home-Range Size

The 95% HM contour of home-range size for 7 male red-shouldered hawks (excluding M5, see below) averaged 1.21 ± 0.35 (SE) km² (range = 0.42–2.54 km²; Table 1). M5 was excluded from this analysis because he was presumably a non-territory holding "floater" at the time of capture. We captured M5 in June during the post-fledging period. He frequently returned to the area where he was trapped, but his 95% HM contour was 30 times larger than the pooled mean for the other 7 males (Table 1). Unlike the other radio-tagged hawks, the home range of M5 overlapped portions of home ranges maintained by ≥8 pairs.

The 2 males (M3 and M4) with the largest home ranges (excluding M5) were similar to F7 in that they hunted in disjunct islands of wooded or mesic hunting habitat. M4 used the same reservoir as F7 and 2 other distant locations, an isolated tree and small oak grove, although in the case of M4 the reservoir was among the 5% excluded from the home-range calculation. Sim-

Table 2. Habitat types used by red-shouldered hawks (n = 17), southern California, 1979–88.

Habitat	Male[a]		Female	
	Proportion of 95% contour	Proportion of locations	Proportion of 95% contour	Proportion of locations
Oak	0.226	0.473 +[b]	0.180	0.390 +[b]
Sycamore	0.017	0.208 +	0.028	0.244 +
Willow	0.050	0.088 +	0.125	0.176 +
Urban	0.059	0.145 +	0.087	0.127 +
Coastal sage	0.468	0.027 −	0.335	0.032 −
Grassland	0.171	0.053 −	0.167	0.024 −
Agriculture[c]			0.069	0.002 −
Riparian scrub	0.010	0.006	0.010	0.005

[a] Excludes M5.
[b] Difference between availability and use, Bonferroni Z-test ($P < 0.05$). + = significantly more than expected; − = significantly less than expected.
[c] Not present in male home ranges.

ilarly, M3 also had a detached use area, in this case an isolated oak grove.

Home ranges of males did not differ ($U = 23$, $P > 0.05$) from those of females. However, when both members of a pair were studied, male home ranges mostly encompassed the female's except in the case of M7-F7, where F7's home range was 3 times larger (Table 1).

The core area for the 7 males available for analysis averaged 0.09 ± 0.02 SE km² (range = 0.04–0.2 km²; Table 1) or 7.5% (range = 2.3–17%) of the size of the average male home range. Male core areas were centered around the nest with the exception of M3. M3, a bird monitored only during the non-breeding season (Jul–Dec), had a core area of 0.12 km² (6% of his home range) located 1.2 km from his nest. Core areas of males were larger ($U = 40.5$, $P < 0.05$) than those of females, possibly due to the restricted level of female movements during incubation and brooding.

Habitat Use

Thirty-nine percent of the habitat within the home ranges (95% HM) of 17 red-shouldered hawks was woodland. Oak and willow were the most common of the woodland habitat types, occupying 21% and 8% of the home ranges, respectively. The most common unwooded areas were coastal sage (41%) and grassland (16%).

The observed number of locations in each habitat type for both males and females (excluding M5) differed (males—$\chi^2 = 735$, 6 df, $P < 0.001$; females—$\chi^2 = 869$, 7 df, $P < 0.001$) from the expected number, based on the area of each type (Table 2). The pattern of habitat use was the same for both sexes. Males and females used the 4 woodland habitats (oak, sycamore, willow, urban) disproportionately more than expected (Bonferroni Z-test, $P < 0.05$; Table 2) and 4 non-woodland habitats (riparian scrub, coastal sage, grassland, agriculture) disproportionately less than expected; use of riparian scrub was approximately proportionate to area. In particular, sycamore woodland was used much more than expected by both males (7.6 times) and females (7.4 times). The selection by red-shouldered hawks for woodland habitats is further supported by the wanderings of M5. Of 137 locations for M5, 91% were in oak and sycamore woodlands; whereas only 9% were in grassland and coastal sage.

The ratio of sycamore-willow habitat to oak woodland habitat can be used to indicate the relative mesic or xeric nature of a hawk's home range, respectively. For the 13 hawks considered in the analysis of home range, this ratio varied from zero (no oak woodland) for M1 and F2 to 63:1 for M3. A positive correlation ($r_s = 0.59$, $n = 13$, $P < 0.01$) existed between home-range size and the proportion of oak woodland.

Although native trees such as oaks and sycamores were used by hawks where available, they were not essential to red-shouldered hawk occupancy. Urban woodlands composed of a myriad of exotic species also support red-shouldered hawk pairs. Two pairs of transmittered hawks in our southern study area (M1-F2, M2-F3) lived in a highly modified man-made environment consisting mostly of exotic vegetation (e.g., *Eucalyptus* sp.), lawns, large buildings (e.g., hospital, fire station), recreational facilities, asphalt roads, and parking lots. Twenty to 25% of the space in both home ranges was occupied by

open water, asphalt, or buildings (McCrary 1981*b*). Although these 2 pairs occupied an urban area containing exotic vegetation, they used woodlands disproportionately more than nonwoodlands as did hawks occupying natural areas (Bloom 1989). The size of these 2 pair's home range also was within the range of other hawks in this study (Table 1). We only examined habitat use of 2 urban pairs. However, we are aware of 18 pairs that occupy similar urban environments and have successfully produced young as did the 2 pairs in this study (P. H. Bloom and M. D. McCrary, pers. observ.).

Another component of the urban environment occupied by the 2 pairs in our southern study area was the level of human activity. We estimate that these hawks shared their home ranges with >1,000 people/week. On numerous occasions we observed hawks hunting, nesting, and fledging young within 25 m of people engaged in jogging, picnics, and baseball games. Human activity in home ranges in more natural areas was generally limited to low-level vehicular traffic.

DISCUSSION

Intraspecific Home-Range Variation

The predominant use of woodland habitat is a direct reflection of the species' hunting behavior in southern California. Red-shouldered hawks in this study hunted exclusively from perches. During 6,691 hours of radio tracking, no hunting attempts by hawks in flight were observed, and all of >250 foraging attempts recorded were initiated from perched positions. Goshawks (*A. gentilis*) in Britain exhibited similar behavior with the majority of foraging attempts initiated from perched positions and with a strong preference for woodland habitats over non-woodland habitats (Kenward 1982).

Since red-shouldered hawks in this study hunted only from perches, the use of non-woodland was limited to only those areas where some form of perch structure was present (utility line, fence post, or isolated tree). The sizes of 11 home ranges in this study were influenced by the presence or absence of these perches.

On this study area, no 1 type of woodland habitat was crucial to successful occupation of an area by red-shouldered hawks, but the type of woodland habitat available to different birds influenced home-range size. The tendency for red-shouldered hawks to use mesic environments, such as riparian zones, wet meadows, and marshes, is well known (Bent 1937, Brown and Amadon 1968, Bednarz and Dinsmore 1981, Titus and Mosher 1981). The amount of sycamore and willow habitat within red-shouldered hawk home ranges in this study influenced home-range size: as the amount of sycamore and willow habitat within home ranges increased, home-range size decreased suggesting enhanced habitat quality.

Red-shouldered hawks prey on a wide variety of species in both xeric and mesic conditions, but the relationship between home-range size and mesic habitats in the red-shouldered hawk is likely linked to abundance of prey species inhabiting aquatic or moist environments (Snyder and Wiley 1976). Prey taken by red-shouldered hawks in our study were mostly small rodents, but included lizards, small snakes, small birds, arthropods, and, where available, frogs, crayfish, and fish (P. H. Bloom and M. D. McCrary, pers. observ.)—species that are frequently more abundant or only available in mesic environments.

Red-shouldered hawks occupying home ranges containing mesic habitats may have had a greater diversity and abundance of prey available to them, and hence used a smaller home range, possibly as a result of the interspersion of perches and small openings where prey concentrate. Village (1982) also found a significant negative relationship between home-range size of the European kestrel (*Falco tinnunculus*) and vole densities, and Gargett (1975) found a similar relationship between black eagles (*Aquila verreauxii*) and their prey.

Interspecific Home-Range Variation

Relative to home ranges of other buteonine raptors in North America, the red-shouldered hawks followed in this study used the smallest home range of any species reported to date. The mean MCP for 7 males in this study was 1.7 km^2, and Parker (1986) reported a mean of 1.2 km^2 for 2 males of the eastern subspecies. Average MCP estimates for other buteonines include: red-tailed hawk (*B. jamaicensis*) 13.8 km^2 and 6.1 km^2 (Fuller 1979, U.S. Dep. Inter. 1979); broad-winged hawk (*B. platypterus*) 12.6 km^2 (Fuller 1979); Swainson's hawk (*B. swainsoni*) 9.1 km^2 and 8.9 km^2 (Fitzner 1978, Bechard 1982); and golden eagle (*Aquila chrysaetos*) 14.5

km² (U.S. Dep. Inter. 1979). The relatively limited space needed by red-shouldered hawks is further borne out by core area size. Fifty percent of their time was spent in 7% of their home range.

One possible explanation for the small size of red-shouldered hawk home ranges could be the perch and wait hunting behavior of this species. Most of the species listed above hunt at least occasionally while in flight. Ultimately, however, home-range size in birds of prey may be the outward expression of many different factors (e.g., habitat use, prey selection, foraging behavior, energetics, and territoriality) and the multiple interactions among them.

MANAGEMENT IMPLICATIONS

The western red-shouldered hawk is a common, highly adaptable predator that frequently occupies home ranges in close association with people (Wilbur 1973). It currently is not a state or federally listed species in California (Harlow and Bloom 1989), and will remain so if land-use planners provide for its conservation. Habitat preservation is the key to conservation of many raptors both in southern California and elsewhere. Ideally, conservation of natural red-shouldered hawk habitats is preferred; however, as demonstrated by 2 pairs of hawks in this study, urban habitats can support viable pairs. The small size of red-shouldered hawk home ranges should easily allow land-use planners to set aside appropriate quantities of suitable environments to ensure its survival. The woodland habitats they occupy also are used for nesting and foraging by most other southern California raptors. Although small compared to home ranges of larger raptors, such as red-tailed hawks and golden eagles, red-shouldered hawk home ranges include those of several smaller species. We believe raptor species that benefit directly from conservation of red-shouldered hawk habitat include more threatened species such as black-shouldered kites (*Elanus caeruleus*), Cooper's hawks (*A. cooperi*), and long-eared owls (*Asio otus*). The habitats of these species have been degraded in southern California (P. H. Bloom, pers. observ.; Garrett and Dunn 1981) and protecting red-shouldered hawk habitat should aid their conservation.

Well-planned parks, open space, and sanctuaries can ensure the survival of the red-shouldered hawk even in areas of intense development and close proximity to human activities. A mosaic of habitats in an area encompassing ≥1.21 km² that includes predominantly (39%) mature woodland appears to be adequate for 1 pair in terms of space and habitat requirements, assuming the equally important consideration that adequate prey densities are also available. Future research on red-shouldered hawks would best be directed toward nest site variables, natal dispersal, and determining the number and dispersion of home ranges needed to maintain a viable population and not just isolated pairs.

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