WESTERN KINGBIRDS NESTING IN ASSOCIATION WITH *BUTEO* HAWKS

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Nesting associations between *Buteo* hawks and passerines have been reported in the literature for over a century (Sharp 1902, Cameron 1913, Bowles and Decker 1934, Bent 1937, Griffing 1974, McGillivray 1978). Reports involving passerine nesting associations with Swainson's Hawks (*Buteo swainsoni*) and Ferruginous Hawks (*Buteo regalis*) have been anecdotal, and to our knowledge the importance of these associations has not been investigated. In their classification of nest defenses Collias and Collias (1984) recognized birds that use "protective nesting associations with formidable species." These formidable species may include large birds of prey, colonies of seabirds, or aggressive insects. Konrad and Gilmer (1982) discussed a potentially mutualistic relationship between Western Kingbirds (*Tyrannus verticalis*) and Swainson's Hawks, in which kingbirds may benefit from the presence of hawks in the form of protection from predators and additional food from insects attracted to the nest site by the presence of prey remains, dead hawk nestlings, or excrement. The raptors, in turn, may benefit from kingbirds feeding on pest insects and from their vigilance in alarm-calling and early detection of predators. We investigated nest-site selection of Western Kingbirds in sagebrush steppe of Oregon and provide support for the idea that this species prefers to nest in association with Swainson's and Ferruginous Hawks.

Our 444.5-ha study area consisted of an isolated group of 187 western juniper (*Juniperus occidentalis*) trees growing along 4.6 km of Juniper Canyon and associated drainages on the Naval Weapons Systems Training Facility (NWSTF), Boardman, in Morrow County, Oregon. Elevations ranged from 215 to 287 m, with moderate slopes of 5% to 20%. Trees in the study area were no further than 1025 m apart, and 115 trees were clustered in a 22-ha area. Beside those in juniper trees, one kingbird nest was located in a big sagebrush (*Artemisia tridentata*), built inside an old Black-billed Magpie (*Pica pica*) nest, and several were built on sheds and fences associated with ranching operations. These were not located in the vicinity of trees and were excluded from analysis.

Using aerial photographs, we located every juniper tree in the study area and marked each tree with a numbered metal tag. In addition, we recorded the height, circumference, and coordinates of each juniper. Trees were inspected for nesting activity no less than once every 2 weeks from April through July in 1996 and 1997. Once we located nests, we checked them at least once a week until their outcome was determined.

We tested for a nesting association between kingbirds and the raptors by using Fisher's exact test (Sokal and Rohlf 1995). First egg dates for kingbird nests ranged from 20 May to 29 June (median 31 May). Because the raptor nests were observed from a distance we did not record clutch-initiation dates but rather the first date that a nest site was noted as occupied. For Swainson's Hawks these dates ranged from 11 April to 27 May (median 5 May). Ferruginous Hawks initiated nests as early as mid March, prior to our arrival on the study area. First observed activity dates ranged from 22 March to 18 April (median 10 April). Hawk nests that failed prior to the kingbird's median clutch-initiation date were excluded from this analysis. When multiple kingbird nests were built in a single tree within the same year, only the first nest was used in our analysis.

We calculated tree density at kingbird nest sites by centering a 15-ha circular plot around each nest tree. We selected 15 ha on the basis of the territory size of kingbirds nesting in the desert of New Mexico (Cuesta 1974), and we assume that this area approximates kingbird territory size in our study area. We compared nest-tree height with the mean height of neighboring trees (within each 15-ha plot) by using a *t* test in which equal variance was not assumed (StataCorp 1997). We used ArcView's Spatial Analyst (Environmental Systems Research Institute 1996) to map tree density throughout the study area by 2-m grid cells. We devised an index of tree density with five classes (class 1 = 1–3 trees/ha, class 2 = 4–9 trees/ha, class 3 = 10–21 trees/ha, class 4 = 22–44 trees/ha, and class 5 = 45–83 trees/ha). Cells were assigned to a density class by the number of trees in the surrounding 15-ha area. Most (67.5%) of the 444.5-ha study area was in tree-density class 1, 20.9% was in class 2, and less than 5% was within tree-density classes 3–5.

In 1996, we located seven kingbird nests, all built in different trees. In 1997 nesting kingbirds used 12 different trees, four of which contained multiple nesting attempts. At kingbird nest sites, the proportion of the surrounding 15-ha area in each tree-density class was similar to that of the study area as a whole (Figure 1). For the nine nest trees in 1997 that had at least one additional tree within the buffered plot, the nest tree and neighboring trees did not differ in mean height (*t* test, $P = 0.58$). In 1996, kingbirds selected two of five trees containing active hawk nests for their own nests, while only five of 182 trees without hawk nests were used by kingbirds (Fisher's exact test, $P = 0.011$). In 1997, kingbirds nested in six of eight trees with active hawk nests and only six of 179 trees without active hawk nests (Fisher's exact test, $P < 0.001$). Even when we exclude the 80 trees that fell within the highest density class the nesting association remains statistically significant in both years (Fisher's exact test, $P = 0.034$, $P < 0.001$, respectively).

Kingbirds have been reported to select areas with large widely scattered trees and, at a finer scale, build nests in the tallest trees (Bergin 1994). The proportions of area in each of five tree-density classes surrounding kingbird nest sites were similar to the proportions for the study site as a whole, suggesting that kingbirds were not selecting or avoiding areas with high or low tree density. Additionally, we were unable to find evidence in this study that kingbirds were selecting taller trees.

The protective-nesting hypothesis suggests that nest success should increase under the protection of a larger, more formidable neighbor (Collias and Collias 1984).

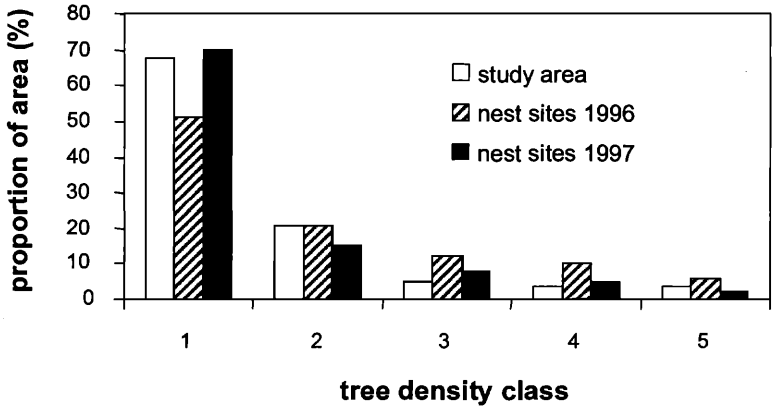

Figure. 1. Proportion of study area (444.5 ha) and proportion of 15-ha buffered area surrounding Western Kingbird nest trees (n = 7 in 1996, n = 12 in 1997) within five density classes (class 1 = 1–3 trees/ha, class 2 = 4–9 trees/ha, class 3 = 10–21 trees/ha, class 4 = 22–44 trees/ha, and class 5 = 45–83 trees/ha).

Potential diurnal nest predators frequently encountered on the NWSTF included the Common Raven (*Corvus corax*) and Black-billed Magpie, and hawks appeared to defend against these species adequately. Western Kingbirds arrived at our study site and began nest building after hawks had initiated nesting. This suggests that kingbirds are seeking the association with *Buteo* nests. Because of small sample sizes we were unable to test the predator-avoidance hypothesis, but we suggest the relationship is more likely commensalistic than mutualistic, conferring no benefit to the nesting raptors, and perhaps bearing an energetic cost to the raptors, as kingbirds were regularly observed harassing both adult and nestling Swainson's Hawks. A motion-triggered video camera used in 1996 as part of a provisioning study recorded frequent and extreme harassment of adult and nestling Swainson's Hawks by kingbirds. On one occasion in July 1997, we observed a kingbird land on the back of a female Swainson's Hawk as she left her nest and ride there, with wings outspread, for approximately 200 m.

This study has demonstrated a nesting association between Western Kingbirds and *Buteo* hawks breeding in juniper–sagebrush steppe. Future work on this interspecific association should focus on the reproductive costs and benefits of sharing a nest site.

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