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NEST-SITE SELECTION AND REPRODUCTIVE SUCCESS OF URBAN RED-SHOULDERED HAWKS IN CENTRAL CALIFORNIA

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ABSTRACT.—Fledging success was determined at nests of urban Red-shouldered Hawks (*Buteo lineatus*) in California. Fourteen of 27 nests in 1994 and 38 of 58 nests in 1995 were in exotic trees, predominantly eucalyptus (*Eucalyptus* spp.). Nesting and fledging success were higher in exotic trees than in native trees in both years, owing in part to greater stability and protective cover. Most nest trees in upland areas (>100 m from water) were exotics, and even in riparian habitats, where tall native cottonwoods (*Populus fremontii*) and sycamores (*Platanus racemosa*) were available, Red-shouldered Hawks selected eucalyptus more often than expected based on their availability. Of the habitat and nest-tree variables measured at each nest, only nest-tree height and diameter were significantly associated with reproductive success, suggesting that large, sturdy trees provided the best nest sites. Red-shouldered Hawk populations in the study area have likely benefited from the planting of exotic eucalyptus and fan palms. Reproductive success was not affected by the degree of urbanization around nest sites, as many successful nests were found in heavily urbanized areas close to human activity.

KEY WORDS: *Red-shouldered Hawk*; Buteo lineatus; *reproductive success*; *riparian*; *exotic trees*; *eucalyptus*.

Selección del sitio del nido y éxito reproductivo de *Buteo lineatus* urbanos en el centro de California

RESUMEN.—El éxito de crianza de pichones fue determinado en los nidos de *Buteo lineatus* urbanos en California. Catorce de 27 nidos en 1994 y 38 de 58 nidos en 1995 fueron en árboles exóticos, predominantemente eucaliptus (*Eucalyptus* spp.). El éxito de anidación y de crianza fue mayor en árboles exóticos que en árboles nativos en ambos años, debido en parte a la mayor estabilidad y cobertura de protección. Casi todos los árboles con nidos en áreas superiores (>100 m del agua) fueron exóticos, inclusive en habitats ribereños en donde *Populus fremontii* y *Platanus racemosa* estaban disponibles, *Buteo lineatus* seleccionó a los eucaliptus con mas frecuencia que lo esperado con base en su disponibilidad. De las variables de habitat y de árboles con nido medidas para cada nido, sólo la altura del árbol y el diametro fueron significativamente asociados con el éxito reproductivo, lo cual sugiere que los árboles grandes y fuertes proveen los mejores sitios de anidación. Las poblaciones de *Buteo lineatus* en el área de estudio aparentemente se han beneficiado de la siembra de eucaliptus exóticos y palmas de abanico. El éxito reproductivo no fue afectado por el grado de urbanización alrededor de los sitios de anidación, pues muchos nidos exitosos se encontraron en áreas altamente urbanizadas cerca de la actividad humana.

[Traducción de César Márquez]

Populations of Red-shouldered Hawks (*Buteo lineatus*) have declined throughout much of the species' range during this century (Henny et al. 1973, Titus et al. 1989, Bednarz et al. 1990). Most of this decline has probably resulted from the destruction and fragmentation of hardwood forests, particularly riparian woodlands, upon which Red-shouldered Hawks are largely dependent for breeding over most of their range (Cohen 1970, Henny et al. 1973, Bednarz and Dinsmore 1981). Urbanization may also have contributed to the decline of this species, as Red-shouldered Hawks in some areas avoid nesting near roads and buildings (Bednarz and Dinsmore 1981, Bosakowski et al. 1992).

Populations of the western race *B. l. elegans,* residing primarily in California, have been affected by human activities to some degree. Breeding primarily in riparian habitats, *B. l. elegans* declined in parts of its range early this century as a result of severe degradation of California's riparian woodlands (Willett 1912, Grinnell and Wythe 1927), which reduced these habitats to <5% of their original levels prior to European settlement of the state (Katibah 1984). After this decline, Red-shouldered

Hawk populations appeared to be fairly stable (but low) in California from about 1950 until the late 1960s (Cohen 1970, Brown 1971, Wilbur 1973).

In the past three decades, Red-shouldered Hawk populations have increased in some parts of California. Breeding Bird Survey data indicate significant statewide increases since 1966 (Sauer et al. 1997), and local increases and range expansions have been noted in a number of locations since then (Harlow and Bloom 1989, Roberson 1993, S. A. Laymon *fide* Shuford 1993). Because riparian woodlands are still greatly reduced from their historic extent, these population increases have not resulted from recovery of the hawk's native riparian habitats, and the reasons for this recent increase are not entirely clear.

Historically, California Red-shouldered Hawks bred primarily in riparian areas, nesting in tall, native riparian trees and foraging in adjacent marshes and grasslands (Willett 1912, Grinnell and Wythe 1927, Grinnell and Miller 1944). Studies conducted in the midwestern and eastern U.S. have reported that Red-shouldered Hawks are sensitive to human disturbance and that they usually nest far from developed areas (Bednarz and Dinsmore 1981, Bosakowski et al. 1992). However, recent studies in southern California have found a number of Red-shouldered Hawks nesting in exotic trees, such as eucalyptus (*Eucalyptus* spp.) and palms (*Washingtonia* spp.), often in urban and suburban areas surrounded by development (Bloom et al. 1993, Bloom and McCrary 1996). Some Red-shouldered Hawks nest where these tall, sturdy exotic trees have been planted in upland areas, sometimes far from riparian habitats (Palmer 1988).

Bloom and McCrary (1996) have suggested that planting of eucalyptus has contributed to the expansion of this species' range and populations in California by providing suitable nest trees in upland areas (including urban areas) that were previously unsuitable for breeding Red-shouldered Hawks. However, no published studies have yet determined the breeding success of Red-shouldered Hawks in native versus exotic trees or in riparian versus upland areas. This study investigated the degree to which urban Red-shouldered Hawks nest in exotic trees and/or upland areas, the breeding success of Red-shouldered Hawks nesting in native versus exotic trees and upland versus riparian areas, and relationships between breeding success and habitat and nest tree variables related to urbanization and habitat quality.

STUDY AREA AND METHODS

In 1994 and 1995, I located Red-shouldered Hawk nests in the northern Santa Clara Valley at the southern end of the San Francisco Bay in Santa Clara County, California. Formerly dominated by oak (*Quercus* spp.) savanna (Clarke 1952), the northern Santa Clara Valley was covered primarily by agricultural land at the turn of the 20th century but now is dominated by residential and industrial development. These residential and industrial lands are sparsely vegetated, with relatively few trees large enough to support Red-shouldered Hawk nests. However, scattered large eucalyptus (most commonly *Eucalyptus globulus*), palms and various coniferous trees provide potential nest trees within these upland areas.

Two major streams, Coyote Creek and the Guadalupe River, as well as a number of smaller streams, flow through the urban Santa Clara Valley and from the foothills of the Santa Cruz Mountains and Diablo Ranges to San Francisco Bay. The narrow riparian corridors along the portions of these streams flowing through the Santa Clara Valley are dominated by Frémont cottonwood (*Populus fremontii*) and several species of willows (*Salix lucidum, S. laevigata, S. lasiolepis* and *S. exigua*) along their lower reaches, and by oaks and western sycamore (*Platanus racemosa*) along their upper reaches. In addition, scattered tall eucalyptus provide additional potential nesting sites within these riparian areas.

I used several methods for locating Red-shouldered Hawk nests ("nest" defined as the site of an actual nesting attempt). During late winter and spring of each year, I searched for Red-shouldered Hawks and their nests in riparian habitats along most of the streams in the study area and in upland areas. Recordings of Red-shouldered Hawk vocalizations were played frequently during surveys to elicit a territorial response from any hawks that might be present. Because Red-shouldered Hawks prefer tall trees for nesting (Bednarz and Dinsmore 1982, Dijak et al. 1990), surveys in upland areas focused on areas with tall trees. Some nests were found using data from the Santa Clara County Breeding Bird Atlas project and from locations provided by members of the Santa Clara Valley Audubon Society. Surveys were more extensive in 1995 than in 1994, particularly in upland areas.

After a nest was found, I periodically monitored it with a spotting scope until the young had fledged or until the adults had abandoned the nest (after nest failure). After young were visible in nests, I visited nests every 3–4 d until the young were near fledging age, at which point visits were made every 2–3 d. The number of young fledging from nests was estimated by the number of young seen in nests within three days of fledging. Nests abandoned before they were completed and "alternate nests" not used for nesting were excluded from analyses if it was thought that they might be located within the territory of a pair whose completed nest was included in these analyses.

Data were analyzed separately for each year. The mean number of young fledged per nest and the number fledged per successful nest (i.e., a nest from which at least one young fledged) were compared between 1994 and 1995 using Mann-Whitney *U*-tests. Kruskal-Wallis tests were used to compare the mean number of young fledging from each nest and the mean number fledging from

Table 1. Tree species used for nesting by Red-shouldered Hawks in 1994. The number of nests found in each tree species, number of nests that successfully fledged young and mean number of young per nest and per successful nest are given separately for nests in riparian areas (<100 m from the nearest stream) and upland areas (>100 m from the nearest stream).

TREE SPECIES	TOTAL NESTS	SUCCESSFUL NESTS	YOUNG FLEDGED PER NEST	YOUNG FLEDGED PER SUCCESSFUL NEST
Riparian				
Platanus racemosa	6	4	1.5 ± 0.5	2.3 ± 0.3
Populus fremontii	7	4	1.3 ± 0.4	1.8 ± 0.2
Washingtonia spp.	2	1	1.0 ± 1.0	2.0
Eucalyptus spp.	6	5	1.8 ± 0.5	2.2 ± 0.4
Upland				
Washingtonia spp.	2	2	3.0 ± 0.0	3.0 ± 0.0
Eucalyptus spp.	4	4	2.8 ± 0.3	2.8 ± 0.3

each successful nest among nests in different tree species. Mann-Whitney *U*-tests were used to compare fledging success between nests in native and exotic trees and between eucalyptus nests in upland and riparian areas, and they were also used to compare fledging success between nests attended by two adults and those attended by a pair that included a subadult (second-year) bird. All Mann-Whitney *U*-tests and Kruskal-Wallis tests were two-tailed.

In each year, the number of successful nests and the mean number of young fledging from nests was determined for each tree species, or, in the case of eucalyptus, genus. Nests were also categorized by their location relative to the nearest stream, "riparian" nests being located <100 m from the nearest stream and "upland" nests being >100 m from a stream; few riparian-associated trees (e.g., cottonwoods and sycamores) are found >100 m from a stream channel within the study area.

In a previous study of riparian tree communities (Rottenborn 1997), I had measured the diameters of all trees on 68 randomly located, 35 m-radius plots along the lower reaches of Coyote Creek, Guadalupe River and Los Gatos Creek. Using these data, I determined the number of stems of native and exotic trees on each of the 68 plots that exceeded the diameter of the smallest tree used for nesting by Red-shouldered Hawks in the present study. A *G*-test was used to compare the mean proportion of the large-diameter stems comprised of exotic species to the proportion of hawk nests from Coyote Creek, Guadalupe River and Los Gatos Creek that were in exotic trees to determine whether or not hawks used native and exotic trees in proportion to their availability within this subset of the study area. For this comparison, I used all hawk nests found along these streams over both years, counting nests used in both 1994 and 1995 only once.

Habitat and nest-tree variables thought to be related to nesting success, including nest-tree height (TREEHT), nest-tree diameter at breast height (TREEDBH), nest height (NESTHT), elevation of the nest site (ELEV) and distance from the nest to the nearest body of water (DISTWAT) were measured at each nest. Within radii of 200 and 500 m of each nest, the percent cover by artificial surfaces (ARTIF200, ARTIF500), including buildings and pavement, was estimated from aerial photos, and the distance from each nest to the nearest building (DISTBUIL) and paved road (DISTPAVE) was measured. Differences in the mean values of these variables at successful and unsuccessful nests were tested using Mann-Whitney *U*-tests. In addition, simple linear regressions of each of these habitat variables versus the number of young fledging from each nest were conducted. These analyses were conducted separately for 1994 and 1995 nests.

RESULTS

Twenty-seven and 58 Red-shouldered Hawk nests were located in 1994 and 1995, respectively. Thirteen of the 1994 nests were used again in 1995, so these two datasets were not independent and were therefore analyzed separately. Twenty-one of the 27 nests found in 1994 (77.8%) and 46 of the 58 nests found in 1995 (79.3%) were successful in fledging at least one young. When all nests were combined for each year, the mean number of fledged young per nest was 1.8 ± 0.2 (±SD) in 1994 and 1.6 ± 0.1 in 1995 ($t = 0.9$, $P > 0.05$), while the mean number of fledged young per successful nest was 2.3 ± 0.1 in 1994 and 2.0 ± 0.1 in 1995 ($t = 0.7$, $P > 0.05$).

Use of Upland Versus Riparian Habitats. Six of the nests found in 1994 (22.2%) and 18 of those found in 1995 (31.0%) were in upland areas >100 m from the nearest stream (Tables 1 and 2). Nests were located ≤1.7 km from the nearest body of water. When all nests were pooled, the mean distance between nests and the nearest body of water was 143 ± 69.8 m in 1994 and 110 ± 33.0 m in 1995. The mean distance from each upland nest

Table 2. Tree species used for nesting by Red-shouldered Hawks in 1995. The number of nests found in each tree species, number of nests that successfully fledged young and mean number of young per nest and per successful nest are given separately for nests in riparian areas (<100 m from the nearest stream) and upland areas (>100 m from the nearest stream).

TREE SPECIES	TOTAL NESTS	SUCCESSFUL NESTS	YOUNG FLEDGED PER NEST	YOUNG FLEDGED PER SUCCESSFUL NEST
Riparian				
Platanus racemosa	14	11	1.6 ± 0.3	2.0 ± 0.2
Populus fremontii	4	3	1.0 ± 0.4	1.3 ± 0.3
Alnus rhombifolia	1	0	0.0	—
Washingtonia spp.	1	0	0.0	—
Eucalyptus spp.	20	17	1.9 ± 0.2	2.2 ± 0.1
Upland				
Quercus agrifolia	1	1	0.0	—
Washingtonia spp.	3	2	1.3 ± 0.7	2.0 ± 0.0
Eucalyptus spp.	14	12	1.8 ± 0.3	2.1 ± 0.2

to water was 590 ± 268 m in 1994 and 302 ± 91.7 m in 1995.

With the exception of a single nest in a coast live oak (*Quercus agrifolia*) in 1995, all upland nests were in exotic trees, predominantly eucalyptus. Nest success (i.e., the percentage of nests that fledged at least one young) differed little between eucalyptus nests in riparian and upland areas (Tables 1 and 2). The mean number of young fledged from each eucalyptus nest in riparian and upland areas was 1.8 ± 0.5 and 2.8 ± 0.3, respectively, in 1994, and 1.9 ± 0.2 and 1.8 ± 0.3 in 1995. The mean number of young fledged from each successful eucalyptus nest in riparian and upland areas was 2.2 ± 0.4 and 2.8 ± 0.3, respectively, in 1994, and 2.2 ± 0.2 and 2.1 ± 0.2 in 1995. Neither of these measures of fledging success differed significantly between riparian and upland nests in either year.

Nest Tree Species and Use of Native Versus Exotic Trees. Red-shouldered Hawk nests were found in four tree species in 1994 (Table 1) and six tree species in 1995 (Table 2). Native trees used for nesting were Frémont cottonwood, western sycamore, white alder (*Alnus rhombifolia*) and coast live oak, while exotics included eucalyptus and fan palms (*Washingtonia filifera* and *W. robusta*). Of the 27 nests found in 1994, 13 (48.1%) were in native trees and 14 (51.9%) were in exotics. Of the 58 nests monitored in 1995, 20 (34.5%) were in native trees and 38 (65.5%) were in exotics.

Eight of 21 nests found in riparian areas in 1994 (38.1%) and 21 of 40 riparian nests in 1995 (52.5%) were in exotics, primarily eucalyptus (Tables 1 and 2). Furthermore, the percentage of nests in exotic trees along the lower reaches of Coyote Creek, Los Gatos Creek and Guadalupe River was much higher than the percentage of large trees that were exotics. Only 18% of the trees having a diameter greater than the most slender Red-shouldered Hawk nest tree were exotics, whereas 56% of the nests detected in the same areas were in exotic trees ($G = 11.44$, $P < 0.01$). A number of nests were found in lone eucalyptus ($N = 3$ in 1994, 8 in 1995) or small eucalyptus groves ($N = 3$ in 1994, 12 in 1995) surrounded by mature cottonwoods or sycamores; generally, these eucalyptus were taller than surrounding native trees. Nest success seemed somewhat lower for nests in native trees than for those in exotic trees (Tables 1 and 2) in both 1994 (61.5% in natives, 85.7% in exotics) and 1995 (75.0% in natives, 81.6% in exotics), although z-tests revealed no significant differences in these percentages ($P > 0.05$).

Because neither nesting nor fledging success differed significantly between riparian and upland nests in eucalyptus and fan palms, riparian and upland nests were pooled for comparison of fledging success among the nest tree species. In both years, the mean number of fledged young per nest was highest in eucalyptus, intermediate in sycamores and fan palms and lowest in cottonwoods (Fig. 1). The mean number of young that fledged per nest differed among tree species in 1994 ($H = 8.43$, $P < 0.05$) and in 1995 ($H = 8.57$, $P < 0.05$), primarily due to the great differences in nest success

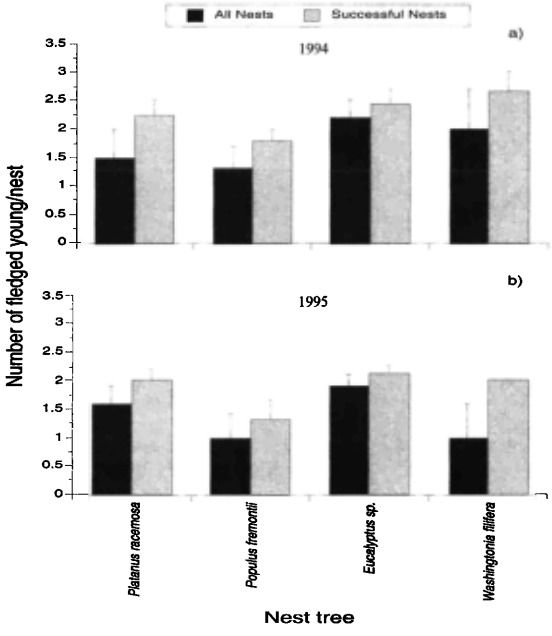

Figure 1. Mean number of fledged young per nest and per successful nest in four tree species used for nesting by Red-shouldered Hawks in 1994 (a) and 1995 (b).

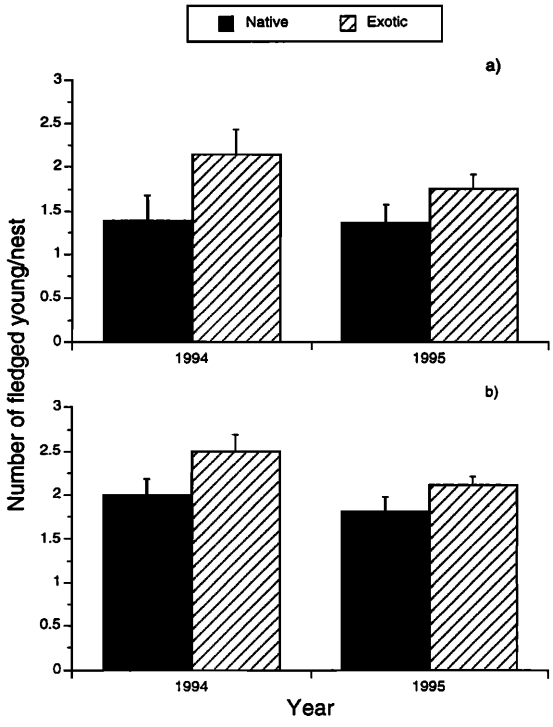

Figure 2. Mean number of fledged young per nest (a) and per successful nest (b) in native and exotic trees used for nesting by Red-shouldered Hawks.

between eucalyptus and cottonwood nests. Because fledging success did not differ significantly between cottonwoods and sycamores or between eucalyptus and fan palms, fledging success was pooled for all natives and compared to fledging success pooled for all exotics. The mean number of fledged young per nest was higher in nests in exotic trees than in nests in native trees in 1994 ($U = 132$, $P < 0.05$), although the difference was not significant in 1995 ($t = 1.61$, $P > 0.05$; Fig. 2).

The mean number of fledged young per successful nest did not differ significantly among tree species (Fig. 1). However, the mean number of fledged young per successful nest was significantly higher in nests in exotic trees than in nests in native trees in 1994 ($U = 78$, $P < 0.05$; Fig. 2). Therefore, even though the lower nest success in native trees (due to nest failures) was not a factor in these comparisons, fledging success was still found to be higher in nests in exotic trees in 1994. There was no significant difference in 1995 ($t = 1.45$, $P > 0.05$; Fig. 2).

In 1994, one of the 14 nests in exotics (7.1%) and five of the 13 nests in natives (38.5%) were attended by a subadult (second year) individual paired to an adult. Three of the four unsuccessful nests in native trees in 1994 were attended by a pair that included a subadult, and the mean number of fledged young per nest in native trees was significantly lower for those pairs containing a subadult than for pairs with two adults in 1994 ($U = 38.5$, $P < 0.01$). In 1995, three of 20 nests in natives (15.0%) and three of 38 nests in exotic trees (7.9%) had a subadult attending. Although two of the five unsuccessful native-tree nests in 1995 were attended by a subadult, differences in fledging success between pairs that did and did not include a subadult were not significant in that year. Nest success was also low for subadults that nested in exotic trees; the single pair with a subadult that nested in a fan palm in 1994 was unsuccessful, and two of the three pairs including a subadult that nested in eucalyptus in 1995 failed to fledge any young.

Relationship of Habitat Variables to Reproductive Success. The habitat and nest-tree variables measured at each nest differed little between successful and unsuccessful nests (Table 3). Nest-tree height and nest-tree diameter were the only vari-

Table 3. Comparison of nest tree and habitat variables between successful and unsuccessful Red-shouldered Hawk nests in 1994 and 1995.

	1994 NESTS		1995 NESTS	
VARIABLE	SUCCESSFUL NESTS (N = 21)	UNSUCCESSFUL NESTS (N = 6)	SUCCESSFUL NESTS (N = 48)	UNSUCCESSFUL NESTS (N = 10)
DISTWAT	180.1 ± 86.7	14.0 ± 6.4	127.7 ± 40.7	43.1 ± 12.9
TREEHT	24.4 ± 1.2	18.3 ± 0.9**	23.8 ± 0.8	21.6 ± 1.5
TREEDBH	101.3 ± 5.5	76.5 ± 2.7*	97.6 ± 2.9	89.5 ± 5.2
NESTHT	17.3 ± 1.1	13.5 ± 0.9	15.9 ± 0.8	15.2 ± 1.3
ELEV	183.9 ± 27.4	179.7 ± 53.74	258.6 ± 22.6	186.4 ± 36.4
ARTIF200	0.43 ± 0.06	0.47 ± 0.15	0.41 ± 0.04	0.46 ± 0.09
ARTIF500	0.45 ± 0.06	0.49 ± 0.16	0.43 ± 0.04	0.49 ± 0.08
DISTBUIL	109.1 ± 26.8	75.0 ± 31.1	93.0 ± 18.3	108.0 ± 35.5
DISTPAVE	80.6 ± 25.0	59.5 ± 24.3	65.5 ± 14.1	70.3 ± 19.2

* $P < 0.05$.
** $P < 0.01$.

ables having significant effects on nest success (and then only in 1994), with successful nests being taller and having a greater diameter than unsuccessful nests. The simple linear regressions between these habitat variables and reproductive success indicated that the number of young fledging per nest increased with increasing nest-tree height in both years and with increasing tree diameter in 1995 ($P < 0.05$ for these individual regressions), but neither nest success nor fledging success was related significantly to variables representing the degree of urbanization around the nests. In fact, many of the nests found in this study were in heavily urbanized areas, and some trees supporting successful nests were located as little as 2 m from a building and 1 m from the nearest road.

DISCUSSION

Studies of nesting Red-shouldered Hawks in eastern North America have found few nests in exotic trees (Bent 1937, Henny et al. 1973, Titus and Mosher 1981, Dijak et al. 1990), probably because they have been conducted primarily in heavily forested areas. Even in California, most studies of Red-shouldered Hawks have reported few nests in exotic trees, owing in some degree to the rural or natural study areas used (Dixon 1928, Wiley 1975). However, 37.7% of the nests found in a study in southern California, which included some urban and suburban areas, were in exotic trees (Bloom and McCrary 1996). My results showed that Red-shouldered Hawks nesting in the heavily urbanized south San Francisco Bay area commonly use exotic trees.

Although Red-shouldered Hawks in some parts of California nest in native oaks and pines well removed from riparian areas (Roberson 1993, P.H. Bloom pers. comm.), only one nest >100 m from a stream in this study was in a native tree. Large native oaks and California bays (*Umbellularia californica*) were present in some upland portions of the study area, but on the floor of the Santa Clara Valley, few native trees suitably large for nesting were present outside riparian areas. Therefore, the planting of tall, sturdy exotic trees in upland areas has provided a number of suitable nesting sites where few existed previously, greatly expanding the extent of suitable breeding habitat and increasing the number of territories within the study area.

Many pairs seemed to prefer eucalyptus even in riparian habitats where mature cottonwoods and sycamores were available. Numerous riparian nests were found in lone eucalyptus or small eucalyptus groves surrounded by mature cottonwoods and sycamores, and exotic tree species were used for nesting more often than was expected based on their availability. Hawks in the genus *Buteo* generally select nest trees in proportion to the availability of trees suitably large for nesting, rather than seeking out specific tree species (Dixon 1928, Bent 1937, Bednarz and Dinsmore 1982). The frequent selection of eucalyptus for nesting in this study likely reflects the taller, broader-limbed nature of many eucalyptus nest trees compared to the native trees available.

The higher nest and fledging success in exotic trees may reflect in part their greater resistance to wind damage. Damage to unstable nests by winds is a potentially important cause of nest failure or abandonment, and successful Red-shouldered Hawks tend to build their nests on large diameter branches that provide stability in high winds (Bednarz and Dinsmore 1982, Dijak et al. 1990). In my study, only one nest in an exotic tree was damaged significantly by wind in each year, whereas in native trees, four nests in 1994 and two in 1995 were heavily damaged by wind. Both nesting and fledging success tended to increase with tree height and diameter, probably due in part to the greater stability of large trees. In fan palms, nests were supported very well by a large number of thick petioles. In eucalyptus, and to a lesser extent in sycamores, nests were usually well supported by thick branches, providing a sturdy platform for nests; nesting success was similar in these two species. However, nests in cottonwoods, which had the lowest success, were usually supported by fewer, often more slender, branches than nests in other species.

It is possible that the evergreen nature of eucalyptus and fan palms provided some additional protection from predators and weather, as most nests were initiated before deciduous natives leafed out. Also, mammalian predators may have difficulty reaching nests in eucalyptus trees given these trees' height and slick, thick trunks, while the "skirts" of dead fan palm leaves may protect nests in palms from mammalian predators (P.H. Bloom pers. comm.).

The percentage of nests occupied by a subadult parent, which tend to have low nest success (Palmer 1988), was higher for native nests than for exotic nests in both years. Eight of 12 pairs with a subadult failed to fledge any young, and fledging success in native trees was significantly lower for pairs that included a subadult than for those including two adults in 1994. If eucalyptus trees confer some advantage to nesting hawks, then older, more experienced birds would be expected to prefer these trees, perhaps relegating younger birds to more marginal territories without tall eucalyptus.

The large number of Red-shouldered Hawk nests found in exotics and the concomitant high nest success seems to have bolstered Red-shouldered Hawk populations in California. The presence of these trees in riparian areas may have partially offset the loss of riparian woodland for this species, and the addition of suitable nest trees in upland areas that previously lacked appropriate trees has likely augmented hawk populations.

Studies in some areas have found that this species is generally sensitive to disturbance, usually nesting far from human activity (Bednarz and Dinsmore 1981, Bosakowski et al. 1992). In my study, many nests were very close to homes, offices and busy roads, and neither the percent cover by developed areas around nests nor the proximity of nests to buildings and roads influenced nest success or fledging success. As reported by Bloom and McCrary (1996), urban-nesting Red-shouldered Hawks are well-adapted to urban environments, and many are quite tolerant of human activity.

Results of my study indicated that California populations of Red-shouldered Hawks have actually benefited from the planting of exotic trees in urban areas. However, these results should not be extrapolated to all Red-shouldered Hawk populations or to riparian-associated bird species in general. Populations of Red-shouldered Hawks in other parts of the species' range are still low or declining, and it appears that persistence of those populations is dependent upon the preservation of large tracts of native woodland (Bednarz and Dinsmore 1981, Peterson and Crocoll 1992). Also, the results of my study are not meant to encourage the planting of exotic vegetation. Exotic plants often lack the resources required by many native animal species (Anderson et al. 1977, Mills et al. 1989). Unlike the Red-shouldered Hawk, many riparian-associated bird species have not recovered from the effects of widespread riparian habitat degradation and do not nest frequently in exotic vegetation.

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