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WILLOW FLYCATCHER NESTING ECOLOGY AND HABITAT RELATIONSHIPS IN THE WILLAMETTE BASIN, OREGON

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Abstract. The Little Willow Flycatcher (*Empidonax traillii brewsteri*) nests in both riparian and upland habitats within low elevation valley and higher elevation forest in the Willamette Basin of northwestern Oregon. Nesting habitat in early-seral conifer forest occurs approximately 4–15 years following even-aged timber harvest or natural events that remove most or all of the forest canopy and allow for extensive growth of a shrub layer. Nesting habitat in the valley occurs in riparian or upland shrub-dominated habitats with an interspersion of herbaceous openings. Our two-year nesting study in the Willamette Basin revealed a Mayfield estimate of seasonal nest success of 40.5% (N = 147). We did not find significant differences in nest success between riparian and upland habitats or between valley and forest habitats; however, there were significant yearly differences. The rate of cowbird parasitism was low (4%), and all parasitism occurred within valley habitats (8% of valley nests). Nest success was significantly higher in western bracken fern (*Pteridium aquilinum*) than other primary nest substrates. Nest habitat selection in early-seral conifer forests was most positive for vine maple (*Acer circinatum*) and trailing blackberry (*Rubus ursinus*), and the best habitat selection model included western bracken fern and vine maple. The greatest concerns for Willow Flycatcher populations in the Basin are the location, type, and timing of management activities, and continued loss and fragmentation of riparian habitat.

Key Words: *Empidonax traillii brewsteri;* habitat relationships; Little Willow Flycatcher; nest success; Oregon; Willamette Basin.

There has been increased interest in the status of Willow Flycatcher subspecies and populations since the Southwestern Willow Flycatcher (*Empidonax traillii extimus*) was listed as endangered in 1995 (U.S. Fish and Wildlife Service [USFWS] 1995). The Oregon Department of Fish and Wildlife (ODFW 1997) listed the Little Willow Flycatcher (*E. t. brewsteri*, hereafter Willow Flycatcher) as State Sensitive in 1997 due to concerns about declining populations and a lack of information on species ecology. *E. t. brewsteri* was formerly a Federal Candidate species (USFWS 1994), and a Federal Species of Concern in Oregon (G. Miller, pers. comm.). The Willow Flycatcher also is a Focal Species for conservation in the Westside Lowlands and Valleys Bird Conservation Planning Region of the Oregon–Washington Chapter of Partners in Flight (Altman 2000).

E. t. brewsteri breeds west of the Sierra Nevada/Cascade Mountains crest north from Fresno County, California to the east coast of Vancouver Island and the Fraser Lowlands in British Columbia (Unitt 1987, Sedgwick 2000). In the Willamette Basin (hereafter Basin) of northwestern Oregon, it occurs in both lowland valley and higher elevation forest habitats. From around the turn of the century through the mid 1900s, all ornithologists used the word "common" in their description of Willow Flycatcher abundance in the Willamette Valley (hereafter Valley) (e.g., Johnson 1880; Anthony 1886, 1902; Gabrielson and Jewett 1940, Gullion 1951).

Breeding Bird Survey (BBS) data for the last 30+ years indicate significant population declines of 3.6% per year for *E. t. brewsteri* in western Oregon and Washington and northwestern California (Sauer et al. 2000). In that same time period, the Valley population trend has mirrored the regional trend (i.e., declining at 4.1% per yr), although the trend is not significant and the sample size (N = 11) is small. Descriptive analysis of BBS data in the Valley indicated that the Willow Flycatcher population has declined from a mean of approximately 11–13 birds per route in the early 1970s to 4–5 birds per route throughout the 1990s. However, on forest BBS routes in the Basin (N = 12), mean number of birds per route has remained relatively steady around 4 birds per route.

We initiated a two-year study in the Basin in 1999 to identify conservation and management needs for Willow Flycatcher. The two primary objectives were: (1) examine nest success as a potential factor in population declines, especially differences in nest success between geographic regions (high elevation forest and low elevation valley), habitat types (riparian and upland), and other parameters (e.g., nest substrate, human activity levels, proximity to water, roads, etc.); and (2) identify important habitat features at nests to help direct habitat management.

METHODS

Study Area

The Basin encompasses ca. 7200 sq km between the crest of the Cascade and Coast Ranges in northwestern Oregon (Wentz and McKenzie 1991). The Basin is approximately 75 km long, and ranges from 30–60 km wide. It includes the broad alluvial floodplain of the Valley floor (ca. 2100 sq km), and is bounded by mountain slopes and foothills on three sides and by the Columbia River on the north. Elevations range from 100 m at the mouth of the Willamette River near Portland to 3423 m in the Cascade Mountains. Land uses are predominantly forestry and recreation in the mountains, and urban and agriculture in the lowlands.

Historical vegetation in the Valley included wet and dry prairies, riparian forest and shrub, and *Quercus* woodlands and savannah. Most of the native vegetation has been converted to agricultural and urban uses. The Valley comprises 12% of Oregon's area, yet has >70% of its human population (Keisling 2000); land ownership is >90% private (Puchy and Marshall 1993).

The climax forest association in most of the Basin is western hemlock (*Tsuga heterophylla*)—western redcedar (*Thuja plicata*) (Franklin and Dyrness 1973); however, much of the study area is dominated by the seral species Douglas-fir (*Pseudotsuga menziesii*). Ownership within the forested portion of the Basin is an approximately equal mix of public and private lands.

Site Selection

We selected two forest watersheds, Molalla and Lake Creek, based on land ownership of project cooperators, and equal representation from the Cascade Mountains and Coast Range respectively. We randomly selected a pool of 10–12 early-seral forest sites of <15 ha within each watershed; each was clearcut 5–20 years prior to our study. Final site selection, made in the field based on access and personnel limitations, resulted in eight study sites in the Molalla watershed and four sites in the Lake Creek watershed.

Private land ownership precluded systematic sampling in the Valley. We opportunistically selected numerous riparian and upland sites considering presence and abundance of Willow Flycatchers, geographic distribution, accessibility, habitat type, and permission to access.

Nest Monitoring

We located nests by observing behavioral cues, then marked and revisited them in a manner designed to reduce predator attraction and investigator-induced predation (Martin and Geupel 1993). Each nest was monitored every three to four days until either the young fledged or the nest failed. We considered a nest successful if at least one young was observed as a fledgling or indirect evidence (e.g., flattened nest rim, extensive fecal matter in nest and on rim) on the final visit suggested fledging. Failed nests were examined to identify cause of failure. If nest contents (eggs or nestlings) were removed, the nest was considered depredated.

We subjectively categorized the level of human activity within 50 and 15 m of each nest as low (occasional or no human activity), moderate (few people on most days), or heavy (daily use by many people).

Habitat Characterization

Data collected at each nest included nest height; nest substrate and substrate height; an ocular estimate of nest concealment from above and below with the nest centered in a 0.3 m box (poor = <20% concealed; fair = 20–60%; good = 60–90%; excellent = >90%); and distances to the nearest road and water. We collected nest vegetation data within a 1-m^2 plot centered on the nest with the corners oriented in each cardinal direction (referred to as nest), and in 5- and 11.3-m radius circular plots centered on the nest (referred to as nest area). Data collected at each plot scale included ocular estimates (to the nearest 5%, totaling 100%) of percent vegetation cover by growth form (i.e., grass/forb, shrub layer, tree layer), by species, and also for non-vegetation (i.e., litter/residue, bare ground, rock, water).

We categorized a nest location as riparian if any hydrophytic vegetation (e.g., willow [*Salix* sp.], Douglas spirea [*Douglasii spiraea*], red-osier dogwood [*Cornus stolonifera*]) was present within an 11.3 m radius of the nest.

Nest Habitat Selection

We assessed nest habitat selection at three different sites in the Molalla Watershed; two revegetating harvest units in 1999, and a different harvest unit in 2000. We collected data at plots randomly located from the center of the study site. The number of random points sampled was equivalent to the number of nests located within the study site. Data collection followed the same protocol as that at nests except for nest-specific data.

Data Analysis

Nest success

We estimated nest success using the Mayfield method (Mayfield 1975) and proportional measures of nest success (i.e., number of successful nests versus number of nests monitored). We calculated 95% normal confidence intervals (CI; Zar 1996) about the Mayfield estimates to determine whether significant differences in nest success occurred between categories. Paired habitat comparisons included forest versus valley (riparian and upland combined), riparian versus upland, and valley upland versus forest upland. We also compared nest success among nest substrate plant species, and between exotic and native nest plant substrates. Mayfield estimates were considered statistically different at the two tailed alpha = 0.05 if the CI did not overlap.

We conducted two-sample t-tests using a pooled standard deviation to compare percent cover variables for growth form and several nest characteristics between successful and failed nests.

Resource selection

We modeled Willow Flycatcher nest habitat selection by fitting multivariate logistic regression models with stepwise model selection procedures in PROC LOGISTIC in SAS (SAS Institute 2000) using nests

TABLE 1. WILLOW FLYCATCHER NEST SUCCESS IN THE WILLAMETTE BASIN, OREGON, 1999–2000

Category	Nests	Proportional nest success[a]	Exposure days	Daily survival rate	Mayfield success estimates[b]	95% CI
All nests	147	0.585	2055	0.970	0.405	na
Forest	72	0.583	1052.5	0.972	0.420	0.304–0.536
Valley	75	0.586	1002.5	0.969	0.390	0.277–0.503
Riparian	31	0.613	447	0.973	0.441	0.263–0.620
Upland	116	0.578	1618	0.970	0.397	0.306–0.488
Forest upland	69	0.594	1018.5	0.973	0.433	0.314–0.553
Valley upland	47	0.553	589.5	0.964	0.337	0.204–0.487

[a] Proportional success is percentage of successful nests of the total nests monitored.
[b] Mayfield success estimates are calculations of nest success based on days of observation.

as used data and random plots as available data. Two models were fit with all variables (percent cover for either growth form or species) for a given location and year. We report test results as significant ($P < 0.10$ or $P < 0.05$) or highly significant ($P < 0.01$).

RESULTS

NESTING CHRONOLOGY

Most Willow Flycatchers arrived in the Basin in the last week of May with peak arrival in the first week of June. The earliest observation of nest building was June 9 and the earliest date of a nest with eggs was June 14; most nest-building and egg-laying occurred in mid- to late June. The earliest hatch date was June 21 and the earliest fledging was July 8. Most hatching occurred in early to mid-July and fledging in the last 10 days of July and the first week of August. Nearly one-third of the nests (31%, N = 46) were still active in August, including nine (20%) that still had eggs. Most of the nests active in August fledged during the first week of August (70%, N = 32); the latest fledge date was August 22.

REPRODUCTIVE SUCCESS

We located and monitored 147 nests (Table 1); 86 (58%) were successful (Mayfield nest success = 40%). Among the six habitat nest location categories, Mayfield estimates were lowest in valley upland (34%) and highest in riparian (44%). Mean clutch size of nests for which there was complete information was 3.4 eggs (range 2–4, N = 115). Mean number of young fledged per nest (successful and unsuccessful) was 1.7. There were no significant differences in clutch size or fecundity between forest and valley habitats or between riparian and upland habitats.

We did not find significant differences in the two-year Mayfield estimates between valley (39% ± 0.1 SE) and forest (42% ± 0.1 SE) habitats, or between riparian (44% ± 0.1 SE) and upland (40% ± 0.04 SE) habitats (Table 1). However, when the data were separated by year, nest success was significantly different between riparian and upland habitats in each year: greater in upland in 1999 and greater in riparian in 2000. Nest success also was significantly different for riparian habitats between each year (2000 > 1999).

Among the four predominant nest substrates, Mayfield estimates of nest success were lowest in vine maple (*Acer circinatum*; 17%) and highest in western bracken fern (*Pteridium aquilinum*; 78%) (Table 2). Nest success was significantly higher in western bracken fern than Himalayan blackberry (*Rubus procerus*) and vine maple, and higher (but not significantly so) than Scot's broom (*Cytisus scoparius*). Nest success was not significantly different between exotic (35% ± 0.1 SE) and native plants (45.9% ± 0.1 SE E).

There was no significant difference in mean percent cover of any plant growth form between successful and failed nests (Table 3), and among the nest and nest site variables only nest height differed (higher at successful nests, $P = 0.098$; Table 4). Proportional nest success was 56% (N = 25) and 55% (N = 55) where human activity was moderate or heavy within 15 m and 50 m, respectively. Proportional nest success was similar (approximately 55–60%) over differing distances up to 50 m from the nearest road, then increased from 51–100 m (Fig. 1). Nest success also increased as the distance to water decreased (Fig. 1).

Nests were parasitized at three sites, and the overall rate of cowbird parasitism was low (4%, N = 6). All parasitism occurred in valley habitats (8% of valley nests), and 5 of the 6 parasitized nests failed.

NESTING HABITAT

We located nests in 17 different plant species, but four species (Himalayan blackberry, N = 47; western bracken fern, N = 21; Scot's broom, N = 19; vine maple, N = 19), accounted for 71% of the nests. Mean nest height (N = 144 nests) was 1.1 m ± 0.4 SD, mean height of the nesting

TABLE 2. WILLOW FLYCATCHER NEST SUCCESS, BY PLANT SUBSTRATE, IN THE WILLAMETTE BASIN, OREGON, 1999–2000

Category	Nests	Proportional nest success[a]	Exposure days	Daily survival rate	Mayfield success estimates[b]	95% CI
Himalayan blackberry	47	0.553	639.5	0.967	0.368	0.227–0.509
Western bracken fern	21	0.857	367	0.992	0.781	0.601–0.961
Scot's broom	19	0.526	288	0.969	0.385	0.162–0.608
Vine maple	19	0.421	193	0.943	0.175	0.000–0.345
Exotic species	71	0.465	959	0.966	0.350	0.237–0.463
Native species	76	0.632	1096	0.974	0.459	0.345–0.573

[a] Proportional success is percentage of successful nests of the total nests monitored.
[b] Mayfield success estimates are calculations of nest success based on days of observation.

substrate was 2.0 m ± 0.7 SD, and mean distance from the nest to the edge of the shrub patch was 5.9 m ± 11.1 SD.

Shrub layer vegetation dominated the cover at nest sites (80% ± 25.3 SD; Table 3). There were no significant differences in mean percent cover by growth form or plot scale between successful and failed nests. In the habitat selection models for percent cover by growth form, shrubs (+) were the only variable in the best model (two of the three sites).

Habitat selection for nest plant species was most pronounced for vine maple (highly significant at all three sites) and trailing blackberry (highly significant at two sites) (Fig. 2). Cover of Himalayan blackberry and Scot's broom were significantly greater at nest plots at one site each, while cover of western bracken fern was significantly greater for nests at one site and at random plots for another site. Species selected against as nesting habitat (i.e., significantly more cover at random plots) were California hazel (*Corylus cornata*; highly significant at all three sites), Douglas-fir (highly significant at one site and significant at another site), and cascara (*Rhamnus purshiana*; significant at one site).

Two of the three sites had significant variables in the model for percent cover by species. California hazel, western blackcap (*Rubus nigerrimus*), Douglas-fir, and western redcedar (all −) were in the best model at the Bureau of Land Management (BLM) 1999 unit. Western bracken fern and vine maple (both +) were in the best model at the Willamette 2000 unit.

DISCUSSION

HABITAT

The Willow Flycatcher is a characteristic species of many shrub-dominated habitats in the Basin. Nesting habitat in early-seral conifer forest occurs approximately 4–15 years following even-aged timber harvest or natural events that remove most or all of the forest canopy and allow for extensive growth of a shrub layer. Nesting habitat in the Valley occurs in riparian or upland shrub-dominated areas with an interspersion of herbaceous openings, and with or without the presence of scattered trees.

The strong association of Willow Flycatcher with upland habitats in the Basin is in contrast to its obligate association with riparian habitats in the arid parts of western North America. The consistent habitat features throughout its range are moisture and the dominance of shrubs or a dense shrub layer of vegetation. In most of the

TABLE 3. DIFFERENCES IN MEAN PERCENT COVER BETWEEN SUCCESSFUL AND FAILED WILLOW FLYCATCHER NESTS, BY GROWTH FORM AND PLOT SCALE, IN THE WILLAMETTE BASIN, OREGON, 1999–2000

Growth form	Scale (m)	Successful nests (N = 85)		Failed nests (N = 60)		P
		Mean ± SD	95% CI	Mean ± SD	95% CI	
Herbs	1	10.5 ± 15.2	7.3–13.8	12.2 ± 17.7	7.6–16.7	0.551
	5	25.3 ± 19.8	21.0–29.6	29.1 ± 19.4	24.1–34.1	0.255
	11.3	19.1 ± 18.5	15.1–23.1	21.5 ± 18.0	16.9–26.1	0.441
Shrubs	1	80.2 ± 24.6	74.9–85.5	79.0 ± 26.6	72.1–85.9	0.784
	5	57.1 ± 23.2	52.1–62.1	54.2 ± 22.0	48.5–59.8	0.438
	11.3	66.1 ± 24.4	60.8–71.4	66.8 ± 24.4	60.5–73.1	0.862
Trees	1	9.0 ± 23.2	4.01–14.0	7.9 ± 22.6	20.1–13.8	0.780
	5	14.5 ± 17.2	10.8–18.2	12.1 ± 13.1	8.7–15.5	0.367
	11.3	12.0 ± 18.6	8.0–16.0	8.7 ± 16.5	4.4–12.9	0.267

TABLE 4. DIFFERENCES BETWEEN SUCCESSFUL AND FAILED WILLOW FLYCATCHER NESTS, BY NEST AND NEST SITE CHARACTERISTICS, IN THE WILLAMETTE BASIN, OREGON, 1999–2000

Characteristic	Successful nests (N = 85)		Failed nests (N = 59)		P
	Mean ± SD	95% CI	Mean ± SD	95% CI	
Activity within 15 m	1.5 ± 0.5	1.1–1.3	1.2 ± 0.5	1.1–1.4	0.774
Activity within 50 m	1.5 ± 0.7	1.4–1.7	1.5 ± 0.8	1.3–1.7	0.975
Nest concealment above	3.1 ± 0.7	2.9–3.2	2.9 ± 0.8	2.7–3.1	0.234
Nest concealment below	2.3 ± 0.8	2.1–2.5	2.1 ± 0.7	1.9–2.3	0.216
Distance to edge (m)	4.0 ± 3.6	3.2–4.8	3.2 ± 3.4	2.3–4.1	0.185
Nest height (m)	1.2 ± 0.5	1.0–1.3	1.0 ± 0.3	0.9–1.1	0.098
Nest substrate height (m)	2.0 ± 0.71	1.8–2.1	2.0 ± 0.7	1.8–2.2	0.690

arid West, moist shrubby conditions occur only in riparian habitat. In the temperate rainforests of northwestern Oregon, the Willow Flycatcher is a regularly occurring species in shrub-dominated upland habitats because moisture is not a limiting factor in vegetation growth, and a dense shrub layer can develop exclusive of riparian areas.

Although Willow Flycatchers nested in upland habitats in both the valley and forest, the higher nest success in riparian habitats and the progressively higher nest success with proximity of nest to water indicates a consistent positive pattern with riparian habitat. These data and the strong association of Willow Flycatcher with riparian habitat in the West suggest that conditions associated with riparian shrub habitat in the Valley may be most suitable. Upland habitats, particularly in the Valley, may be used because of the limited availability of riparian habitat, but these may be functioning as less than optimal habitat.

Willow Flycatcher nesting habitat in early-seral stages of managed forests of the Basin has a life span of approximately 10–12 years. However, the amount of this habitat across the landscape at any point in time is likely to be consistent where forests are managed using even-aged silviculture with standard rotations for sustainable wood production. Thus, the conservation issue for Willow Flycatcher in managed forests is not loss of habitat, but the shifting of habitat and the ability of the species to locate and colonize habitat as new areas become available. This is apparently not a problem because Willow Flycatchers occur at some sites <3 years post-harvest if patches of deciduous vegetation have been retained or resprouted, and sites that are 4–6 years post-harvest are often densely populated with flycatchers.

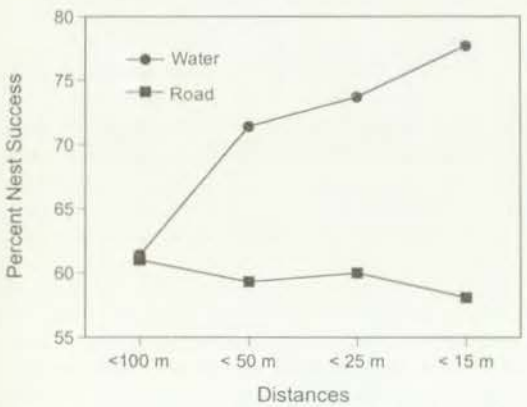

FIGURE 1. Relationship between Willow Flycatcher nest success and distance to roads and water in the Willamette Basin, Oregon, 1999–2000.

Willow Flycatcher use of forest habitats in the Pacific Northwest likely increased with the advent of large-scale clearcutting in the last 50–100 years. Additionally, the amount of upland non-forest habitats dominated by exotic shrubs such as Himalayan blackberry and Scot's broom has likely increased in the last 50 years. Both these factors may be compensating for loss of the flycatcher's riparian nesting habitat, in terms of regional habitat availability. Riparian habitat in the Valley is highly fragmented and much smaller in extent than at the time of European settlement (Titus et al. 1996), and continues to be reduced in extent in recent years (Frenkel et al. 1983).

NESTING

Nest success among Willow Flycatcher subspecies has been reported to be highly variable, but generally lower for Southwestern Willow Flycatcher than the other three subspecies (Stoleson et al. 2000b). Our Mayfield estimate of nest success (40%) matches that reported for a population of *E. t. brewsteri* in the Sierra Nevada (40%, N = 90; Bombay 1999). Small nest sample sizes for other populations of *E. t. brewsteri* limit the validity of other comparisons; however, our proportional nest success (58%) is sim-

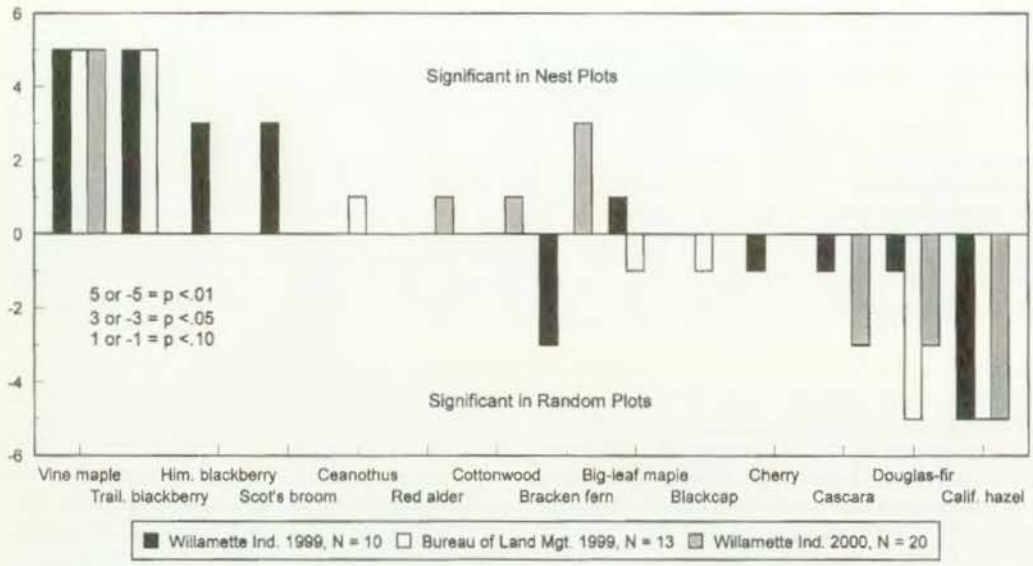

FIGURE 2. Vegetative cover of plant species significantly associated with Willow Flycatcher nest sites and random plots in three revegetating harvest units in the Molalla watershed, Oregon, 1999–2000.

ilar to that reported in the Sierra Nevada (54.5%, N = 11; Sanders and Flett 1989), and higher than another site in the Sierra Nevada (37.5%, N = 8; Kings River Conservation District 1985) and in British Columbia (33%, N = 6; Campbell et al. 1997).

Our proportional nest success rate compares favorably with nest success rates for open-cup nesting passerines in North America, which range from approximately 38–70% with a mean of 52% (Nice 1957, Martin 1993). However, these multi-species summaries include many species with different reproductive strategies than the Willow Flycatcher (e.g., double or triple-brooding, larger clutch size). Other species' nest success rates may not be comparable with a species like Willow Flycatcher, which is mostly single-brooded in the Basin and has a relatively low reproductive capability. Nest success for a single-brooded species generally needs to be greater than that of multiple-brooded species in order to sustain populations. Murphy (1983) suggested that flycatchers in general, most of which are single-brooded, have evolved the need to have a relatively high nest success rate.

Willow Flycatchers in the Valley often nested close to areas of moderate or high human activity, but human activity did not appear to be a factor in nest success. Where human activity was moderate or heavy, nest success (55%) was nearly the same as overall proportional nest success (58%), and proportional nest success in valley habitats (59%, N = 75) where most of the human population occurs.

Despite the dominant agricultural landscape of the Valley, cowbird parasitism did not appear to be a limiting factor for Willow Flycatcher populations. The Brown-headed Cowbird population trend in the Valley is similar to that of Willow Flycatcher; i.e., a non-significant declining trend of 2.4% per year (4.1% for Willow Flycatcher) with a mean relative abundance of 9 birds per route (6.2 for Willow Flycatcher; Sauer et al. 2000). Our parasitism rate was similar to that reported for *E. t. brewsteri* in British Columbia (7%, N = 45; Campbell et al. 1997).

We found no evidence or indication of double-brooding (i.e., raising a second brood after successfully fledging a first), and this is considered rare in northern populations of Willow Flycatchers (Sedgwick 2000). The range of our fledging dates, coupled with the fact that a complete reproductive cycle for successful nests takes approximately 30–35 days, suggests that double-brooding is probably a rare event in the Basin.

Despite a concerted effort to locate nests in riparian habitat, especially in 2000, our riparian nest sample was disproportionately low. This could have arisen due to logistical inefficiencies in sampling riparian areas and/or fewer birds nesting in riparian habitat. Most riparian shrub patches are small, linear, and patchily distributed across the landscape with single pairs or small

populations. Sparse and patchy habitat logistically requires more time to locate and monitor nests than those in continuous habitat. Conversely, upland shrub patches in the valley and in the forest often are extensive enough to support numerous pairs, thus requiring less time to find and monitor nests.

MANAGEMENT AND CONSERVATION

Riparian shrub habitat should be emphasized when management for Willow Flycatcher is being considered in the Valley. Anecdotal references confirm the historic association of Willow Flycatcher with riparian habitat, and current knowledge of the loss of riparian habitat coincides with recent declining population trends (i.e., BBS data). Our data also suggested an emphasis on riparian habitat because nest success was higher there and lower in upland valley habitat.

Management to control deciduous shrub vegetation in revegetating clearcuts, often via spraying or hand removal, is a concern for Willow Flycatcher populations in early-seral forests of the Basin. Because nearly all the nesting substrates in early-seral forest were deciduous shrub or shrub-layer vegetation, removal or killing of such deciduous vegetation should be discouraged where Willow Flycatcher management is a priority.

Two of the four plant species in which most nests were found (Himalayan blackberry and Scot's broom) are both aggressive exotic species that outcompete native shrubs and form shrub monocultures. Much of the current habitat restoration work in the Valley includes removal of these species, which could be detrimental to nesting Willow Flycatchers at that site. If the long-term management at such sites does not (as is often the case) include restoring a shrub-dominated community, the negative impacts could be long-term. However, concerns about the adverse impact of exotic plant control on Willow Flycatcher habitat and populations in the Valley are tempered by several factors. First, restoration activities are not widespread, and the degree to which restoration activities remove Himalayan blackberry and Scot's broom may not keep ahead of the rate at which new areas are overtaken by both species. Secondly, populations in early-seral forest habitats are not impacted by restoration activities and these habitats support a substantial portion of the Willow Flycatchers in the Basin. Finally, some habitat restoration work in the Valley includes development of riparian shrub vegetation, which has the potential for providing suitable Willow Flycatcher habitat in the future.

The most immediate concern about adverse impacts of restoration and management activities on Willow Flycatchers in the Basin is the timing of the actions, especially because nearly one-third of Willow Flycatcher nests were still active in August. Where protocols call for restoration activities outside the breeding season, the terminal date of breeding is often given as July 15 or August 1. Activities initiated immediately after the former date would impact most Willow Flycatcher nesting, and after the latter up to one-third of the nests. If management and restoration actions are scheduled to avoid or minimize impacts on nesting Willow Flycatchers, August 15 should be considered the end of the nesting season. Management conducted prior to this date could result in a local population that loses a partial or entire cohort, which would impact not only that breeding season but subsequent ones as well.

We speculate that the high nest success in western bracken fern may be related to the fragile nature of the plant. Most potential nest predators (e.g., squirrels, chipmunks, snakes) would likely not be supported by the vegetation in their approach to the nest, except perhaps for small mammalian predators such as mice. Willow Flycatcher nesting in western bracken fern has been reported in the Basin from the late 1800s (Anthony 1886). Most nests of *E. t. brewsteri* in British Columbia (43%, N = 44) were in western bracken fern (Campbell et al. 1997). Western bracken fern is a native species that readily occupies open forest habitats that are not intensively managed for timber. It should be considered a high priority for retention if a management goal is to support nesting Willow Flycatchers.

We are uncertain about the value of vine maple to Willow Flycatchers in early-seral forests. Vine maple was positively associated with nesting habitat at all three sites and was a positive variable in the best habitat model for one of the sites. However, nest success in vine maple was extremely low. Unlike western bracken fern, vine maple may provide more opportunities for mammalian predation because it has a woody and well-branched structure for a climbing predator. Thus, vine maple may provide unique cover or foraging habitat that is selected for in the nest area, but it may be deficient when selected as the actual nest substrate.

Despite significant population declines for *E. t. brewsteri* as indicated by the BBS, Willow Flycatcher is a regularly occurring species in both forest and lowland shrub-dominated habitats in the Basin. Our data indicated that nest success was not significantly influenced by location (forest or valley), habitat (riparian or upland), human activity, or cowbird parasitism.

The greatest concerns for Willow Flycatcher populations in the Basin are the location, type, and timing of management activities, and continual loss and fragmentation of riparian habitat. Willow Flycatcher conservation in the Basin will require balancing maintenance of suitable conditions in early-seral forests with efforts to enhance the capacity of riparian habitat in the Valley to support expanded populations. We suggest that both of these approaches will be most successful if management supports factors related to habitat selection and higher nest success as described in this study.

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