

## NESTING SUCCESS OF THE WESTERN WOOD-PEWEE IN COLORADO

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Although the Western Wood-Pewee (*Contopus sordidulus*) has a large western North American breeding distribution, little is known about its reproductive biology (Bent 1942, Murphy 1983, Curson 1996). Here we provide information on the nest-site characteristics and nesting success of the Western Wood-Pewee in the forests of Ponderosa Pine (*Pinus ponderosa*) in the foothills of Colorado.

We located 26 Western Wood-Pewee nests in the Ponderosa Pines and adjacent riparian corridors (Box Elder, *Acer negundo*; willow, *Salix* sp.; cottonwood, *Populus* sp.) of Boulder County, Colorado (elevation 1550 to 2150 m, 40° 00' N, 105° 20' W), in 1990 ( $n = 15$ ) and 1992 ( $n = 11$ ). Nests were found during different stages of reproduction, and we observed them every three to five days until the nest was successful or failed. We observed nests directly or by mirror-pole, recorded their contents, and determined causes of nest failure. By examining nest contents and condition, we categorized the causes of nest failure as predation, parasitism, weather, or unknown. We used the Mayfield method (Mayfield 1961, 1975) to determine nesting success. The Mayfield method provides a standardized measure of nest success, by taking into account the number of days of exposure, that is comparable to other studies of nesting success. We measured nest height, nest distance to trunk, and nest distance to the outer edge of foliage.

Most pewee nests were successful in fledging at least one young (1990, 83.3%,  $n = 12$ ; 1992, 80%,  $n = 10$ ; combined, 81.8%,  $n = 22$ ). Three nests were preyed upon, and one nest was destroyed following a severe hail storm. All nests observed from incubation ( $n = 9$ ) had a clutch of three eggs and a hatching success of 81.5%. There was a mean of 2.76 [standard error (SE)  $\pm 0.09$ ,  $n = 21$ ] nestlings and 2.66 (SE 0.11,  $n = 18$ ) fledglings per nest. Fledging success per egg laid ( $n = 27$ ) was 76.2% and per nestling ( $n = 58$ ) was 82.7%. The probability of a pewee egg surviving to hatch (16 days) was 0.89; of a nestling surviving to fledge (14 days) 0.76. Using the Mayfield method we calculated a pewee nest to have a 66.4% chance of surviving 30 days of exposure, at a mortality rate of 0.013 per day, to fledge at least one young.

Most of the 26 nests were located in Ponderosa Pines (84.6%); three nests were in Narrow-leaf Cottonwood (*Populus angustifolia*), one in a willow tree. Nests were typically built in the upper half of the tree (mean nest height, 7.20 m  $\pm$  SE 0.78 m) and were located on a medium-sized branch usually closer to the outer edge of the foliage (distance to foliage, 1.33  $\pm$  0.15 m) than to the trunk (distance to trunk, 2.05  $\pm$  0.21 m).

Nest height of Western Wood-Pewees in this study is similar to the nest height of those in Arizona [78% ( $n = 9$ ) mean height  $> 9.1$  m], but higher than nests in California pines (3 of 4 nests at 2.4 m) found by Harrison (1979). The Western Wood-Pewee's nest placement is similar to that of many other tree-nesting tyrant flycatchers in North America that have a mean nest height greater than 2.0 m above the ground (Murphy 1983). Nests of the Western Wood-Pewee, Eastern Wood-Pewee (*C. virens*), and kingbirds are typically placed closer to the foliage than to the trunk, which has been shown to be an important strategy in reducing nest failure in the Eastern Kingbird (*Tyrannus tyrannus*) (Murphy 1983).

Success of the Western Wood-Pewee nests in this study was higher than that found for other tyrannid flycatchers (Murphy 1983, Klaas 1993, Sedgwick 1993). The mortality per day (1.3%) of the Western Wood-Pewee is similar to that of other

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tyrannids reviewed by Murphy (1983), so the higher success of pewees may be due, in part, to the pewee's total nesting period (incubation and nestling) being shorter than those of the Eastern, Western (*T. verticalis*), and Cassin's (*T. vociferans*) Kingbirds (32–36 nest days; Ehrlich et al. 1988). Pewees have a higher probability of nest success than nonparasitized Eastern Phoebe (*Sayornis phoebe*) (66.4% versus 43.0–61.0%; Klaas 1993). Within the same habitat, Western Wood-Pewees had a significantly higher nesting success ( $G = 6.8326$ ,  $df = 1$ ,  $p < 0.05$ ) than Solitary Vireos (*Vireo solitarius*). The probability of a vireo egg surviving to hatch (14 days) was 0.55; of a nestling surviving to fledge (16 days) 0.43, with a mortality rate of 4.3% per day (Chace 1995).

The frequency of predation on Western Wood-Pewee nests was much lower than that of other species building open-cup nests in the Ponderosa Pine forest of Boulder County. Pewee nests were preyed upon (13.6%) much less frequently than were Solitary Vireo nests in the same area (49.4 %,  $n = 81$ , 1993–1994, Chace 1995). Potential nest predators include the Steller's Jay (*Cyanocitta stelleri*), Blue Jay (*C. cristata*), Black-billed Magpie (*Pica pica*), American Crow (*Corvus brachyrhynchos*), Common Raven (*C. corax*), Abert's Squirrel (*Sciurus aberti*), Least Chipmunk (*Eutamias minimus*), Colorado Chipmunk (*E. quadrivittatus*), and the Bull or Gopher Snake (*Pituophis melanoleucus*).

Brown-headed Cowbirds (*Molothrus ater*) did not successfully parasitize any of the 26 pewee nests, while within the same study area 47% ( $n = 132$ ) of Solitary Vireo nests were parasitized in 1984, 1985, 1986, 1992, and 1993 (Chace et al. in press). Some tyrannids accept cowbird eggs and are parasitized frequently (e.g., the Willow Flycatcher, *Empidonax traillii*), while other species reject cowbird eggs (Eastern Kingbird) (Sedgwick and Knopf 1988, Sealy and Bazin 1995) The Western Wood-Pewee is not a frequent host of the cowbird (Friedmann 1971); however, without experimental evidence it is uncertain whether the pewees remove cowbird eggs, drive cowbirds from the nest site, or cowbirds do not choose pewee nests to parasitize.

The low rate of failure due to parasitism and predation in an area where such losses are common suggests that a combination of nest placement and nest defense may increase the nesting success of the Western Wood-Pewee. Briskie et al. (1990) found that parasitism decreased with increasing nest height, which could explain the greater nest success of high-nesting pewees over low-nesting Solitary Vireos (mean height  $2.55 \text{ m} \pm \text{SE } 0.12$ ,  $n = 81$ , Chace 1995). The adults' defense of the nest may contribute to the high nest success in this species. Tyrannids are well known for their aggressiveness (Bent 1942, MacKenzie and Sealy 1981). The Western Wood-Pewee has been observed to drive Steller's Jays from the nest area (Bent 1942, pers. obs.), and nest defense can reduce the frequency of cowbird parasitism (Briskie et al. 1990, but see Smith et al. 1984). We observed a Western Wood-Pewee successfully drive a female cowbird away from an active late-stage (day 14) nest. We observed that when we approached a nest the incubating adult would typically flush silently and perch a short distance away. Discovery of a pewee nest by a predator or cowbird may be difficult since the adults are secretive around the nest site (Uyehara and Narins 1995). However, aggression toward a potential nest predator or cowbird may be beneficial in situations where the intruder has detected the nest. A combination of nest placement and appropriate anti-predator/anti-cowbird behavior may increase the nesting success of Western Wood-Pewees over that of other passerines within the Ponderosa Pine forest.

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