State of California
THE RESOURCES AGENCY
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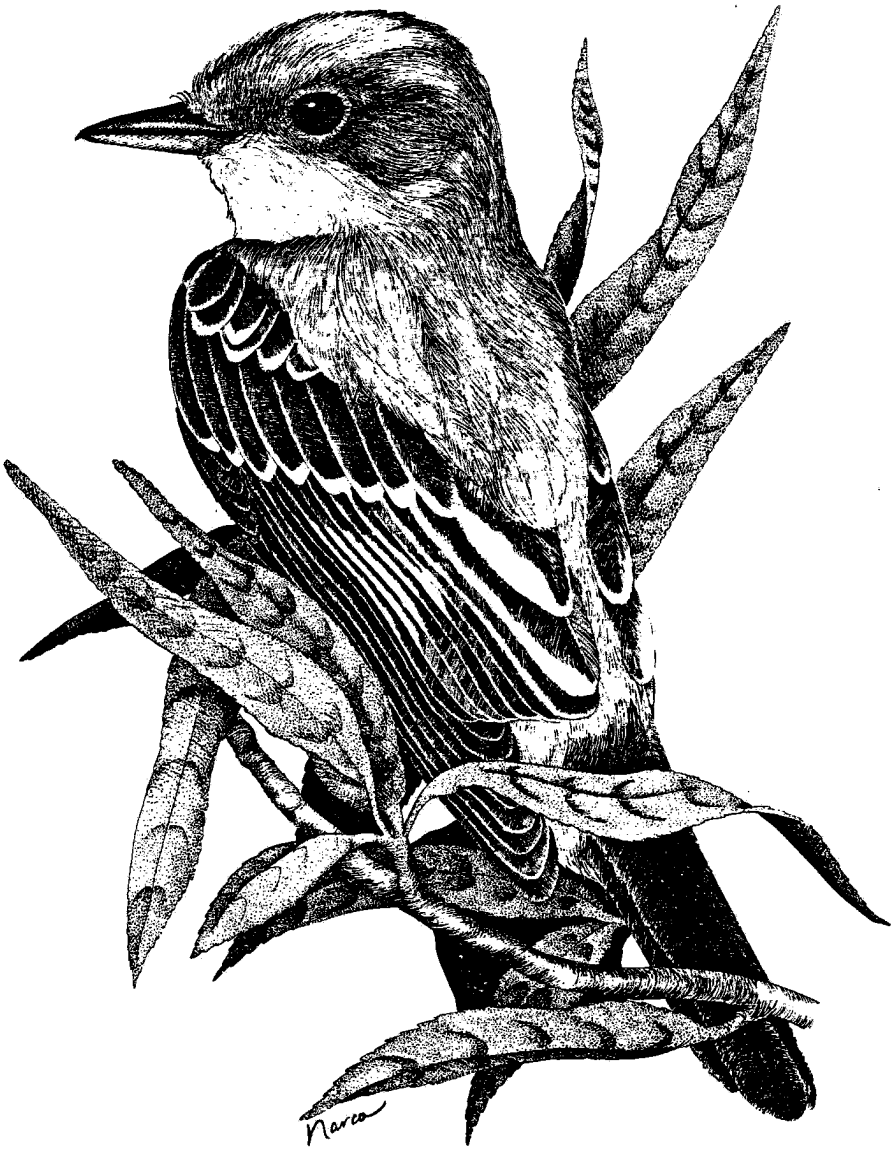
By
Melody Serena



Wildlife Management Branch
Administrative Report 82-27
October 1982

Cover: Willow Flycatcher (*Empidonax traillii*)

Art Work by Narca Moore-Craig

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ABSTRACT

Willow Flycatchers (*Empidonax traillii*) were surveyed on six National Forests (Inyo, Sierra, Stanislaus, Tahoe, Plumas, Lassen), Yosemite National Park, and along the South Fork of the Kern River. These areas span the north-south axis of the Sierra Nevada. A total of 72 singing males or pairs was located: 2 in the Inyo; 12 in the Sierra; 39 in the Tahoe, 4 in the Plumas; 8 in the Lassen; 5 in Yosemite; and 2 along the Kern River. An additional 49 records of singing males were provided by independent observers in 1982: 5 in the Stanislaus National Forest; 2 along the Eel and 7 along the Mad River, in Humboldt County; 8 along the Santa Margarita River and 2 near the Dairy Mart Ponds, in San Diego County; and 25 along the South Fork of the Kern River, in Kern County. Some records may represent transient individuals.

A statistically significant association was found between Willow Flycatcher occurrence and meadow size: birds were most frequently found on relatively large meadows. Flycatcher occurrence was also significantly associated with stream size, with birds most often occurring near large streams. No significant association existed between flycatcher occurrence and either the percent of the meadow covered by water or the percent covered by willow.

A significant positive association was found between the occurrence of Brown-headed Cowbirds (*Molothrus ater*) and Willow Flycatchers. Cowbirds were observed in the majority of meadows where flycatchers were seen, and were also relatively very common where Willow Flycatchers were found most abundantly, on the Tahoe National Forest. It follows that cowbirds are apparently not successful in completely eliminating Willow Flycatchers where the two come into contact. At the same time, ample opportunity exists for some amount of reduction in the flycatcher population because of nest parasitism. Cowbirds also may be responsible for localized instances of Willow Flycatcher extirpation.

Factors which potentially have contributed and continue to contribute to the loss of Willow Flycatcher habitat in the Sierra Nevada include the development of reservoirs, grazing of willow by livestock, meadow erosion, fires set in the past by cattlemen and sheepherders, lodgepole pine encroachment of meadows, and the diversion of streams for hydroelectric development.

Wildlife Management Branch Administrative Report 82-27
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RECOMMENDATIONS

1. Devote at least one more field season to Willow Flycatcher survey work, in order to define the status of this species in California.

2. Work with other agencies to limit the adverse impact of grazing on willow stands in meadows on public land.

3. Work with other agencies to curtail erosion along streams in meadows on public land.

4. Initiate further research to define the impact of Brown-headed Cowbirds as nest parasites of Willow Flycatchers.

5. Monitor the development of hydroelectric projects with respect to their possible detriment to areas of known or potential Willow Flycatcher habitat.

6. Work with other agencies to reestablish willow where it is absent in areas of otherwise suitable Willow Flycatcher habitat.

INTRODUCTION

The official breeding range of the Willow Flycatcher, (Empidonax traillii) (formerly identified as the western race of Traill's Flycatcher (E. t. brewsteri)) extends "from extreme southwestern British Columbia, northern Washington, central Idaho, and central Wyoming south to northern Lower California, southern New Mexico, central Texas, and Durango" (Bent 1942, quoting the 1931 A.O.U. Checklist). The species is also known to breed regularly in the eastern United States, south of approximately Kentucky, Maryland, and New Jersey (Bent 1942.). Historically, Willow Flycatchers nested across the entire length and breadth of California, virtually wherever mesic willow thickets occurred (Grinnell and Miller 1944). In the last few decades, however, they have been eliminated from virtually all lower elevation habitats in the state. No recent breeding records are available from either the Sacramento or the San Joaquin Valleys, including areas of apparently excellent nesting habitat such as occur on the Nature Conservancy's Creighton Ranch Preserve (Rob Hansen, Alan Craig, independent pers. comms.). The species occurs only sporadically in low-lying southern California, with recent breeding records confined to a few sites in San Diego County (Garrett and Dunn 1981; Salata 1981).

Two factors have been consistently blamed for the reduction in numbers of Willow Flycatchers: the elimination of breeding habitat, and nest parasitism by Brown-headed Cowbirds (Molothrus ater). Changes associated with agricultural development in the San Joaquin and Sacramento Valleys (e.g. the draining of wetlands and the clearing of riparian vegetation) have directly and greatly diminished the extent of suitable Willow Flycatcher nesting habitat in these two areas; progressive agricultural development has simultaneously encouraged the proliferation of cowbirds, which were unknown west of the Sierra Nevada before approximately 1920 (Rothstein et al. 1980). Given Willow Flycatchers' strong propensity for "broad bottomlands" (Grinnell and Storer 1924), the damming of major drainages from the North Fork of the Feather River south to the South Fork of the Kern has also probably eliminated long stretches of originally prime flycatcher habitat across the state. Cowbird nest parasitism has been singled out as the factor most responsible for virtually eradicating nesting Willow Flycatchers from southern California in general; to the north, recent records have indicated that the species breeds locally in montane willow thickets where cowbird pressure is presumed to be less severe (Garrett and Dunn 1981).

Based on the preceding information, the goals of this study were fourfold: 1) gather and synthesize records documenting the historical occurrence of Willow Flycatchers in California; 2) document the distribution of Willow Flycatchers in selected portions of montane California; 3) describe essential and limiting aspects of their breeding habitat in these areas, and 4) obtain data bearing on the potential importance of Brown-headed Cowbirds in limiting Willow Flycatcher populations as a result of nest parasitism.

METHODS

Surveys were conducted on public and private lands within the boundaries of six National Forests (Lassen, Plumas, Tahoe, Stanislaus, Sierra, Inyo), Yosemite National Park, and land included in and adjacent to the Nature Conservancy's Kern River

Preserve, along the South Fork of the Kern River (Figure 1). This provided a representative sampling of Willow Flycatcher habitat along the entire length, and on both east and west slopes of the Sierra Nevada. Specific survey sites were selected in accordance with the following criteria: 1) Suitability of habitat -- current opinion and published accounts agree that breeding Willow Flycatchers in California are expected to be found in situations that are more or less open (i.e. lacking high canopy cover), mesic, and include some proportion of willow clumps or thickets. 2) Accessability -- time and vehicle limitations demanded that surveys be conducted at sites located within a mile or two of roads traversable by two wheel drive vehicles.

Field work extended from 1 June to 21 July, 1982. This interval was determined by the breeding biology of the birds: Willow Flycatchers are one of the last spring and the first fall transients, with spring migrants occurring in potential breeding habitat well into June, and fall migrants beginning to leave by the end of July (Garrett and Dunn 1981). To augment confusion, transient males indulge in such characteristically territorial activities as singing and chasing each other (Rob Hansen, pers. comm.), and breeding males essentially stop singing once the young are fledged, or soon after (Ettinger and King 1980). Male Willow Flycatchers were accepted to be resident and breeding if they were observed to sing repeatedly from an exposed perch in characteristic territorial fashion and/or react to a taped Willow Flycatcher song by first approaching the source of the sound and then singing in turn. Thus, survey results from especially the first three weeks of June potentially were biased in opposing directions: 1) non-breeding transients may have been counted as local breeders; 2) late arriving breeders may have been entirely missed. Survey dates for the various areas considered in this study are specified in the Results.

Additional data were collected at survey sites in order to quantitatively describe the sites and evaluate the impact of Brown-headed Cowbirds on Willow Flycatchers. These data were:

1) Size of meadow. This was estimated visually.

2) Overall "wetness" of the meadow. This was estimated as the percent of ground which was at least slightly covered by free water, either standing or moving.

3) Percent cover by willow (Salix spp.). This was estimated as the percent of meadow covered by vertically projected willow "crowns". Unless otherwise stated, willows may be assumed to have taken the growth form of clumps or thickets from 1.0 to 3.0 m in height (3.3 to 9.9 ft).

4) Occurrence and type of running water on or adjacent to the meadow. "Rivulets" were defined as moving water bodies less than 0.3 m (1 ft) wide. "Small streams" were approximately 0.3 to 1.3 m (1 to 4 ft) in width. "Large streams" constituted the balance of moving water bodies.

5) Number of Brown-headed Cowbirds of either sex heard or observed in the meadow or its immediate environs.

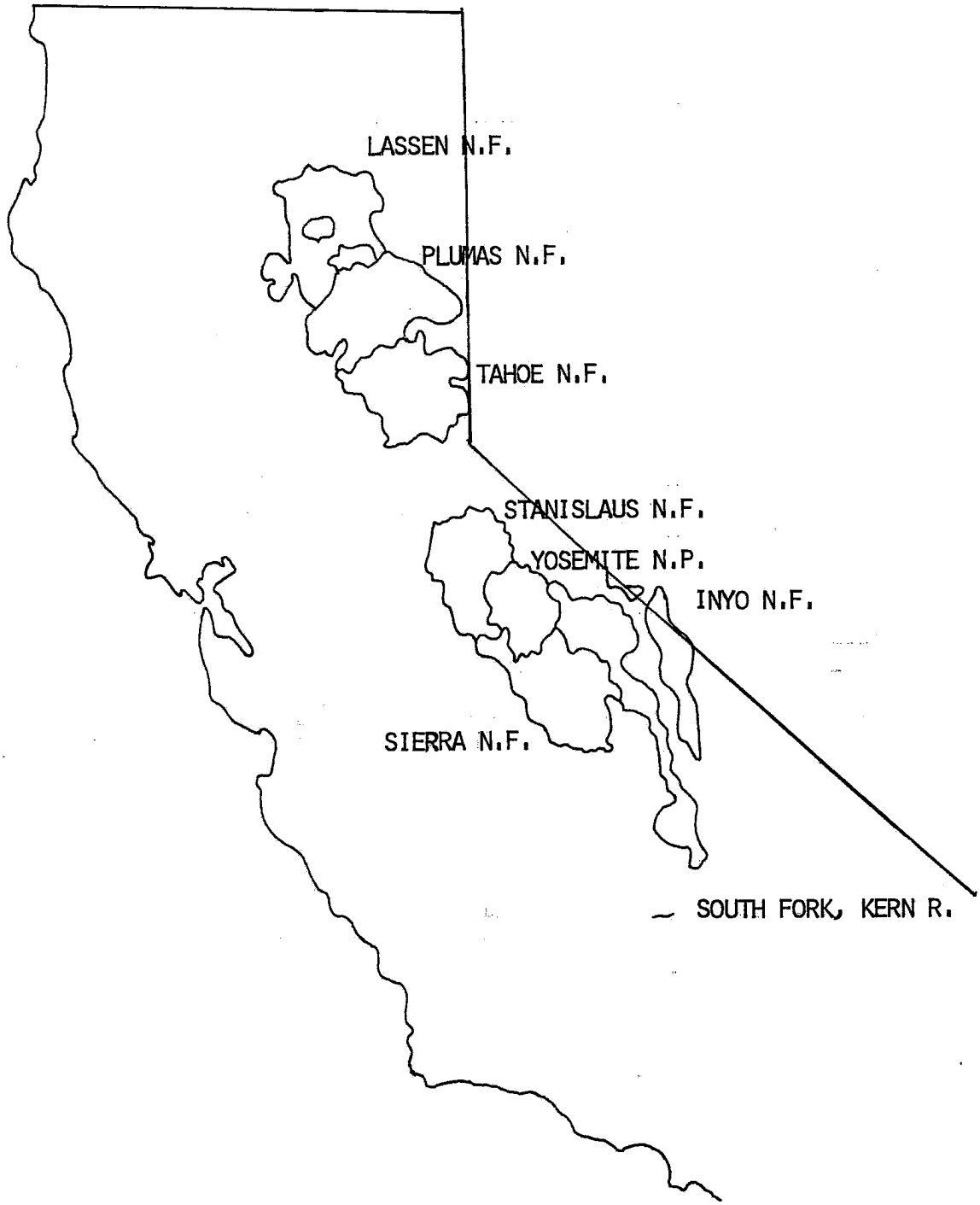

FIGURE 1. WILLOW FLYCATCHER SURVEY AREAS
IN THE SIERRA NEVADA, 1982

RESULTS

Historical Distribution of Willow Flycatchers in California

Review of accounts published between 1913 and 1944 indicates that Willow Flycatchers were predictably found in areas of suitable habitat in California throughout that time.

In the southern part of the state, Willett (1933) described the species as a common summer resident of willow thickets in low-lying areas as well as mountain canyons to more than 1524 m (5000 ft). Specific breeding localities which he cited include Pasadena, Lytle Creek Canyon in the San Gabriel Mountains, and near Colton, San Bernardino Co., and Los Angeles. Elsewhere in the south, Grinnell and Swarth (1913) suspected that Willow Flycatchers which they observed during the second and third week of June were breeding in thickets of desert willow along Carrizo Creek and in Palm Canyon, in the San Jacinto Mountains. The same conclusion was reached by Grinnell (1914) with respect to several individuals which he saw in dense willows along the lower Colorado River in late April and early May, 1910 (but see cautionary remarks in Methods concerning transients' territorial-type behaviors). The species has been documented to breed as far south as extreme northern Baja California (Grinnell 1928); southernmost breeding localities cited for California proper include San Diego, and the base of Cuyamaca Peak at 1128 m (3700 ft), San Diego Co. (Grinnell and Miller 1944). East of the Sierra Nevada, Willow Flycatchers were described as breeding "sparingly" in the Inyo area (Grinnell 1915).

Northernmost breeding records quoted during this period include the Scott River Valley, Edgewood, and Bray, Siskiyou Co., and Alturas, Goose Lake, Cedarville and Jess Valley, Modoc Co. (Grinnell and Miller 1944). Altitudinal breeding extremes provided by the same source range from less than 30 m (100 ft) above sea level in Santa Clara Co. to at least 2438 m (8000 ft) near Mammoth, Mono Co. In the Yosemite region, Grinnell and Storer (1924) encountered this species most abundantly in the Merced River valley, near Snelling. More generally, they characterized it as locally common in willow thickets of broad bottomlands along the lower streams of the west slope of the Sierra Nevada, on the floor of Yosemite Valley, and near Mono Lake. In the Lassen Peak region, Grinnell et al. (1930) found Willow Flycatchers at altitudes ranging from 79 to 1829 m (260 to 6000 ft) above sea level (not all of these necessarily represented birds on territories, however). With a single exception, all individuals were found associated with willow thickets growing along streams or lakes or in meadows. The most general summary from this period characterized Willow Flycatchers as unequivocally common wherever conditions were suitable for them: "...this flycatcher exists in summer time practically wherever its special habitat exists...In breeding season (it is) strikingly restricted to thickets of willows, whether along streams in broad valleys, in canyon bottoms, around mountain-side seepages, or at the margins of ponds or lakes." (Grinnell and Miller 1944).

Current Status of the Willow Flycatcher in Selected Areas of the Sierra Nevada

Discussion of the areas surveyed for Willow Flycatchers are considered below in the same order in which they were surveyed. For a complete list of the sites at which Willow Flycatchers were observed, along with the sites' legal descriptions, see Appendix I.

Inyo National Forest

Surveys were conducted from 1 through 9 June. Areas checked consisted of fairly high (1554 to 2560 m elevation, 5100 to 8400 ft) meadows located along streams draining east from the Sierra Nevada. Drainages surveyed, at least in part, included Lee Vining, Walker, Rush, Reversed, Laurel, Convict, Rock, Bishop, Big Pine, Birch, and Independence Creeks. Only two potentially territorial males were encountered, along Lee Vining and Rush Creeks. Both areas are under private ownership. A third Willow Flycatcher was seen in a willow-choked meadow along Reversed Creek, south-west of June Lake. This bird was found to be totally unresponsive to a taped recording of a Willow Flycatcher song, and was classified as a transient.

No Willow Flycatchers were seen at either of the two sites along Bishop Creek where birds were observed by David Gaines in 1979, on 5 and 21 June respectively (Forest Service report on the breeding birds of Bishop Creek, David Gaines, 1979). One of the sites, located 0.3 km (0.2 mile) east of the juncture of Highway 168 and SCE road no. 2, is heavily grazed by horses and mules, and was occupied by a minimum of two (probably three) male Brown-headed Cowbirds on both mornings that it was surveyed in 1982.

Many proposals have recently been submitted to develop small hyrdoelectric projects powered by the streams of the east slope of the Sierra Nevada (Kathy Noland, USFS, pers. comm.). These proposals generally call for diverting stream flow for some distance through a pipe, thus virtually eliminating natural water flow along the affected stretch of creek. The total number of projects which will eventually be approved and built, and their cumulative effect on existing Willow Flycatcher habitat along the eastern slope of the Sierra Nevada, has not yet been determined.

A few Willow Flycatchers may breed in willows in such relatively mesic areas as still occur in the Owens Valley. A pair was found nesting in the area in 1979, and subsequently raised a brood of cowbirds (Garrett and Dunn 1981).

Sierra National Forest

Surveys were conducted from 11 through 19 June, on the Pine Ridge, Kings River, and Minarets Ranger Districts (R.D.). Flycatcher habitat which was examined in these areas consisted of scattered montane meadows, from 1463 to 2225 m (4800 to 7300 ft) in elevation. Willow Flycatcher observations were: on the Kings River R.D., a pair at Long Meadow, two singing males at Lost Meadow, and six singing males (as well as three non-singing individuals, presumably females) at Dinkey Meadow; on the Minarets R.D., two singing males and a female at Beasore Meadows; on the Pine Ridge R.D., one singing male at Markwood Meadow. Of these, only Markwood and part of Long Meadow are on public (Forest Service) land. Willow Flycatchers have been recorded at Long Meadow since 1978. Subsequently, no males were observed at this site in 1980, and one male was seen in 1981 (Hap Ritter, USFS Pacific Southwest Forest and Range Experiment Station, pers. comm.). At Lost Meadow, three males were recorded in 1979, with no subsequent survey information available (Ritter, pers. comm.). While no past survey results are available for Dinkey Meadow, several males occurred there both in 1980 and 1981 (Ritter, pers. comm.).

No Willow Flycatchers were found at a site at the juncture of Highway 168 and Stevenson Creek, due west of the Shaver Lake dam, where a singing male was seen in 1978, though not in subsequent years (Ritter, pers. comm.).

On the west slope of the Sierra Nevada hydroelectric projects typically alter areas of Willow Flycatcher habitat by drowning rather than dessicating them. At the present time, Dinkey Meadow is the only site on the the Sierra National Forest which both harbors Willow Flycatchers and is threatened by inundation. If approved, Dinkey Dam will flood this meadow by no later than 1990.

One factor which appears to severely restrict the occurrence of Willow Flycatchers in this and other forests in the Sierra Nevada is the limited occurrence of willow thickets in suitably open areas. For example, a thorough survey of meadows located on timber sales on the Minarets R.D. in 1979 and 1980 yielded a sample of 276 meadows for which vegetational inventories and (in most cases) maps had been prepared. Of these, only 37 meadows (13%) were described as including any willow at all within their boundaries, while no more than 16 (6%) included enough to qualify as potential Willow Flycatcher nesting sites. Historical rather than intrinsic environmental factors may be responsible for the dearth of willow in at least some of these cases. In particular, it has been suggested that fires set during the last half of the 19th century by stockmen in order to kill encroaching lodgepole pine seedlings and stimulate spring grass production in meadows may have contributed to the elimination of willow over parts of especially the southern Sierra Nevada (Vankat 1977; DeBenedetti and Parsons 1979; Richard Bagley, Minarets R.D. Fire Control Officer, pers. comm.).

Stanislaus National Forest

This area was surveyed from 22 through 26 June. Sampling was limited by access: a number of areas of reportedly good willow development on the Calaveras and Summit R.D.'s were inaccessible through June in 1982 because of persistent snow. Those few meadows supporting a significant growth of willow which were accessible on the Mi-Wok, Groveland, and Summit R.D.'s were surveyed at elevations ranging from 1585 to 2316 m (5200 to 7600 ft). No Willow Flycatchers were detected at any site.

At Ackerson Meadow, a privately owned meadow on the Groveland R.D. at 1372 m (4500 ft), singing Willow Flycatchers regularly occurred in June from 1972 through at least 1976 (Gaines 1977). A minimum of five singing males occupied the area in 1982 (Jon Winter, pers. comm.).

According to Jan Hurley (USFS, Stanislaus N.F.), most of the lower elevation meadows on this Forest probably lack willow because of a history of heavy grazing pressure by domestic livestock. The greatest part of this damage was presumably inflicted early in this century and late in the last, when sheep were run in high densities throughout the area (John Hicks, USFS, pers. comm.).

Tahoe National Forest

Surveys were conducted from 30 June through 6 July, on the Sierraville R.D., at elevations ranging from 1920 to 2103 m (6300 to 6900 ft). This constituted the only area north of Fresno where Willow Flycatchers were regularly and relatively abundantly encountered. Thirty-nine singing males were recorded: 14 of these occurred in the willow clumps in the wet, open land surrounding Webber Lake, with an additional 23 encountered along several of the 12.9 or 14.5 km (8 or 9 miles) of prime, willow-dotted river bottom habitat extending east from Webber Lake along the Little Truckee River (Figure 2). The remaining two males occupied a wet, willow-filled meadow approximately 2 km (1.2 miles) southwest of Webber Lake. All but 11 of these individuals (at Perazzo Meadows, along the Little Truckee) occurred on privately owned land.

The numbers quoted above certainly represent an incomplete census of the total population on the Sierraville R.D. Some examples of presumably good Willow Flycatcher habitat which remained unsurveyed in this area are Moscove Meadow, the lowest reaches of Sagehen Creek, and the open land southwest of Independence Lake. Based on the inspection of aerial photos and an observed density of four to approximately ten singing birds per river mile (one pair per approximately 0.3-0.8 ha, 0.7-2.0 acres) of ideal willow habitat), the maximum population on the Sierraville R.D. probably does not exceed 80 pairs of birds.

None of the areas of known Willow Flycatcher concentrations on the Tahoe is presently threatened by proposed hydroelectric projects. Some large local reservoirs which may have flooded Willow Flycatcher habitat in the recent past are Jackson Meadow Reservoir, Stampede Reservoir, Boca Reservoir, and Prosser Creek Reservoir.

Yosemite National Park

This area was surveyed on 10 June, and again from 7 to 9 July. Potential Willow Flycatcher areas consisted of large or very large, ungrazed meadows, at 1219 to 2134 m (4000 to 7000 ft) above sea level (Figure 3). Willow Flycatchers were detected at three of the eight meadows surveyed: two pairs at Wawona (10 June), two pairs at Hodgdon (corroborated by D. Gaines, pers. comm.), and at least one individual at Westfall. Birds have been seen at Hodgdon Meadow in June from 1972 through at least 1976; fledglings were observed there in 1974 and 1975 (Gaines 1977). No Willow Flycatchers were seen at Peregoy Meadow, although birds have probably bred here in recent years, as well as at Crane Flat Meadow (David DeSante, pers. comm.).

In the Yosemite Valley, Willow Flycatchers nested abundantly through the late 1920's; the last breeding record for this area dates from 1949, however, when a nest was found near Mirror Lake. This dramatic decline correlates temporally with a general proliferation of Brown-headed Cowbirds in the Sierra Nevada (Rothstein et al. 1980), and it is possible that the two trends are causally connected (Gaines 1977).

Plumas National Forest

This area was surveyed from 7 through 11 July, at elevations ranging from 1341 to 1829 m (4400 to 6000 ft). Areas of potential habitat were sampled throughout the entire Forest; relatively few sites were found to combine the necessary traits of

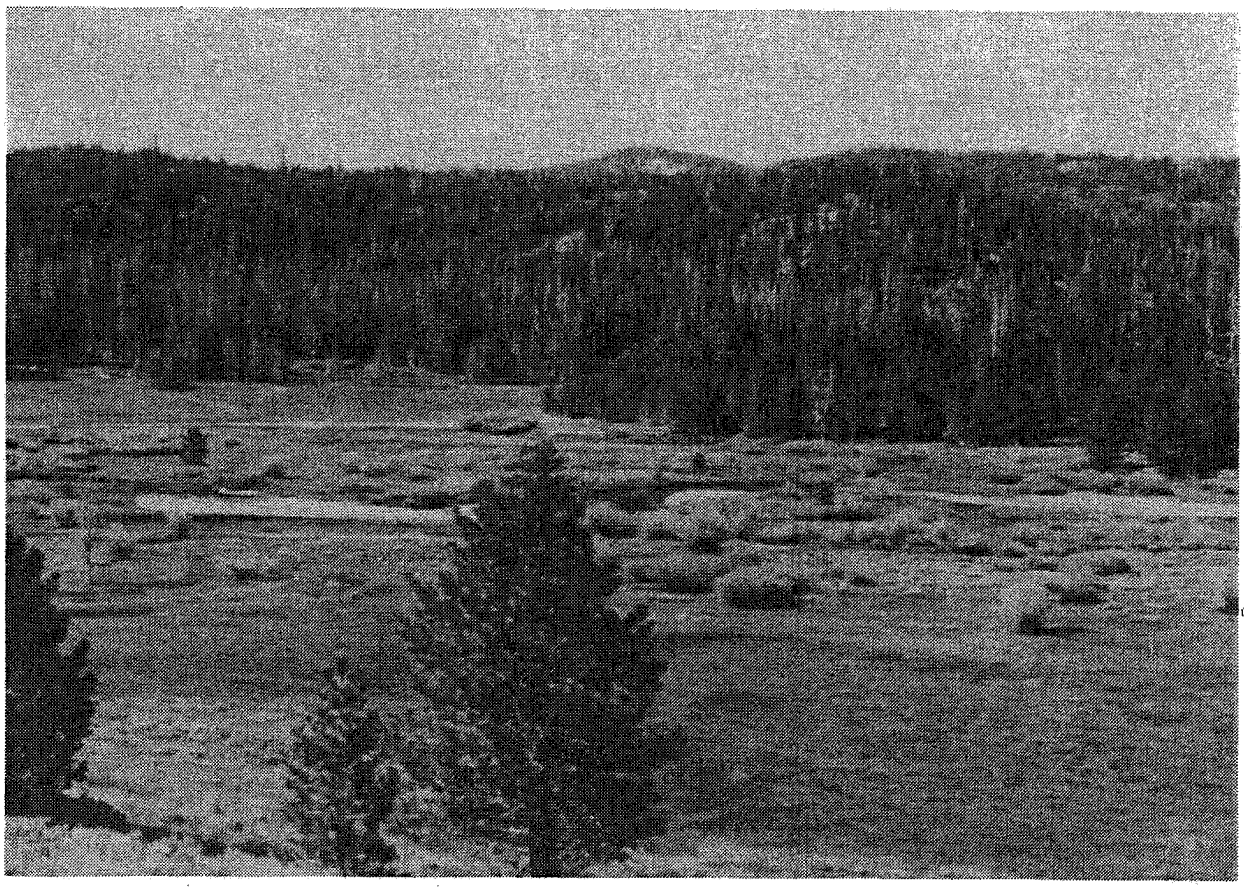

Figure 2. The open, wet, willow-dotted contours of the Little Truckee River Valley constitute ideal Willow Flycatcher breeding habitat. Photo by M. Serena.

Figure 3. Hodgdon Meadow, Yosemite National Park. Two pairs of Wilow Flycatchers occurred here in 1982. Photo by R. Schlorff.

openness, wetness and abundant willow. Local examples of broad bottomlands such as the Genesee, Squaw and Clover Valleys are well-drained, privately owned, and have for many years been devoted to agriculture and especially cattle grazing. While many large willows still occur in some of these areas, they have without significant exception lost their lower twigs and leaves to shade- and forage-hungry cattle. Shrubby areas along smaller streams are more often dominated by alder (Alnus tenuifolia) than willow. Potential Willow Flycatcher areas on this Forest primarily included the willow dominated margins of old beaver ponds and the soggy, relatively open areas bordering streams flowing into Bucks and Antelope Lakes (both reservoirs) (Figure 4). Willow Flycatchers were seen at Little Antelope Creek (a pair of birds near a beaver pond), McRae Meadow (a singing male at one of a series of wet, willow-filled stringer meadows along Nelson Creek), and the privately owned Haskins Valley, directly southeast of Bucks Lake (two territorial males). The species probably has nested at this last site since at least the late 1960's - early 1970's, when they were found to be "common in willows along streams in open areas around the lake in July and August" (Tim Manolis, pers. comm.). None of the three sites is presently threatened with inundation because of dam construction.

Lassen National Forest

Sites on and adjacent to the Almanor R.D., representing the northernmost extension of the Sierra Nevada, were surveyed from 13 through 16 July. Elevations ranged from 1311 to 1981 m (4300 to 6500 ft). This Forest is generally lower than the Plumas, and includes a greater proportion of open creek and river bottoms. As in the case of the Plumas, such land was usually homesteaded early, remains largely in private hands, and has had a long history of cattle grazing associated with it. Stringer meadows, dotted along the length of smaller mountain drainages, are typically dominated by alder. On this forest, Willow Flycatchers were found in the following situations: 1) A single pair of birds was seen along Humbug Creek, near its juncture with Miller Creek. The lush willow stand which constitutes the birds' nesting habitat is largely protected from grazing because it grows in a shallowly flooded area which is mostly avoided by cattle. 2) A single singing male occurred in patchily dense willows growing along Robbers Creek on the fenced, ungrazed Swain Mountain Experimental Forest. 3) Two singing males occupied the narrow belt of ungrazed willow growing between fenced pasture and Highway 172 at Battle Creek Meadows. The total extent of willow did not exceed 0.1 ha (0.25 acre). Grazed, "high-lined" willow clumps to the east and west supported Yellow Warblers (Dendroica petechia) but no Willow Flycatchers. Grinnell et al. (1930) reported finding seven Willow Flycatchers in the Battle Creek Meadows area, along a 11.3 km (7 mile) transect surveyed in late July, 1925. 4) Four singing males were heard in a large, partly flooded expanse of willows on private land directly east of the town of Westwood. Horses graze at the periphery, but the center is too wet to be frequented by livestock.

None of the above areas is being considered for possible hydroelectric development at the present time.

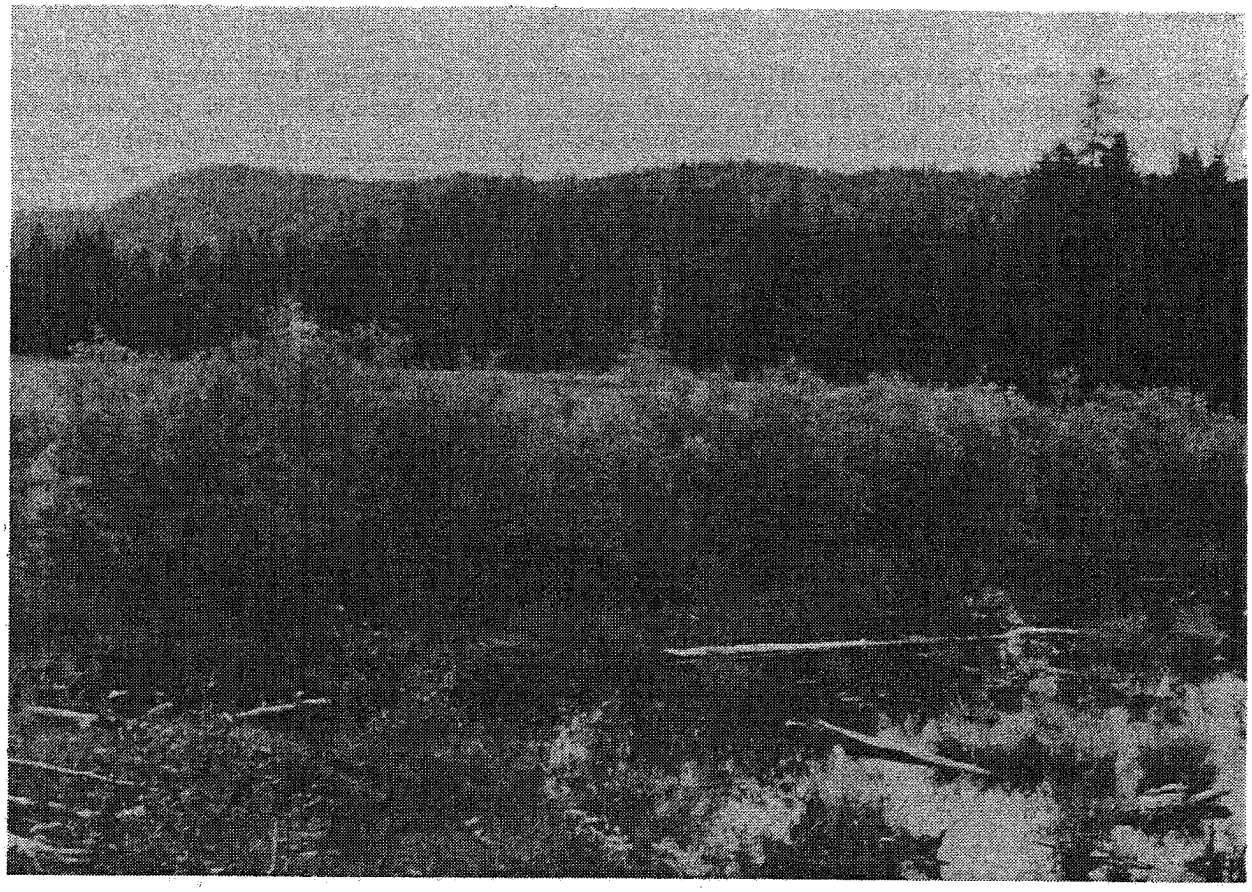

Figure 4. A pair of Willow Flycatchers occupied the willow thickets bordering this beaver pond along Little Antelope Creek, Plumas National Forest, in 1982. Photo by M. Serena.

South Fork of the Kern River

Twenty-two singing Willow Flycatchers and a nest were located by Brett Engstrom, during the summer of 1982, primarily on the Nature Conservancy's Kern River Preserve, at an elevation of approximately 792 m (2600 ft). Four additional males were recorded in mid- to late July on land adjacent to the preserves by Bob Barnes and in the course of this study. The South Fork of the Kern therefore represents the largest known concentration of Willow Flycatchers in the Sierra Nevada south of Fresno.

Willow Flycatcher habitat in this area consists of a more or less dense growth of willow (primarily black willow (*S. gooddingii*), which occurs both as thickets and as small trees), in conjunction with cottonwood (*Populus fremontii*), mulefat (*Baccharis viminera*), and stinging nettles (*Urtica* sp.). The vegetation forms narrow corridors following sloughs and the river proper; surrounding these corridors are the flat, open, well-drained pasturelands of the South Fork Valley. Willow Flycatchers typically were heard singing at the interface of forest and pasture, particularly where willows grew directly over a stretch of standing or slowly moving water (Figure 5).

The habitat described above extends about 12 km (7 or 8 miles) from Lake Isabella (a reservoir) east along that part of the river having a sandy (as opposed to rocky) bottom. An additional male was heard singing in the summer of 1982 in the Domeland Wilderness, at a sandy beach located about 18 km (11 miles) east of the Onyx Ranch, where the trail from Long Valley Campground intersects the Kern River (sighting by Jim Royer, reported by Bob Barnes).

The Valley of the South Fork of the Kern marks nearly the southern terminus of the Sierra Nevada.

Habitat Characteristics

Meadow Size

It is clear that relatively large meadows are much more likely to harbor Willow Flycatchers than smaller meadows (Table 1); 17 of the 24 meadows (71%) at which birds were found were larger than 15 ha (37 acres), while 20 of the 24 (83%) were at least 8 ha (20 acres) in extent. Both percentages are considerably higher than expected on the basis of chance alone: just 26 (30%) of the entire sample of 76 meadows were larger than 15 ha (37 acres), for example, while 36 (42%) were 8 ha (20 acres) or more. The positive association between presence of Willow Flycatchers and increasing meadow size is statistically highly significant ($X^2 = 28.18$, d.f. = 4, $p<0.01$).

Meadow Wetness

No significant relationship was found to hold between the extent of water covering meadows and the occurrence or absence of Willow Flycatchers (Table 2) ($X^2 = 1.14$, d.f. = 4, $p>0.05$).

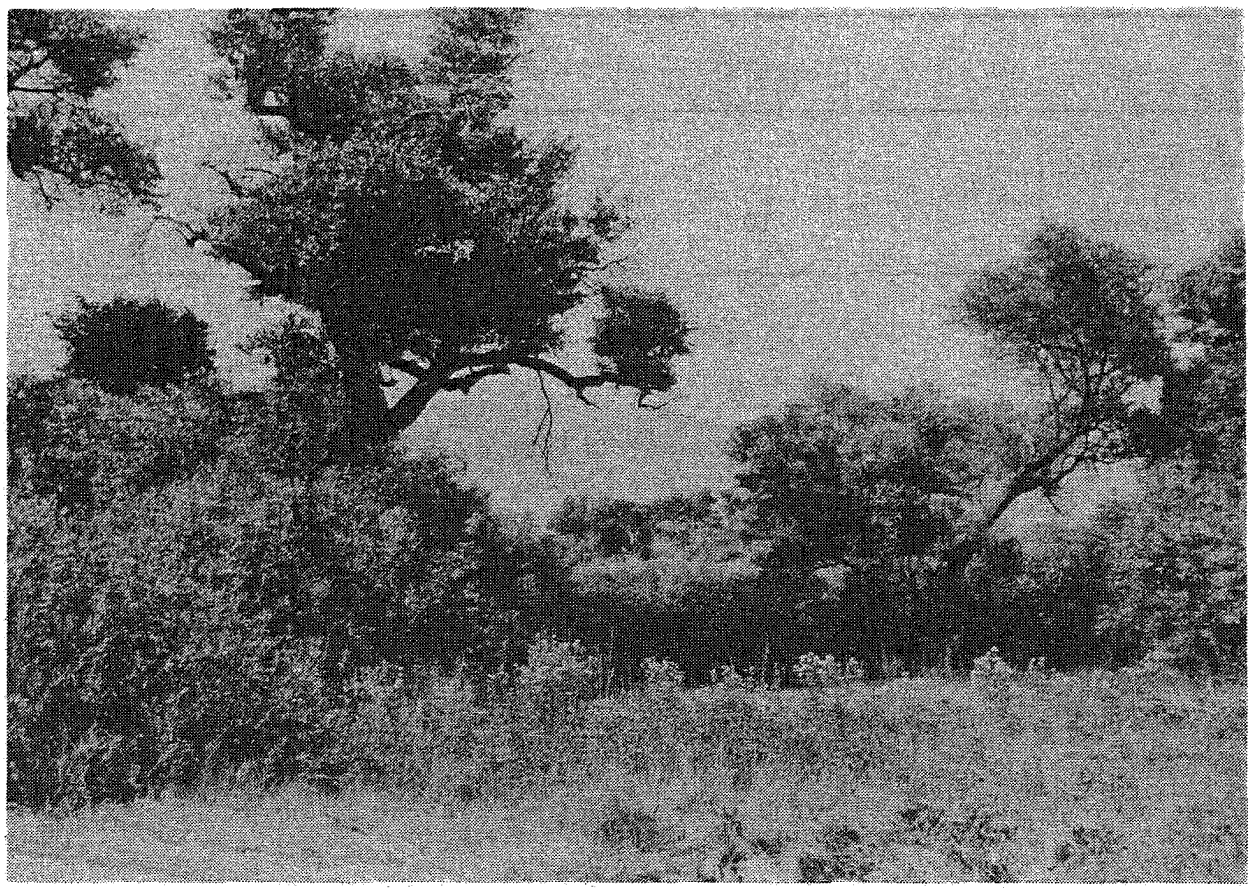

Figure 5. South Fork, Kern River. A minimum of twenty-seven singing males occurred here in riparian willows in 1982. Photo by M. Serena.

Table 1. Relationship Between the Occurrence of Willow Flycatchers (Pairs or Territorial Males) and Meadow Size

	Size of Meadow (Hectares)				
	1-2	2-4	4-8	8-15	>15
W.F. present	1	2	1	3	17
W.F. absent	10	17	19	7	9

Table 2. Relationship Between the Occurrence of Willow Flycatchers (Pairs or Territorial Males) and Meadow Wetness

	Percent of Meadow covered by water				
	0-20	21-40	41-60	61-80	81-100
W.F. present	13	3	4	6	1
W.F. absent	30	12	7	10	3

Percent Willow Cover

There was no significant association between the percent of willow cover on meadows and the occurrence or absence of Willow Flycatchers (Table 3) ($X^2 = 0.82$, d.f. = 3, $p>0.05$).

Stream Type on Meadow

Willow Flycatchers showed a positive association with relatively large streams (Table 4). Twelve (50%) of the meadows harboring Willow Flycatchers were drained by streams of the largest stream category (as compared with 28% of the entire meadow sample), while 21 (87%) were drained by streams of either the largest or the next largest category (as compared with 76% of the entire meadow sample). The positive association between stream size and flycatcher presence is statistically significant ($X^2 = 9.15$, d.f. = 3, $p<0.05$).

Occurrence of Brown-headed Cowbirds with Respect to Willow Flycatchers

According to Rothstein et al. (1980), cowbirds in the Sierra Nevada typically disperse from meadows to their preferred feeding areas (e.g. pack stations, campgrounds) in late morning or early afternoon, so surveys beginning after 1000 hours were excluded from this analysis. Cowbirds and Willow Flycatchers were found to be positively associated: at the majority of sites (32 of 46) either both species were present or neither species was present (Table 5). Furthermore, cowbirds were observed at 12 of the 15 meadows of which Willow Flycatchers were observed (80%), as compared with 50% of meadows in general. The positive association between cowbirds and flycatchers is statistically highly significant ($X^2 = 7.74$, d.f. =1, $p<0.01$).

Distribution of Brown-headed Cowbirds by Forest

The percentage of meadows on which cowbirds were sighted ranged from a low of 25% (3 of 12) on the Inyo National Forest to 80% (4 of 5) on the Lassen (Table 6). The sample includes only those meadow surveys initiated at or before 1000 hours, for the reason previously given. These differences among Forests were not statistically significant ($X^2 = 5.89$, d.f. = 5, $p>0.05$).

DISCUSSION

Habitat Variables and the Distribution of Willow Flycatchers

Meadow Size

Willow Flycatchers were most often found in large meadows. This apparent preference may reflect environmental factors which are likely to correlate positively with size, such as the amount or predictability of insect biomass, or the absolute amount of willow present. The association between meadow size and flycatcher presence also may reflect a tendency for small populations (assumed to correlate with small meadows) to both die out more frequently and become reestablished more slowly than large populations. In general, the probability of population extinction is predicted to increase insofar as: 1) total population size is low; 2) fecundity is low; or 3)

Table 3. Relationship Between the Occurrence of Willow Flycatchers (W.F.) (Pairs or Territorial Males) and Willow Cover

	Percentage of Willow Cover over Meadow			
	0-20	21-40	41-60	>60
W.F. present	17	5	1	1
W.F. absent	38	16	5	3

Table 4. Relationship Between the Occurrence of Willow Flycatchers (W.F.) (Pairs or Territorial Males) and Meadow Stream Type

	Stream Type			
	Large Stream (>1.3 m)	Small Stream (0.3-1.3 m)	Rivulet (<0.3 m)	Absent
W.F. present	12	9	3	0
W.F. absent	12	32	13	5

Table 5. Co-occurrence of Brown-headed Cowbirds and Willow Flycatchers (W.F.) at surveyed sites in the Sierra Nevada

	Cowbirds present	Cowbirds absent
W.F. present	12	3
W.F. absent	11	20

Table 6. Occurrence of Brown-headed Cowbirds on Meadows Surveyed for Willow Flycatchers on Six National Forests in the Sierra Nevada

Forest	Cowbirds present	Cowbirds absent
Tahoe	5	3
Stanislaus	2	3
Sierra	5	5
Inyo	3	9
Plumas	3	2
Lassen	4	1

survivorship is low. Small meadow populations typically consisting of one or two pairs of these single-brooded, migratory passerines are liable to be frequently extirpated on all three accounts. The probability that colonists randomly encounter an area should increase as: 1) the number of colonists seeking unoccupied habitat (again reflecting fecundity and survivorship) increases, and 2) the area of the habitat increases. It follows that small meadows may constitute perfectly suitable Willow Flycatcher breeding habitat and still typically not harbor the species because populations commonly die out and are only infrequently reestablished. The proportion of small meadows occupied by flycatchers is expected to decline as either fecundity or survivorship decreases in the general Willow Flycatcher population (e.g. as cowbirds proliferate in an area).

Meadow Wetness

No statistically significant relationship was found between overall percent of meadow moisture (or wetness) and the likelihood of Willow Flycatcher occurrence. This primarily reflects the fact that the large montane meadow areas favored by these birds ordinarily include extensive portions of dry as well as soggy terrain. Within these larger units, however, the birds showed a strong preference for relatively wetter habitats, invariably establishing territories in areas where 40 to 90 percent of the ground was covered by a centimeter or more of water.

Percent of Willow Cover

No significant relationship was apparent between percent willow cover in a meadow and Willow Flycatcher occurrence. The birds occupied a considerable range of willow habitats in terms of the distribution of the plants. However, they generally appeared to prefer tall clumps of bushes separated by open areas to dense, continuous thickets.

A positive relationship probably does exist between the attractiveness of willows as breeding sites and the density of their foliage within 2 m (6.6 ft) of the ground. This low layer of vegetation has been reported as the setting for virtually every Willow Flycatcher nest described in the literature (Grinnell and Storer 1924; Grinnell et al. 1930; Bent 1954). In this study, Willow Flycatchers were conspicuously absent from otherwise apparently suitable areas where the lower branches of willows had been stripped of leaves and twigs or were missing entirely due to livestock (Figure 6). However, grazing is not inherently incompatible with the abundant occurrence of Willow Flycatchers. Sheep graze every summer around Webber Lake on the Tahoe National Forest, for example, and cattle graze regularly along the balance of the Little Truckee River valley. In such circumstances, willows are usually spared for one of two reasons: 1) grazing pressure is relatively light in terms of the numbers of animals present or the amount of time they spend on the pasture, or 2) willows locally occur in very wet or dense situations, which sheep and cattle apparently avoid.

Stream Type on Meadow

A significant relationship existed between the size of a stream draining a meadow and the probability of Willow Flycatcher occurrence: the birds were most often encountered near relatively larger streams. This reflects a probable correlation between stream size and overall size of the stream bottom or meadow area. In addition, smaller streams are more likely to flow seasonally, thereby potentially restricting the growth of riparian vegetation and associated insects.

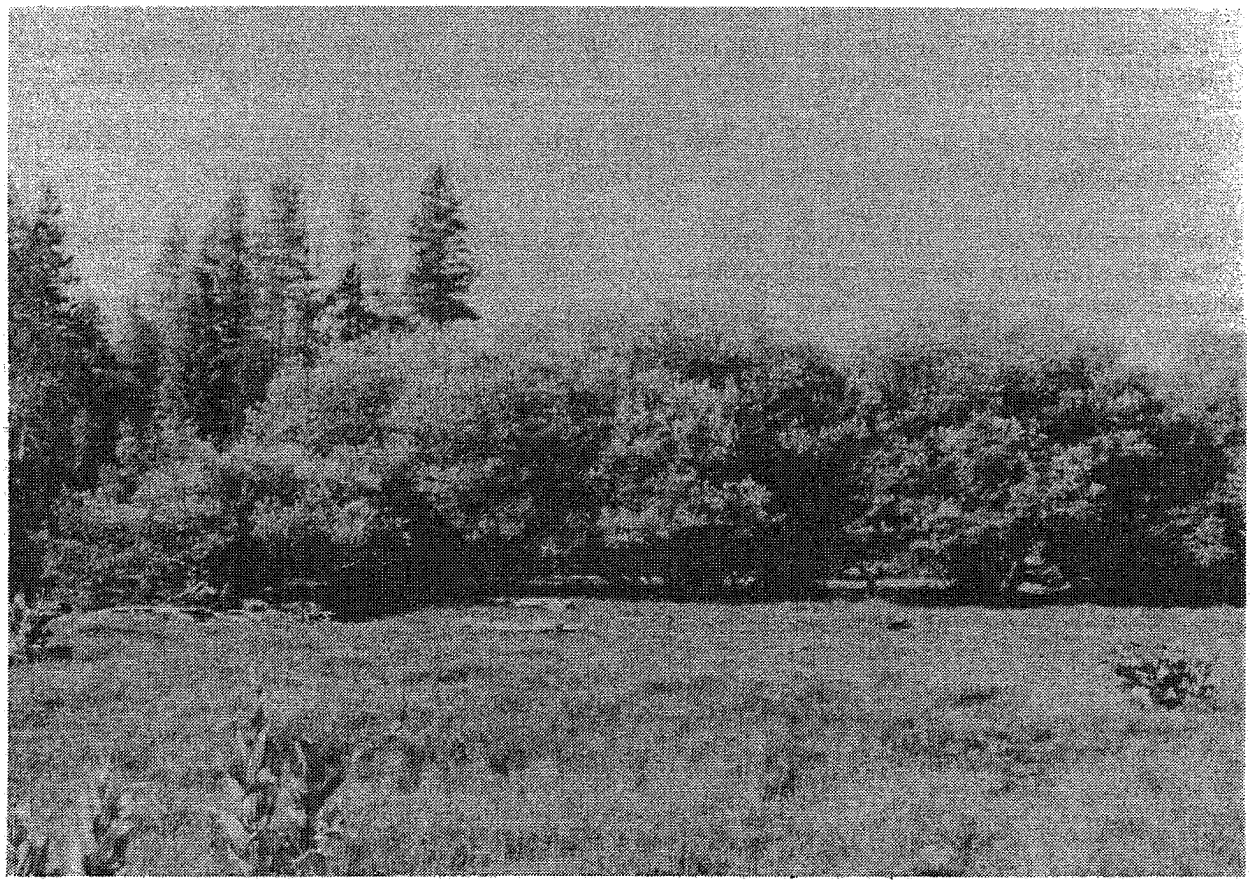

Figure 6. "High-lined" willows at Battle Creek Meadows. Willow Flycatchers ordinarily build their nests in the lowest 2 m (6.6 ft) of willows, which here have been stripped of cover by grazing cattle. Photo by M. Serena.

Occurrence of Brown-headed Cowbirds

Two predictions follow from the hypothesis that cowbirds effectively reduce Willow Flycatcher numbers where the two species coincide:

1) The two species should be negatively associated. In the most extreme case, Willow Flycatchers should only occur in meadows not utilized by cowbirds.

2) Areas generally harboring a large population of Willow Flycatchers should correspondingly harbor a low population of Brown-headed Cowbirds.

Neither prediction is supported by the data gathered during this study. Cowbirds and Willow Flycatchers were actually found to be positively associated: one or more cowbirds were present in nearly all meadows in which Willow Flycatchers occurred. The Tahoe National Forest, with a relatively large population of Willow Flycatchers, ranked second highest for occurrence of cowbirds of the six Forests surveyed. Both results are compatible with the idea that Brown-headed Cowbirds frequent sites supporting high densities of potential hosts, including Willow Flycatchers. They also imply that Brown-headed Cowbirds are presently not completely eliminating Willow Flycatchers where the two coincide in the Sierra Nevada. The indirect measures of nest parasite pressure used in this study are not, however, expected to be sensitive to a patchy or localized elimination of flycatcher populations by cowbirds (e.g. in the immediate environs of stables or campgrounds). In fact, cowbirds may occur rather infrequently in such areas if they have previously eliminated most susceptible passerine hosts.

Such measures also are expected to be blind to the possibility that the average density of Willow Flycatchers has declined moderately as cowbirds became established in the Sierra Nevada.

Status of Willow Flycatcher in California

A total of 72 pairs of Willow Flycatchers (assuming that every apparently territorial male observed was both resident and mated) were located in the study: 2 in the Inyo National Forest; 12 in the Sierra N.F.; 39 in the Tahoe N.F.; 4 in the Plumas N.F.; 8 in the Lassen N.F.; 5 in Yosemite; and 2 along the Kern River. An additional 49 records of singing males were provided by independent observers in 1982: 5 in the Stanislaus N.F.; 2 along the Eel River and 7 along the Mad River, in Humboldt County (P. Springer and J. Kelly, pers. comm.); 8 along the Santa Margarita River (L. Salata, pers. comm.) and 2 near the Dairy Mart Ponds (P. Sorensen, pers. comm.), in San Diego County; and 25 along the South Fork of the Kern River, in Kern County.

The Willow Flycatchers enumerated above certainly represent an underestimate of the entire California breeding population. The magnitude of the difference is difficult to assess with certainty, for a number of reasons:

1) Some individuals certainly were missed even in the areas surveyed in this study. It is highly unlikely that these would more than double the known total, however.

2) Some individuals that were counted as territorial males may have been transient or remained unmated. The first type of error would serve to inflate survey results from primarily the first three weeks of June. Over this period just 2 territorial males were encountered in the Inyo National Forest, and 12 in the Sierra National Forest. The second type of error could have operated throughout the study. Its absolute contribution to error is unknown.

3) Large areas of suitable habitat remain unsurveyed in California, particularly in the southern Sierra Nevada (Sequoia and Kings Canyon National Parks, the Golden Trout Wilderness), and the northern mountains and coast.

4) The pattern of sporadic concentration of birds documented during this study implies that significant populations may yet be found in areas of suitable habitat that could not be surveyed during this study.

The results of this study indicate that areas of suitable Willow Flycatcher habitat are most likely to consist of broadly open stream and especially river bottoms supporting lush stands of shrubby willows. Isolated mountain meadows supported less than a third of the birds located in this study, despite the fact that a majority of survey time was devoted to investigating those areas. While birds were regularly observed in meadows where conditions were appropriate, the average number of birds present per meadow was low (usually one or two pairs; maximally six pairs at Dinky Meadow). In addition, only a minority of meadows were sufficiently large and supported adequate willow to constitute acceptable flycatcher habitat.

The pattern of decline which has characterized the Willow Flycatcher population in southern and low-lying California probably has extended to the Sierra Nevada as well. In these mountains, large open valleys have always constituted preferred areas for homesteading and grazing, which in turn has led to extensive degradation of potential Willow Flycatcher habitat from the browsing and trampling of willows by livestock. Overgrazing is frequently blamed for initiating gullying in meadows which can become so severe as to significantly lower the meadow's water table (Figure 7). Man-caused fires have been implicated in reducing montane willow development in two very different ways, as previously discussed. Fires set by cattlemen and sheepherders, especially in the southern Sierra Nevada, may have steadily eliminated willows, particularly in drought years, and the subsequent suppression of fires by state and federal land management agencies may have reduced the size and moistness of many meadows because of lodgepole pine (*Pinus contorta*) encroachment (DeBenedetti and Parsons 1979; Ray Ratliff, USDA Forest Service Pacific Southwest Forest and Range Experiment Station, pers. comm.). Finally, the strong association observed between cowbirds and Willow Flycatchers implies that the latter is potentially liable to, if not already actually suffering from, a significant degree of nest parasitism.

Figure 7. Dramatic stream erosion at Beasore Meadows correlates with a history of severe overgrazing early in this century. Photo by M. Serena.

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Appendix I

Legal description and number of Willow Flycatcher pairs/territorial males located in the Sierra Nevada, 1982 (P = Privately owned land)

Inyo National Forest

(P) Lee Vining Creek (1) - T1N, R25E, sec. 24, NW 1/4, SW 1/4
SW of June Lake (1 transient) - T2S, R26E, sec. 15, NW 1/4, SW 1/4
(P) Rush Creek (1) T1S, R26E, sec. 17, SE 1/4, NE 1/4

Sierra National Forest

(Partly P) Long Meadow (1) - T11S, R27E, sec. 10, NE 1/4, NE 1/4
(P) Lost Meadow (2) - T10S, R25E, sec. 25, SE 1/4, NE 1/4
Markwood Meadow (1) - T10S, R25E, sec. 3, NW 1/4, NE 1/4
(P) Dinkey Meadow (6) - T10S, R26E, sec. 20, N 1/2, SW 1/4
(P) Beasore Meadows (2) - T6S, R23E, sec. 5, W 1/2

Stanislaus National Forest

(P) Ackerson Meadow (at least 5)- T1S, R19E, sec. 24, N 1/2

Tahoe National Forest

(P) Lacey Valley, due S of Webber Lake (13) - T19N, R14E, sec. 28, SW 1/4, NE 1/4
(P) Lacey Valley, SW of Webber Lake (2) - T19N, R14E, sec. 32, SW 1/4, NE 1/4
(P) Webber Lake Campground (1) T19N, R14E, sec. 29, SE 1/4, NE 1/4
Perazzo Meadows (11) - T19N, R14E, sec. 26, W 1/2, SW 1/4
(P) Little Truckee River, due E of Cold Stream (8) - T19N, R14E, and R15E, sec. 24, SE 1/4, SE 1/4; and sec. 17, W 1/2, SW 1/4
(P) Little Truckee River, 1 mile E of Cold Stream (3) - T19N, R15E, sec. 16, N 1/2, SW 1/4
(P) Little Truckee River, along Highway 89 (1) T19N, R15E, sec. 13, SW 1/4, NE 1/4

Yosemite National Park

Wawona Meadow (2) - T5S, R21E, sec. 3, N 1/2
Westfall Meadow (1) - T3S, R21E, sec. 24, S 1/2, and sec. 25, N 1/2
Hodgdon Meadow (2) - T2S, R19E, sec. 3, NW 1/4

Plumas National Forest

Little Antelope Creek (1) - T27N, R12E, sec. 25, SW 1/4, NE 1/4
McRae Meadow (1) - T22N, R11E, sec. 16, NW 1/4, NW 1/4
(P) Haskins Valley (2) - T23N, R7E, sec. 11, N 1/2, NW 1/4

Lassen National Forest

(P) Humbug Creek/Miller Creek (1) - T27N, R7E, sec. 31, SW 1/4, SE 1/4
(P) Westwood (4) - T28N, R9E, sec. 5, SE 1/4, SW 1/4
(Partly P) Robbers Creek/Swain Meadow (1) - T30N, R8E, sec. 22, SW 1/4, SW 1/4
(P) Battle Creek Meadows (2) - T29N, R3E, sec. 30, SW 1/4, SW 1/4

South Fork of the Kern River

(Mostly P) Lake Isabella to Onyx Ranch (26) 11 mi. NE of Onyx Ranch (2)