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Department of Fish and Game

THE STATUS AND DISTRIBUTION OF THE WILLOW FLYCATCHER IN CALIFORNIA, 1986

by

John H. Harris
Susan D. Sanders
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Wildlife Management Division
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Cover: Willow Flycatcher (Empidonax traillii)
Art work by Narca Moore-Craig

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ABSTRACT

The Willow Flycatcher, (Empidonax traillii), was formerly a common summer resident in California, breeding in riparian willow thickets (Grinnell and Miller 1944). This first priority Bird Species of Special Concern (Remsen 1978) has been extirpated from most of its California range, and is currently under review for possible state Endangered status (R. Schlorff, pers. comm.). In this report we present the results of the 1986 Willow Flycatcher survey in the Sierra Nevada and provide details concerning the status of the species in California.

We visited 125 sites during the 1986 survey, recording 96 singing male Willow Flycatchers at 30 sites. In addition, we have received reports of an additional 7 birds in the Sierra Nevada/Cascade Mountains region, 14 birds reported on parts of the Nature Conservancy's Kern River Preserve which we did not visit, and one additional bird observed at one of our sites by another biologist. Thus there was a total of 118 singing males. Fifty-six of the sites visited in 1986 were not surveyed in 1982. Visits to these "new" sites resulted in sighting of 12 singing males at 6 sites. The largest number of singing males (39), was recorded at the Kern River Preserve. The Little Truckee River drainage, which had the largest number of singing males in 1982, had 25 in 1986. The Shaver Lake area, Sierra National Forest, had 9 singing males. The Little Truckee River, Kern River, and Shaver Lake areas together account for 67% of the Willow Flycatcher sightings in the Sierra Nevada during 1986 and 73% during 1982. Unitt (in press) and L. Salata (pers. comm.) reported breeding populations of about 15 and 12 pairs respectively on the Santa Margarita and San Luis Rey Rivers, San Diego County. The estimated statewide total number of Willow Flycatchers detected in 1986 was about 145 singing males.

We found that 104 of 111 (93.6%) singing male Willow Flycatchers inhabited meadows larger than 8 hectares. As noted by Grinnell and Miller (1944), Serena (1982), and the Kings River Conservation District (1985) we also found that Willow Flycatchers prefer wet meadows. Sites with Willow Flycatchers were wetter than sites without singing males. Virtually all of the sites with more than one singing male had standing water. Willow Flycatchers were found only where willow thickets were present, and where willows were at least 2 m in height. Sites with Willow Flycatchers had higher foliage density than those without them.

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RECOMMENDATIONS

1. The Department of Fish and Game should prepare a petition and make a recommendation to the Fish and Game Commission to list the Willow Flycatcher as Endangered in the state because of its small population size, evidence of severe decline in numbers, and the concentration of the majority of the state's breeding Willow Flycatchers in only five isolated areas.

2. Management planning should consider the plight of all three of the recognized subspecies of Willow Flycatcher occurring in California, and should address the preservation of genetic variation in this species. There is need for more research to clarify the subspecific status of California Willow Flycatchers.

3. Future surveys should attempt to clarify the status of the species in areas not thoroughly surveyed, including north coastal California, the Klamath Mountains and Cascades, northeastern California in general, and prortions of the Central Valley, particularly the San Joaquin Valley. Reports suggest that there may be a few birds in these areas, though large populations are not likely to be found.

4. The sampling unit for habitat studies should include all the area within two standard deviations of an average foraging sally from willow cover, rather than an entire meadow or meadow system.

5. Existing meadow sites should be protected from habitat loss (as from hydroelectric projects or housing developments). Acquisition of private parcels or purchase of conservation easements by public agencies or conservation organizations may be appropriate in some situations.

6. Riparian vegetation should be completely protected from livestock grazing wherever possible, particularly where grazing is reducing foliage density, or drying meadow sites by soil compaction and gullying. As a guideline, we suggest curtailment of any activities which reduce meadow wetness below 50% in the vicinity of willows, or which reduce willow foliage density below 70%.

7. Grazing in riparian zones should be curtailed from June through mid-August, when Willow Flycatchers are nesting. This period could be adjusted depending on location. For the Tahoe National Forest, a period from 1 June through 15 August is suggested (Flett and Sanders 1987), while for the Sierra National Forest, 1 July through 20 August would be appropriate (Valentine 1987).

8. Further studies are needed on the responses of Willow Flycatchers to Brown-headed Cowbird (Molothrus ater) nest parasitism, particularly at lower elevation sites, such as the south fork of the Kern River.

9. Response of Willow Flycatchers to revegetation and meadow restoration should be studied, as a possible means of increasing the amount of available habitat and of attracting Willow Flycatchers to otherwise suitable meadows.

THE STATUS AND DISTRIBUTION OF THE WILLOW FLYCATCHER IN CALIFORNIA, 1986

INTRODUCTION

The Willow Flycatcher, (Empidonax traillii), was formerly a common summer resident in California, breeding in riparian willow thickets (Grinnell and Miller 1944). It has been extirpated from most of its California range, and is currently under review for possible state Endangered status (R. Schlorff, pers. comm.). Most of the remaining populations occur in isolated mountain meadows of the Sierra Nevada and along the Kern, Santa Margarita, and San Luis Rey rivers (Remsen 1978, Serena 1982, Unitt in press). Remsen (1978) listed the Willow Flycatcher as a species of highest priority, facing extirpation if current trends continue. In 1980, reports from the Pacific coast and southwest regions resulted in addition of the species to the Audubon Blue List (Arbib 1979). The Blue List for 1981 included Utah, Arizona and New Mexico as areas where the status of the species was of concern (Tate 1981). The California Department of Fish and Game conducted a survey for Willow Flycatchers in six Sierra Nevada National Forests and Yosemite National Park in 1982 (Serena 1982), and recommended continued research to determine the status of the species. In 1983, the Kings River Conservation District (KRCD) began studies of Willow Flycatchers at Dinkey Meadow and other nearby meadows in the vicinity of Shaver Lake (Stafford and Valentine 1985). Dinkey Meadow, known to harbor breeding Willow Flycatchers, was slated for inundation by the Dinkey Creek Hydroelectric Project. Directors of the Kings River Conservation District have since cancelled the project due to financial considerations. However, the project could be revived in the future. In 1984, the Willow Flycatcher was added to the U.S. Forest Service Region 5 Sensitive Species list. The U.S. Fish and Wildlife Service has also designated the Willow Flycatcher as a Sensitive Species for Region 1 (Washington, Idaho, Oregon, California, and Nevada) based on significant declines in this region (Sharp 1986). The Willow Flycatcher was again included on the Blue List in 1986 (Tate 1986).

We report the results of the 1986 Willow Flycatcher survey in the Sierra Nevada and summarize information about the species' status in California. The purposes of our study were to survey sites at which Willow Flycatchers had been previously seen, search for "new" sites , and attempt to refine our knowledge of habitat requirements.

METHODS

Survey Locations and Census Methods

We conducted our surveys between 24 June and 26 July 1986. This period was chosen in order to minimize the likelihood of counting migrant birds. Studies at Dinkey, Poison and Long meadows, Sierra National Forest, (Stafford and Valentine 1985) suggest that Willow Flycatchers frequently arrive at their breeding location as late as mid-June and occasionally as late as early July. In the same area, Willow Flycatchers depart at any time from the end of July to late August, with a peak in mid-August. During the 1982 survey (Serena 1982) some sites were visited in the first week of June. Birds observed at that time could have been migrants.

We conducted our surveys early in the morning, generally from sunrise until 1000 hours. Spontaneous singing declines after 1000 (King 1955, Unitt in press), although individuals can be heard at any time of day. A second, less intense, period of singing generally occurs before dusk. At each site, we walked along the perimeter of all willow habitat, listening and playing taped territorial songs and calls of male Willow Flycatchers. We recorded the number of singing male Willow Flycatchers detected at each site, and noted the locations of all Willow Flycatchers on sketched maps of the sites. A significant fraction of the singing males may remain unpaired through the breeding season, as current studies on the Little Truckee River and Shaver Lake area indicate (Flett and Sanders 1987, Stafford and Valentine 1985). The assumption that singing males

represent pairs may thus lead to an overestimate of the number of breeding birds. On the other hand, song frequency declines after pairing (Stafford and Valentine 1985), thus successfully paired males may be missed in a song survey.

During 1982, the Lassen, Plumas,Tahoe, Stanislaus, Sierra, and Inyo National Forests were surveyed (Serena 1982). Other areas surveyed included The Nature Conservancy's Kern River Preserve and Yosemite National Park. We visited most of the sites included in the 1982 survey including all locations which had Willow Flycatchers in 1982 or subsequent years. New areas of coverage included portions of the Eldorado, Toiyabe, and Sequoia National Forests, Sequoia National Park, and Kings Canyon National Park. We also visited new sites in the Lassen, Plumas, Tahoe, Sierra, and Inyo National Forests. New sites were chosen on the basis of suggestions submitted to the Department of Fish and Game (R. Schlorff, pers. comm.), conversations with other biologists, and studies conducted in the vicinity of Shaver Lake (Stafford and Valentine 1985 and pers. comm.). Some new sites were visited based on new observations made in the field during the survey.

Habitat Variables

The vast majority of the surveyed sites were meadows. Meadows were defined on the basis of the presence of hydrophyllic vegetation (grasses, sedges, and willows) and openness. In some cases the meadows surveyed were portions of complex meadow systems. The survey and habitat analysis in such cases was generally restricted to the portion of the meadow system containing willows (Salix sp.) and alders (Alnus sp.). Some new sites were visited which did not have riparian shrubs. These sites were examined briefly, but were not subjected to complete habitat analysis or intensive survey for Willow Flycatchers. A few of the sites (principally along the Kern and Owens rivers) were not discrete meadows, but portions of long riverbank systems. In such cases, the unit for habitat analysis consisted of the riparian vegetation and any area of wet meadow adjacent to the riparian vegetation. The proper definition of the unit of habitat for analysis of habitat characteristics poses problems for surveys such as ours. Based on the experience of this and previous surveys, we hope to make recommendations which should help to refine future surveys.

We recorded the approximate percent of the survey unit which appeared to be wet (i.e., with surface water present) or recently wet. The presence or absence of running or standing water was noted, and bodies of running water were classified into three size categories: < 30 cm (1 foot) wide, 30-120 cm (1-4 feet) wide, and > 120 cm (4 feet) wide (these variables are likely to vary seasonally; however, this could be minimized by restricting the survey to a four week period). We estimated the percent cover of willow (two categories: < 3m height and > 3m height), alder, aspen, lodgepole pine, and grass/sedge/forb cover. Percent cover was estimated by imagining a vertical projection of the crown perimeter of shrubs onto the ground surface. Percent cover was the percent of the entire survey unit covered by each vegetation category. Meadow size was estimated and recorded as one of six size categories: <1 ha, 1-2 ha, 2-4 ha, 4-8 ha, 8-16 ha, > 16 ha.

Willow foliage density was estimated using a 50 X 50 cm square card, marked into four quadrants (c.f. Chappell 1978). Willow clumps for foliage density measurements were randomly selected, and the card was placed one arm's length into the clump at ground level and centered at a height of about 1.5 m. The amount of the card which was visible at a distance of ten paces (approimately 8 m) was recorded. Ten such sets of measurements were taken for each survey unit. At some of the survey locations, we also measured the distance from ground level to the lower edge of willow foliage. Such measurements were taken ten times at each of the survey units.

We estimated the proportion of the willow cover on each survey unit which belonged to each of five categories of clump sizes. The clump size categories were: 0-2 m diameter, 2-4 m, 4-8 m,8-16 m, and > 16 m.

Evidence of grazing, such as trampling, streamside erosion, channelization, or "high-lining", was also noted. We recorded the numbers of any grazing animals present during the surveys, but these numbers were not subjected to statistical analysis because of the obvious problems with daily and seasonal variation. We conducted four cow-dropping counts at each site. These counts consisted of recording the number of cattle droppings encountered in a 2m wide X 30m long transect. At each site two such transects were counted at the perimeter of willows, and two transects were counted which were at least 10m from the perimeter of willows.

Statistical Methods

Many of the habitat variables were categorical. These variables were analysed by chi-square tests of independence. Continuous variables were transformed when they failed a test of normality. Arcsine transformation was used for percentage data, logarithmic transformation for other forms of data. We analysed continuous variables in two ways: by comparing mean values of the variables for sites with and without Willow Flycatchers, and in some cases by regression against Willow Flycatcher numbers. These regressions were occasionally significant, indicating the importance of the variable in assessing habitat suitability for Willow Flycatchers. However, the model r^2 for these regressions was generally very low. The low r^2 values may be a result of selecting inappropriate habitat variables for study. We suggest some modifications of our survey procedure for future investigators. Also, the fact that Willow Flycatchers are rare means that some areas of suitable habitat will be unoccupied (see below), and that the overall variation in numbers is low (most sites have one to three birds). These factors dictate that regression analysis is unlikely to provide a truly predictive model of Willow Flycatcher habitat use. Rather, a habitat suitability model (e.g. Kings River Conservation District 1985) based on qualitative or categorical treatment of habitat variables is probably more appropriate. We suggest some refinements of the KRCD model based on our results below.

RESULTS

Willow Flycatcher Numbers and Distribution

Overview

We visited 125 sites during the 1986 survey, recording 96 singing male Willow Flycatchers at 30 sites (Figure 1). Appendix 1 gives a complete listing of the sites visited, dates of visits, and locations. In addition, we have received reports of an additional 7 birds in the Sierra Nevada/Cascade Mountains region, 14 birds reported on parts of the Kern River Preserve which we did not visit, and one additional bird observed at one of our sites by another biologist. Thus there was a total of 118 singing males. Fifty-six of the sites visited in 1986 were not surveyed in 1982. These sites were added to the survey based on the suggestions of biologists and sightings of Willow Flycatchers between 1982 and 1986. Visits to these new sites resulted in sighting of 12 singing males at 6 of the sites. Areas with more than 2 singing males are shown in Table 1. The Nature Conservancy's Kern River Preserve had the largest number of singing males (39). The Little Truckee River drainage, which had the largest number of singing males in 1982, had 25 in 1986. The Shaver Lake area, Sierra National Forest, had 9 singing males. This area includes Dinkey, Long, and Poison meadows. Dinkey Meadow had 6 singing males in 1982 and 3 singing males in 1986. The Little Truckee River, Kern River, and Shaver Lake areas together account for 67% of the Willow Flycatcher sightings in the Sierra during 1986. These three areas accounted for 73% of the Sierra Nevada sightings during 1982.

Roughly the same total number of birds was seen at the sites surveyed in both 1982 and 1986 (103 in 1982, 99 in 1986). Seven sites which had Willow Flycatchers in 1982 had none in 1986. Six of these sites had only 1 bird in 1982. Six additional sites decreased in number. Most important among this group were Lacey Valley (declined from 13 to 7), Little Truckee River (one site declined from 8 to 2), and Dinkey Meadow (declined from 6 to 3). Three sites which had no

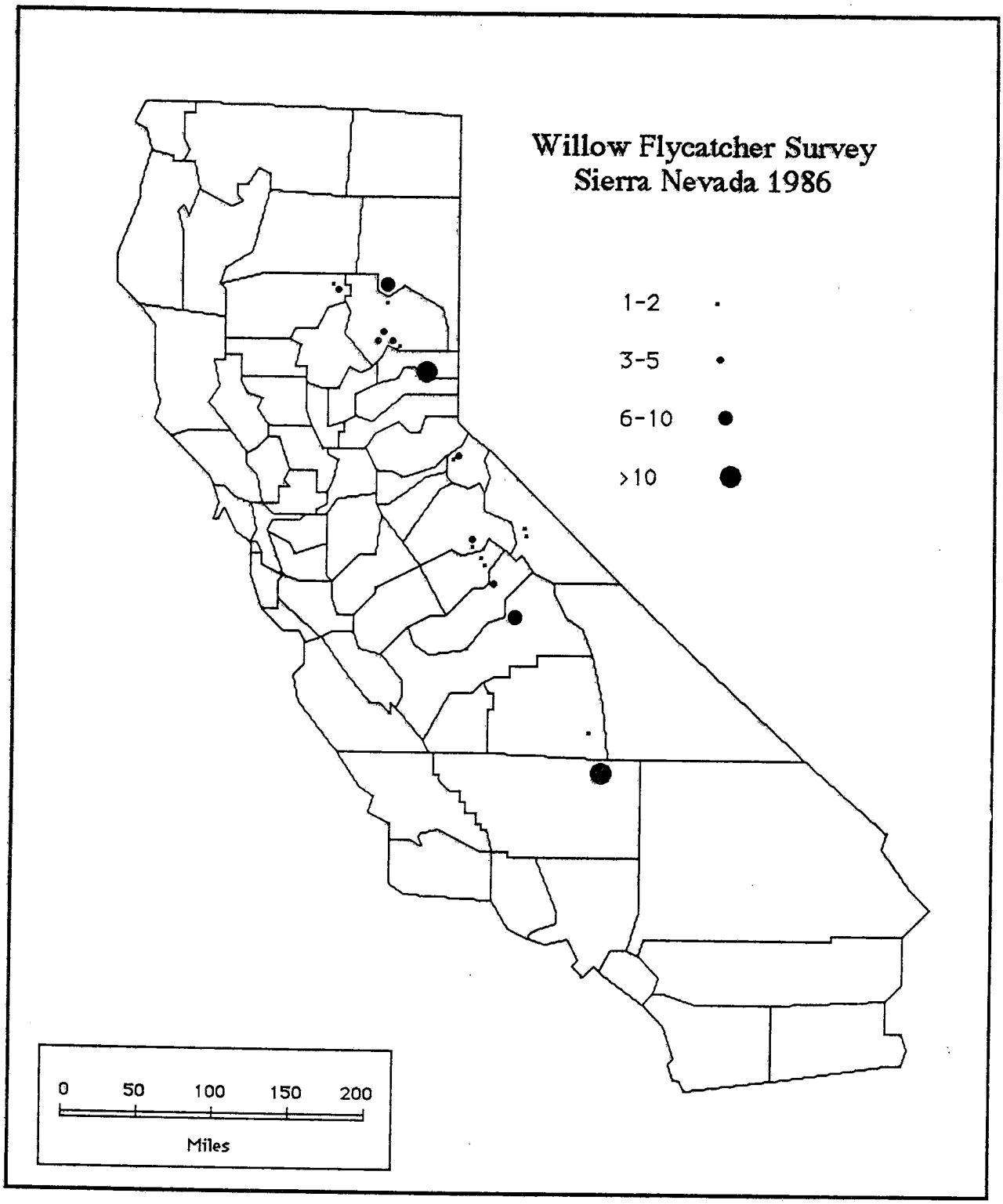

Figure 1. Locations of singing male Willow Flycatcher sightings in the Sierra Nevada: 1986. Only sites visited by the survey team are included.

Table 1. Willow Flycatcher concentrations in the Sierra Nevada and Cascade Mountains: 1982-1986. For each site the number of singing male Willow Flycatchers is indicated for years in which surveys have been conducted. The table includes all sites which have had more than 2 singing male Willow Flycatchers at some time during the study period. Only sites in the Sierra Nevada and Cascade ranges are included. The total given for the Little Truckee River drainage includes Perazzo Meadows and Lacey Valley.

Location	1982	1983	1984	1985	1986
Little Truckee R. Total (Tahoe N.F.)	39	---	---	---	25
Perazzo Meadows (Tahoe N.F.)	11	17	12	8	11
Lacey Valley (Tahoe N.F.)	13	14	10	12	7
Kern River Preserve (Nat. Conserv.)	26	---	23	29	39
Shaver Lake Area (Sierra N.F.)	10		15	8	9
Beasore Meadow (Sierra N.F.)	2	---	---	---	4
Hodgdon Meadow (Yosemite N.P.)	2	---	---	3	1
Ackerson Meadow (Stanislaus N.F.)	5	---	---	---	2[1/]
Westwood Meadow (Lassen N.F.)	4	---	---	---	6
Gurnsey Meadow (Lassen N.F.)	0	---	---	---	3
Faith, Charity Valleys (Toiyabe N.F.)	---	---	---	---	5
Mono Lake area (Inyo N.F.)	2	---	---	---	3
Klamath River (Siskiyou Co.)	---	---	---	3[2/]	---

1/ Reports indicate that there may have been 3 singing males (J. Winter, pers. comm.)
2/ Reported by M. Robbins.

Willow Flycatchers in 1982 had birds in 1986. In two cases 3 birds were present in 1986, in the other case 2 birds were present. Seven additional sites increased in numbers of Willow Flycatchers. Most important among these were Westwood (increased from 4 to 6), Beasore Meadow (increased from 2 to 4, Figure 2), Long Meadow (increased from 1 to 3), and the South Fork of the Kern River (increased from 26 to 39). It is likely that some of the observed changes in number were due to difference in sampling intensity, for example 4 hours were spent at Westwood during our survey, but only half an hour was spent there during 1982.

Among the new sites visited, 6 sites had Willow Flycatchers. A site on the Feather River near Clio had 2 Willow Flycatchers. Other new sites included one on the Little Truckee River (3 birds), Summit Meadow 2 (Shaver Lake area, 1 bird), Faith Valley and Charity Valleys (Toiyabe National Forest, 3 and 2 birds respectively), and Troy Meadow (Sequoia N.F., 1 bird, 1 has been seen in previous years). The Faith Valley and Charity Valley sites are only a few km apart, and there is some apparently suitable habitat nearby in Hope Valley, although we did not locate singing males there during the 1986 survey.

Lassen National Forest

Ten sites in the Lassen National Forest were surveyed from 14 through 17 July. Elevation of the sites ranged from 1340 to 1875 m (4300 to 6000 feet). As noted by Serena (1982), this Forest is lower than much of the Plumas National Forest and contains more open creek and river bottoms. Much of the suitable or formerly suitable habitat for Willow Flycatchers is on private land and has a history of homesteading and grazing. Many of the smaller meadows along mountain drainages are dominated by alder. Eleven singing male Willow Flycatchers were found at four locations: a single male on Humbug Creek (one in 1982), a single male at Battle Creek (two in 1982), 6 singing males near the town of Westwood (four in 1982), and 3 singing males at Gurnsey Creek (none in 1982). We did not find any Willow Flycatchers at Robbers Creek where a single male was located in 1982.

Plumas National Forest

We surveyed 12 locations in the Plumas National Forest from 7 through 10 July. Elevation of these sites ranged from 1330 to 1875 m (4250 to 6000 feet). Many of the larger meadows are on private land and have been heavily grazed (Serena 1982, pers. obs.). Some of these meadows lack willows entirely or the willows are extensively high-lined. Several of the meadows visited during our survey, however, had extensive willow areas. McRae Meadow has extensive willow and alder and is ungrazed. As in the Lassen National Forest, many of the smaller, steep mountain drainages are lined by alders. We found a total of 7 singing male Willow Flycatchers at four locations: 2 males at Haskins Valley (two in 1982), 2 males at McRae Meadow (one in 1982), 2 seen at Round Valley Reservoir West (none in 1982) and 2 at a new site on the Feather River, near the town of Clio. There appeared to be more suitable habitat in this vicinity which was not surveyed due to time constraints, but should be surveyed in the future. We did not find Willow Flycatchers at Little Antelope Creek, where one was found in 1982.

Tahoe National Forest

We surveyed 16 sites in the Tahoe National Forest from 27 June through 25 July. In addition, intensive studies were conducted of the populations at Lacey Valley and Perazzo Meadows (Sanders, Flett and Harris 1986, Flett and Sanders 1987). Elevation of these sites ranged from 1970 to 2160 m (6300 to 6900 feet). We found 25 singing male Willow Flycatchers at five locations, all in the drainage of the Little Truckee River. This area includes extensive meadows near Webber Lake, Perazzo Meadows, and additional meadows along the Little Truckee River west of highway 89 (Figure 3). The meadow systems along the Little Truckee River are very wet and have substantial willow growth. Thirty-nine singing males were

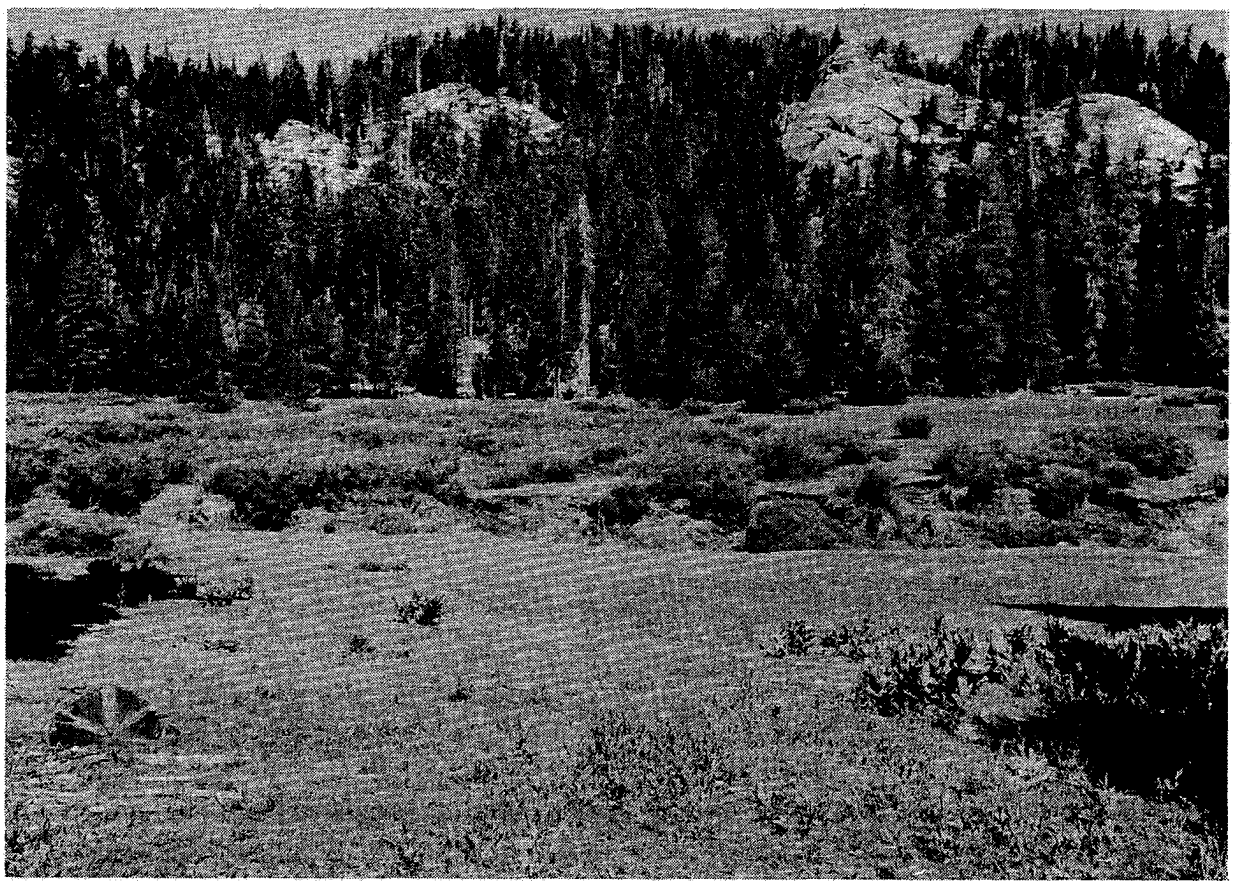

Figure 2. Beasore Meadow, Sierra National Forest. Photo by John H. Harris.

Figure 3. Singing male Willow Flycatcher at Perrazo Meadows, Tahoe National Forest. Photo by Tom Lambert.

located in this National Forest during the 1982 survey. Perazzo Meadows and Lacey Valley are two Little Truckee River sites which have been consistently surveyed over the last five years (Table 1). The Perazzo Meadows population has fluctuated, but there were about the same number of singing males (11) in 1986 as in 1982. During the summer of 1987, a July snowstorm caused a complete reproductive failure of this population (Sanders and Flett, pers. obs.)The Lacey Valley population appears to be declining, and accounts in part for the overall decline along the Little Truckee River. One Little Truckee River site which had 8 singing males in 1982 had only 2 during 1986 and another declined from 3 to 2 males. Two additional sites, 1 at Webber Lake and another along the Little Truckee River , each had 1 singing male in 1982 and none in 1986. One new site along the Little Truckee River had 3 singing males. We received a report (C. Cicero, pers. comm.) of a singing male at Haypress Meadow in late June 1986.

Eldorado National Forest

Ten sites in the Eldorado National Forest were surveyed from 24 June through 27 June, and an additional site was visited on 22 July. Elevation of these sites ranged from 2090 to 2440 m (6700 to 7800 feet). This forest was not surveyed during 1982, and the sites visited were selected on the basis of suggestions made to R. Schlorff by Eldorado National Forest personnel and by decisions made by survey personnel in the field. None of the sites visited had Willow Flycatchers. The majority of the survey locations are heavily grazed and/or contain little willow of sufficient height. Indian Valley has a large expanse of willow, but the meadow generally appears to be dry. Kirkwood meadow has a large amount of lush, tall willow, and much of the upper part of the meadow is wet. Grazing appears to be light, and mainly restricted to a few horses in the lower part of the meadow. It is possible that Willow Flycatchers were missed because the noise of trucks and construction equipment associated with several projects in the ski area made song surveys difficult. Both Kirkwood and Indian Valley are near the upper limit reported for Willow Flycatcher breeding (8,000 feet, Grinnell and Miller 1944). Leeks Spring Valley appears to hold some promise. However, much of the willow in this valley shows evidence of high-lining by cattle, and much of the meadow surface is trampled and grazed to a stubble less than two inches in height. With reduction in grazing, it is possible that this meadow might be suitable Willow Flycatcher habitat. Oyster Creek is a small, wet meadow with tall, dense willows, mostly in small clumps. This meadow might be worth surveying in the future.

Toiyabe National Forest

Six locations in the Toiyabe National Forest were surveyed from 25 through 27 June. Elevation of these sites ranged from 2090 to 2400 m (6700 to 7700 feet). This National Forest was not surveyed in 1982. The sites were chosen by survey personnel while in transit between meadows in the Eldorado National Forest. Singing male Willow Flycatchers were found at two locations: 3 at Faith Valley (a possible fourth was seen perched on top of a willow in the distance, but could not be heard) and 2 at upper Charity Valley. Faith Valley is a large, wet meadow with extensive willow thickets. Much of the meadow appeared to be too wet for cattle at the time of the survey. Upper Charity Valley is part of a meadow system most of which has little willow, but the surveyed portion consists of a large, wet thicket which does not appear to be grazed. There is extensive willow habitat in Hope Valley, but much of the valley appears to be too dry and/or heavily grazed. However, it is possible that Willow Flycatchers may be present. Sorenson's Meadow appears to be excellent habitat, with large, thick willows in a wet meadow. This meadow is small, but may support one or two pairs at times and would be worth checking in the future.

Stanislaus National Forest

Eight sites were visited in the Stanislaus National Forest from 15 July through 17 July. Elevation of these sites ranged from 1375 to 2375 m (4400 to 7600 feet). The meadows in Stanislaus National Forest were generally dry. Willow Flycatchers were only observed at Ackerson Meadow (as was the case in 1982), where 1 singing male was seen during our survey. However,

reports indicate that at least 2 and possibly 3 singing males were present during the breeding season (J. Winter, pers. comm.). According to Winter (pers. comm.), five singing males were present during 1982. Flett (unpubl. data) reported that at least 3 and possibly as many as 5 singing males were present in 1984.

Yosemite National Park

We surveyed five locations in Yosemite National Park on 17 and 18 July. Elevation of these sites ranged from 1250 to 2190 m (4000 to 7000 feet). We detected singing male Willow Flycatchers at three locations: one at Hodgdon Meadow (two in 1982), one at Wawona (two in 1982) and two at Westfall Meadow (one in 1982, Figure 4). More intensive surveys at Wawona, a very large, wet, ungrazed meadow, may reveal additional Willow Flycatchers.

Sierra National Forest

Fifteen sites were surveyed in the Sierra National Forest from 1 through 5 July. Elevation ranged from 1655 to 2560 m (5300 to 8200 feet). Most of the sites are in the vicinity of Shaver Lake and Wishon Reservoir and are on private land. We detected singing males at five locations: 4 at Beasore Meadow (2 in 1982), 2 at Poison Meadow 3 (none in 1982), 1 at Summit Meadow 2 (not surveyed in 1982), 3 at Dinkey Meadow (6 in 1982) and 3 at Long Meadow (1 in 1982). The Shaver Lake area (9 sites) has been intensively studied since 1983 by the Kings River Conservation District. The overall population in the Shaver Lake area during 1985 and 1986 is smaller than that in 1982 (Table 1). Dinkey Meadow had 6 singing males in 1982 (this may have been an overestimate, B. Valentine, pers. comm.), but has had 3 in all subsequent years except 1985, when there were only 2 singing males. Long Meadow, which had only 1 singing male in 1982, has had 3 in every year since 1984. In 1982, Willow Flycatchers were detected at Lost Meadow and Markwood Meadow, where we failed to find singing males in our study. These areas were surveyed between 11 and 19 June 1982, so the birds seen then could have been migrants. This conclusion may be further supported by the paucity of suitable habitat (a single small clump of willow) at Lost Meadow.

Sequoia National Forest and Sequoia-Kings Canyon National Parks

Eighteen sites were surveyed in this area from 16 through 18 July. Elevations ranged from 1500 to 2750 m (4800 to 8800 feet). This region was not surveyed in 1982. Most of the survey locations were suggested by L. Norris and B. Barnes, while others were chosen while in transit between sites. We located only 1 singing male Willow Flycatcher, at Troy Meadow. This bird was in the only part of the willow habitat which was surrounded by wet meadow; other willow thickets along the stream were unoccupied. Singing male Willow Flycatchers have been seen at Long Meadow, Sequoia National Forest (B. Barnes, pers. comm.), but none were located during the survey. Enough wet meadow and willow appeared to be present for one or two singing males. The vast majority of the sites visited in this region were unsuitable because of a scarcity of willows. Some of the sites have been occupied by Willow Flycatchers in the past (L. Norris). For example, the meadow near the Grant Grove Ranger Station, Kings Canyon National Park, had singing male Willow Flycatchers nearly every summer from 1980 to 1984. However, the Park Service subsequently burned these willows (L. Norris pers. comm.), and Willow Flycatchers have not been seen since. Kennedy Meadow has a considerable amount of willow, but the area including surrounding meadow grasses is very dry.

Inyo National Forest

Nineteen sites were visited in the Inyo National Forest from 18 through 26 July. Elevation of these sites ranged from 1220 to 2625 m (3900 to 8400 feet). Two singing male Willow Flycatchers were observed at Lee Vining Creek, where one male was detected in 1982. A singing male was located in 1982 along Rush Creek, but none were found there in 1986. This site was

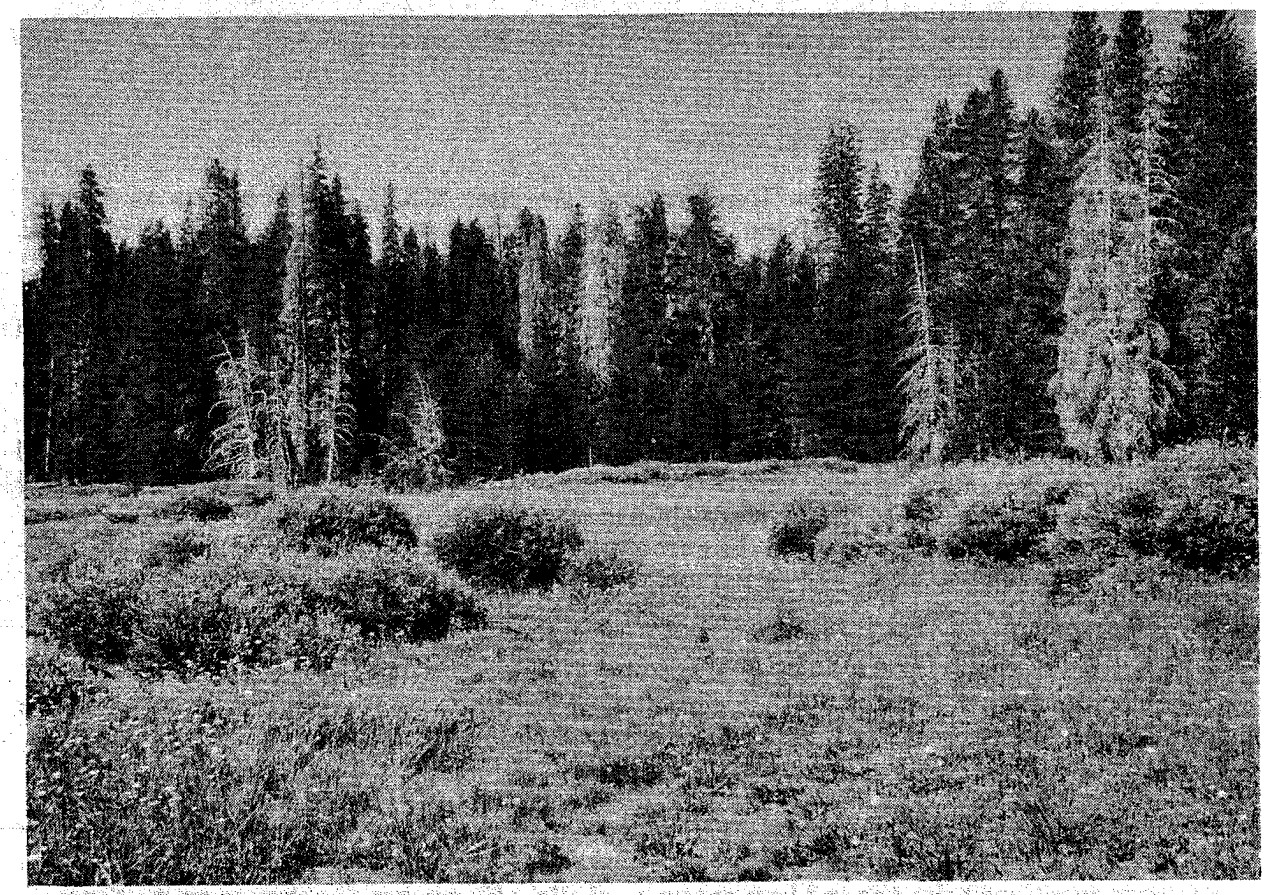

Figure 4. Westfall Meadow, Yosemite National Park. Photo by Susan Sanders.

visited during the first week of June in 1982, so that sighting may have been a migrant. The same might be true of the male reported by D. Gaines on 5 June 1979 at Aspendell. We received one report of a singing male Willow Flycatcher in Lundy Canyon, Mono County on 24 July (D. Gaines, pers. comm.). Apparently Willow Flycatchers have been sighted in Lundy Canyon for several years. An effort was made to survey representative habitat along the Owens River, including four sites near Bishop and three sites south of Bishop (Calvert Slough, Black Rock Reservoir, and Tinnemaha Reservoir). No Willow Flycatchers were observed at any of these sites. Most of the sites contained extremely dense willow thickets surrounded by very dry grassland or sage scrub. This habitat is quite different from any habitat where we typically observed Willow Flycatchers and may be unsuitable. It is likely that water diversion and ground-water pumping have adversely affected habitats in the Owens Valley by lowering the water table (thus drying meadows). Willow Flycatchers once bred in this valley and may still occasionally occur there (Grinnell and Miller 1944, Garrett and Dunn 1981). One was observed raising a young cowbird near Bishop in 1979 (reported to R. Schlorff). One of the best unoccupied sites visited during the survey was at Green Creek, north of Mono Lake. This site has extensive, dense willow thickets in a very wet meadow. Though intensively searched, no Willow Flycatchers were observed. This site should be included in any future surveys.

The Nature Conservancy Kern River Preserve

The Nature Conservancy Kern River Preserve (elevation 828 m, 2650 feet) was surveyed from 9 July through 13 July. In addition, a number of sightings were mapped and reported by M. Halterman, S. Laymon, and Z. Labinger, who were conducting studies on the Yellow-billed Cuckoo (Coccyzus americanus occidentalis) at the Preserve. Our estimate of the total number of Willow Flycatchers on the south fork of the Kern River is derived by mapping all sightings by these biologists and the survey team, and eliminating any possible duplicate sightings. The Kern River Preserve contains several miles of riparian cottonwood-willow (Populus fremontii, Salix laevigata and S. gooddingii) forest. Willow Flycatcher habitat consists of willow thickets distributed along the river and adjacent sloughs. At some locations, (e.g., Mariposa Marsh), the willows are located in the standing water of sloughs and beaver ponds. The vast majority of singing males (about 85%) were observed where willows were either directly in or adjacent to standing water or wet meadow. Willow Flycatchers were counted by B. Engstrom during a 1982 cuckoo study, and have been surveyed every year since then. The total number of singing males detected in 1986 was 39, the largest known population in California. The Kern River population appears to have increased steadily since 1984. The increase is distributed fairly evenly over the area. Livestock grazing has been eliminated in several of the areas of concentration within the preserve since 1981. Grazed areas adjoining the preserve, such as Onyx and Bloomfield Ranches, had no birds in 1986. Prince Pond, which has had as many as 13 birds, was acquired in 1982 and has been ungrazed since 1983. Mariposa Marsh, ungrazed since 1981, has increased from 7 to 12 birds in the last three years. Prince Pond had fewer birds (7) in 1986 than in the two previous years, but the birds may have moved to adjoining flooded habitat. Flooded areas west of Prince Pond had at least 6 singing males where none had been sighted previously. These areas are not flooded every year, in contrast to the above-mentioned sloughs and beaver ponds. Willow Flycatcher distribution on the Kern River floodplain may be related to the distribution of flooded areas in a given year.

During the summer of 1987 (Harris, pers. obs.), preliminary studies indicated that nearly all nests at Mariposa Marsh and the Slough Channel were parasitized by Brown-headed Cowbirds. Only 11 young were fledged out of 8 territories in which nests were located, and fledging dates were as late as 15 August because of frequent renesting after parasitism.

Habitat Characteristics

Meadow Wetness

We analysed meadow wetness data by first comparing the average percent of meadow wet

for two groups: sites with and without Willow Flycatchers. Sites with Willow Flycatchers averaged 47.70 % wet (n = 30, s.e. = 5.40). Sites without Willow Flycatchers had a mean meadow wetness of 29.36% (n = 92, s.e. = 3.30). A t-test on the transformed data shows a significant difference between these values (t = 2.838, df = 120, p = .005).

We also performed a categorical analysis (Table 2), dividing the meadows into four categories: 0-24% wet, 25-49% wet, 50-74% wet, and 75% wet or greater. Willow Flycatcher presence was clearly related to meadow wetness ($\chi^2 = 9.097$, df = 3, p = 0.028). Willow Flycatchers were unlikely to be present on meadows which were less than 25% wet (Table 2). Serena (1982) observed that the wetness within areas used by Willow Flycatchers was generally at least 40%. We also tested for this relationship between presence or absence of Willow Flycatchers and meadow percent wet using two categories: greater than and less than 40% wet. Willow Flycatchers occurred at 38% of the meadows which were more than 40% wet, but at only 17.5% of the meadows which were less than 40% wet ($\chi^2 = 7.125$, df = 1, $p < 0.01$). Sixty one percent of the sites with more than one Willow Flycatcher were in meadows with greater than 40% wet.

Regressions of meadow wetness against Willow Flycatcher numbers were performed, using the entire data set and a subset of those sites with Willow Flycatchers present. For the entire set, numbers of Willow Flycatchers were significantly related to meadow wetness (F = 11.08, df = 121, p = 0.002). However, the model r^2 is low (0.08), indicating that meadow wetness as measured in our study accounted for only 8% of the variation in numbers of Willow Flycatchers. A similar situation occurs when only the sites with Willow Flycatchers were used, although more of the variation is explained ($r^2 = 0.127$, F = 4.068, df = 29, p = 0.056). Clearly meadow wetness is an important habitat factor, although wetness alone is not a powerful predictor of Willow Flycatcher numbers.

Riparian Attributes

There was a significant association between size of stream or river and the occurrence of Willow Flycatchers ($\chi^2 = 10.491$, df = 4, p = 0.033; Table 3). Sixty percent of all occurrences (and 69.6 % of sites with more than one bird) were at sites with streams at least 1.2 m (4 feet) in width. Both streams greater than 4 feet in width and those between 1 and 4 feet had about 30% occurrence of Willow Flycatchers, but streams smaller than 1 foot in width had only an 11% occurrence rate.

Presence or Absence of Standing or Running Water

The presence of Willow Flycatchers was related to the presence or absence of standing or running water ($\chi^2 = 9.975$, df = 3, p = 0.019). No Willow Flycatchers were found at sites without standing or running water (Table 4). Fifty-three percent of the sites with singing males had both standing and running water, and an additional 40% of the sites had running water. Sites with only standing bodies of water and no running water were rare. This association was also noted by Serena (1982).

Willow Cover

The percent cover of small (<3m) willows had no relationship to Willow Flycatcher numbers. The mean percent cover for sites with (16.7%) and without (16.4%) Willow Flycatchers were not significantly different (t = 0.056, df = 93, p = 0.956). The regression of transformed percent cover against Willow Flycatcher numbers was not significant (F = 0.51, p = 0.48, r^2 = 0.005).

The mean percent cover of large (>3m) willows did not differ significantly between those

Table 2. Presence or absence of Willow Flycatchers at meadow sites differing in the percent of the meadow covered with water. The numbers of sites at which singing males were present or absent are shown. The total number of sites for each category of meadow wetness, and the total number of sites at which Willow Flycatchers were present or absent are also shown.

	Percent of Meadow Wet				
Willow Flycatcher	0-24%	25-49%	50-74%	75-100%	Total
Present	9	5	8	8	30
Absent	56	10	11	15	92
Total	65	15	19	23	122

Table 3. Presence or absence of Willow Flycatchers in relation to size of riparian system. The number of sites at which singing males were present or absent is given for each riparian system size class. The size classes are as follows: class 1, < 1 foot (30 cm) wide; class 2, 1-4 feet (30-120 cm) wide; class 3, > 4 feet (120 cm) wide.

	Riparian System			
Willow Flycatcher	Class 1	Class 2	Class 3	Total
Present	4	8	18	30
Absent	31	18	42	91
Total	35	26	60	122

Table 4. Occurrence of Willow Flycatchers in relation to the presence or absence of running and standing water. The number of sites at which singing male Willow Flycatchers were observed for categories of running and standing water are shown. The categories are as follows: class 0, no running or standing water; class 1, standing water only; class 2, running water only; class 3, running and standing water both present.

	Standing and Running Water				
Willow Flycatcher	Class 0	Class 1	Class 2	Class 3	Total
Present	0	2	12	16	30
Absent	15	6	46	25	92
Total	15	8	58	41	122

sites with (13.8%) and without (9.7%) Willow Flycatchers ($t = 1.063$, $df = 93$, $p = 0.29$). However, the regression of percent cover and Willow Flycatcher numbers was significant ($F = 8.04$, $p = 0.006$). Though the regression is significant, the model r^2 is quite small (0.08), indicating that little of the variation in Willow Flycatcher numbers could be explained by percent cover of large willows. A regression of percent cover of large willows against Willow Flycatcher numbers for only those sites where Willow Flycatchers were present explains more of the variation ($F = 6.2$, $p = 0.02$, $r^2 = 0.19$).

Meadow Size

The presence or absence of Willow Flycatchers was clearly related to meadow size (Table 5, $\chi^2 = 17.79$, $df = 5$, $p = 0.003$). No Willow Flycatchers were found in the three smallest meadow size classes (0-4 ha). Willow Flycatchers were found in 30% of the sites of size class 4 (4-8 ha), 35% of sites of size class 5 (8-10 ha), and 38% of sites of size class 6 (>16 ha). Fifty-six percent of the sites with more than one Willow Flycatcher were in the largest meadow size class. Neither the percent cover of willows nor meadow size is a direct measure of the amount of suitable habitat. We suggest that future surveys should attempt to directly estimate the area of willow. In an attempt to explore this relationship further, we created a new habitat variable by multiplying the percent cover of large willows by the meadow size category for each meadow. This new variable is a crude estimate of the amount of area of large willows. The regression of this large willow area against Willow Flycatcher numbers is significant ($F = 6.93$, $p = 0.01$) and gives a better (though still poor) fit to the data than does percent cover of willow ($r^2 = 0.20$). We do not intend to base conclusions about Willow Flycatcher habitat relationships on a variable not actually measured in the field, but this result suggests that estimating willow area might be a more productive field procedure for future surveys.

Willow Foliage Density

Sites with Willow Flycatchers had more dense willow foliage than those sites without Willow Flycatchers. At ground level, the mean foliage densities were 61.1% for sites with Willow Flycatchers and 45.4% for sites without the birds ($t = 3.24$, $df = 84$, $p = 0.002$). At a height of 1.5 m, the mean foliage densities were 67% for sites with Willow Flycatchers and 55.4% for sites without the birds ($t = 2.52$, $df = 84$, $p = 0.014$). Regressions of willow foliage density against Willow Flycatcher numbers were significant at ground level ($F = 12.85$, $p = 0.001$, $r^2 = 0.13$) and at a height of 1.5m ($F = 6.16$, $p = 0.015$, $r^2 = 0.07$). As was the case for most habitat variables, the proportion of variation in Willow Flycatcher numbers which could be explained by the regressions was quite small.

Height to Bottom of Willow Foliage

Sites without Willow Flycatchers had a greater height to the bottom of willow foliage. The means for sites with Willow Flycatchers (26.0cm) was significantly different from those sites without Willow Flycatchers (46.1 cm)($t = 2.29$, $df = 48$, $p = 0.03$). Clearly the height to the bottom of willow foliage is closely related to willow foliage density, since severely browsed willows have little or no foliage at ground level. A regression of height to the bottom of willow foliage against Willow Flycatcher numbers was significant ($F = 8.30$, $p = 0.006$, $r^2 = 0.15$).

Cattle Dropping Transects

There was no relationship between cattle dropping counts and the presence or numbers of Willow Flycatchers. We tested for differences between mean dropping counts at sites with and without Willow Flycatchers. For dropping counts at the perimeter of willows, the means were 3.5 at sites with birds and 4.9 at sites without birds ($t = 0.98$, $df = 85$, $p = 0.33$). For dropping counts in the open, the means were 7.26 for sites with birds and 9.47 at sites without birds ($t = 0.94$,

Table 5. Occurrence of Willow Flycatchers in relation to meadow size. The number of sites at which Willow Flycatchers were present or absent is shown for each meadow size class. Meadow sizes were estimated in hectares.

	Meadow Size						
Willow Flycatcher	0-1ha	1-2ha	2-4ha	4-8ha	8-16ha	>16ha	Total
Present	0	0	0	7	7	16	30
Absent	1	13	23	16	13	26	92
Total	1	13	23	23	20	42	122

df = 85, p = 0.35). Regressions were also not significant at the perimeter of willows (F = 1.123, p = 0.069, r^2 = 0.01) or in the open (F = 1.883, p = 0.115, r^2 = 0.02).

Clump Size Distribution

The distribution of willows among various clump sizes was very similar for sites with and without Willow Flycatchers (Table 6). Student's t tests between sites with and without Willow Flycatchers were conducted for each clump size category. None of these tests were significant (Table 6). There are several reasons why our analysis may have been inadequate to test the hypothesis that Willow Flycatchers prefer areas with discontinuous clumps over solid masses of willows. Our clump size categories may have been inappropriate. Secondly, it might be that the amount of willow perimeter is the relevant habitat characteristic. For example, a single mass of willow might have a highly folded perimeter, with the same effect as having several smaller willow clumps. A larger perimeter provides more areas from which Willow Flycatchers can sally over open meadow habitat.

DISCUSSION

Status of the Willow Flycatcher in California

The Willow Flycatcher was formerly considered common and widely distributed in the state wherever suitable habitat existed (Grinnell and Miller 1944). Areas where it was most common include the Central Valley, the southern coastal region and central California in general. Specific areas mentioned in which Willow Flycatchers were common or abundant include the Kings River (Goldman 1908), the vicinity of Buena Vista Lake (Linton 1908), the south and central coast (Willett 1912, 1933), the swampy thickets near Los Angeles and the valley rivers of central California (Belding 1890), the San Francisco Bay region (Barlow 1900), and Yosemite Valley (Grinnell and Storer 1924). Ridgway considered it to be the most abundant and generally distributed Empidonax species (cited in Belding 1890). In the Sierra Nevada, Willow Flycatchers were felt to be common along willow-lined streams, especially in broad river bottomlands (Grinnell and Storer 1924, Grinnell et al. 1930, Sumner and Dixon 1953). Nesting sites were found from sea level to about 2,500m (8,000 ft) (Grinnell and Miller 1944).

As a breeding species, the Willow Flycatcher has been extirpated from most of its former range, surviving only in mountain meadows of the Sierra Nevada, and along the south fork of the Kern River, the Santa Margarita River, and the San Luis Rey River (Remsen 1978, Garrett and Dunn 1981, Serena 1982, Unitt in press). As a spring and fall transient, the Willow Flycatcher is still fairly common in riparian willow habitat throughout the state (McCaskie et al. 1979, Garrett and Dunn 1981). Willow Flycatchers no longer breed in the Central Valley (McCaskie et al. 1979), and records from the southern coast and central coast have been sporadic (Stallcup and Greenberg 1974, Garrett and Dunn 1981, Unitt 1984, Roberson 1985). Extensive searches in the Sacramento River Valley (Gaines 1974) have revealed no breeding Willow Flycatchers. Careful search of riparian habitat in southern California in the summer of 1978 revealed only two singing males (Garrett and Dunn 1981), although subsequent surveys have revealed populations on the Santa Margarita and San Luis Rey rivers in San Diego County (L. Salata, pers. comm., Unitt in press). Even in the Sierra Nevada, the species has apparently declined (Gaines 1977, Serena 1982), having become alarmingly scarce in the Yosemite region. The 1982 survey resulted in the observation of 103 singing males in the Sierra Nevada. Nineteen sightings were reported in addition, giving a statewide total of 122 singing males for 1982.

Our surveys and other reports resulted in total sightings of 118 singing males. Unitt (in press) and L. Salata (pers. comm.) suggest breeding populations of about 15 pairs on the Santa Margarita River and about 12 pairs on the San Luis Rey River (both in San Diego County). This gives a statewide total for the 1986 known population of about 145 singing males. It appears that

Table 6. Clump size distribution in relation to occurrence of Willow Flycatchers. The numbers represent the average of the total willow percent cover which belonged to each clump size, for sites with and without Willow Flycatchers. Results of t-tests between the average percent willow cover for sites with and without Willow Flycatchers are given for each clump size. None of the tests are significant.

	Willow Clump Diameter				
Willow Flycatcher	0-2m	2-4m	4-8m	8-16m	>16m
Present	3.2	15.8	24.0	14.2	42.8
Absent	3.8	16.1	22.7	23.1	34.6
t	0.402	0.081	0.265	1.88	0.97
df	85	85	85	85	85
p	0.69	0.94	0.79	0.06	0.34

in California, the species has been reduced to a small number of marginal populations. Sierra Nevada populations may be particularly susceptible to weather fluctuations, as demonstrated by the total failure of the Perazzo Meadows breeding population after a 1987 July snowstorm (Sanders and Flett, pers. obs.).

These marginal populations belong to three subspecies, one of which (E.t. extimus) has declined dramatically in most of its range (southern California, southern Nevada, Arizona, New Mexico). Three relatively small areas account for about two thirds of the known Sierra Nevada population. With the two San Diego County populations, these account for 70 percent of the known statewide population of Willow Flycatchers.

Our survey results indicate that the majority of Sierra Nevada Willow Flycatchers are located in three general areas. Between the Little Truckee River (Tahoe National Forest) and Westwood Meadow (Lassen National Forest), we found 43 singing males, most of which were along the Little Truckee River (Table 1). Nineteen singing males were found in the central Sierra, from Ackerson Meadow (Stanislaus National Forest) to the Shaver Lake area (Sierra National Forest). The south Fork of the Kern River had the largest population, with 39 singing males. In addition to these major areas, small numbers of singing males were located on the east side of the Sierra, near Mono Lake (3 singing males) and in the vicinity of Carson Pass (5 singing males). There is a large gap in the distribution of sightings between the central Sierra and the Kern River. There have been a few reports in recent years of Willow Flycatchers in the Sequoia and Kings Canyon National Parks (L. Norris, pers. comm. to R. Schlorff) but no birds were found during this year's survey, and there seems to be insufficient habitat to support large populations.

Portions of northern California, particularly the area north of Lassen National Forest, from the Nevada border to the coast, should be surveyed in the future. During our survey, a singing male was located along the Feather River, near Clio. This site was visited briefly, and there appears to be more suitable habitat which should be surveyed in the future. Singing males have been reported in recent years from the Forks of the Salmon (1), the vicinity of Mt.Shasta (1), and Lower Klamath Lake (3 nests in 1985) (M. Robbins, pers. comm.). Singing males have been reported from Humboldt County in the vicinity of Garberville (R. LeValley, pers. comm.) and from Willow Creek (Serena 1982); these sightings may have been migrants (R. LeValley, pers. comm.). Recent Breeding Bird Surveys have produced a few sightings in the northern tier of counties (S. Droege, pers. comm.). There are 29 survey routes in Humboldt, Trinity, Del Norte, Siskiyou, Shasta and Modoc Counties. Seven of these routes have recorded Willow Flycatchers during the period from 1982 to 1985 (4,3,3 and 6 birds in the four years). A single male was observed at the Modoc National Wildlife Refuge for the first time in 1985, and a pair fledged a single young at the Refuge in 1986 (W. Radke, pers. comm.). This successful nesting may have resulted from protection of riparian habitat from grazing over the last 6 years. Further surveys in northern California will likely produce more sightings, but there is no indication that large populations occur in this region.

Some portions of the Central Valley have not been recently surveyed (Valentine 1987). The Sacramento River Valley has recently been surveyed for Bank Swallows (Riparia riparia) and Yellow-billed Cuckoos (Coccyzus americanus), with no reports of breeding Willow Flycatchers (Gaines 1974, R. Schlorff and S. Laymon, pers. comm.). The San Joaquin Valley, on the other hand, may harbor Willow Flycatchers (M. Stafford and B. Valentine, pers. comm.). Surveys along some of the major river systems of the San Joaquin Valley would be justified, although the dearth of reports leads us to believe that large populations are unlikely to be discovered.

The subspecific identity of California Willow Flycatcher populations provides further reason for concern about the species status in the state. Three subspecies occur in California (Unitt in press). Empidonax traillii brewsteri breeds from Fresno County north, from the coast to the Sierra Nevada crest. Empidonax traillii adastus breeds east of the Sierra/Cascade axis. The type locality for this taxon is in southern Oregon, and it is known to range into Modoc County (Phillips 1948) and perhaps south to northern Inyo County (Unitt in press). Willow Flycatchers north of the Kern

River in California may represent a zone of intergradation between E.t. brewsteri and E.t. adastus (Phillips 1948). Southern California populations of Willow Flycatchers have recently been shown (Unitt in press) to belong to the subspecies E.t. extimus (Phillips 1948). The northern limits of breeding for this taxon are Independence in the Owens Valley, the south fork of the Kern River, and the Los Angeles basin. It has also suffered serious declines in the portions of its range outside of California (Unitt in press). Thus the small number of breeding Willow Flycatchers in California is further divided among three subspecies, each of which has declined to very low numbers within the state.

Reasons for the Decline of the Willow Flycatcher

Many authors agree that alteration and loss of riparian habitat (c.f. Katibah 1984), especially in the Central Valley, had a role in the decline of Willow Flycatchers (Remsen 1978, Garrett and Dunn 1981). However, the absence of Willow Flycatchers in apparently suitable habitat suggests that other factors are also at work. Brown-headed Cowbird nest parasitism has been suggested as a cause of the Willow Flycatcher's decline (Gaines 1974). Studies at low elevations in southern California suggested that the Willow Flycatcher is susceptible to cowbird parasitism (Hanna 1928, Rowley 1930). Friedmann (1963) reported 150 instances of Brown-headed Cowbird parasitism of Willow Flycatchers, 41 of which were reports from southern California. Studies on the Kern River Preserve, begun after our survey, suggest that Brown-headed Cowbird parasitism on Willow Flycatchers is heavy, affecting the numbers of birds fledged and the fledging date (Harris, pers. obs.). Gaines (1974) concluded that 9 of 12 species (including the Willow Flycatcher) known to have declined along the Sacramento River are highly susceptible to cowbird parasitism. Decline of Willow Flycatchers in central and coastal California coincides with the spread of cowbirds in the 1920s and 1930s (Gaines 1974, Garrett and Dunn 1981, Laymon 1987). The lack of overlap in breeding seasons between Brown-headed Cowbirds and Willow Flycatchers in the Shaver Lake area, and the lack of observed parasitism (Stafford and Valentine 1985) suggests that cowbird parasitism might be less important in the Sierra Nevada than in lower elevation areas. There are apparently only two Sierra Nevada records of Brown-headed Cowbird parasitism on Willow Flycatchers (Flett and Sanders 1987).

Livestock grazing in riparian habitats has been suggested as a possible factor in decline of the Willow Flycatcher in the Sierra Nevada and elsewhere (Serena 1982, Stafford and Valentine 1985, Taylor 1986, Taylor and Littlefield 1986, Flett and Sanders 1987). The activities of cattle can adversely affect Willow Flycatchers by the disturbance of nests (Stafford and Valentine 1985, Flett and Sanders 1987, Valentine 1987). Four of 20 nests observed in the Shaver Lake area were destroyed by cattle before fledging of the young, and an additional four nests were destroyed shortly after the young were fledged (Stafford and Valentine 1985, Valentine 1987). Grazing may affect the hydrology of meadows by soil compaction, streambank trampling and gullying, and mineral redistribution, eventually lowering the water table of moist meadows, reducing the amount of free water available, and changing the meadow's vegetation composition (Ratliff 1984, Van Haveren and Jackson 1986). In addition, cattle and sheep consume the lower branches and shrub layers of riparian vegetation, make trails through willow thickets, and consume and trample seedlings of riparian plants thus changing such structural features as willow foliage height and willow foliage volume (Mosconi and Hutto 1981, Rickard and Cushing 1982, Ratliff 1984, Taylor 1986). These changes could clearly have a negative effect on Willow Flycatchers (Serena 1982, Taylor 1986, Taylor and Littlefield 1986). At the Malheur National Wildlife Refuge in Oregon, ungrazed transects had higher willow foliage density and volume, and had more Willow Flycatchers than grazed transects (Taylor and Littlefield 1986). These authors also present data indicating a correlation between increases in Willow Flycatcher numbers and decreases in grazing. Recovery of riparian vegetation when grazing is eliminated and efforts are made to restore the habitat provide encouraging evidence that habitat may be improved for Willow Flycatchers (Winegar 1977,Duff 1979, Rickard and Cushing 1982, Clay 1984). Other factors that might be involved in the decline of Willow Flycatchers in the Sierra Nevada include loss of meadow habitat due to reservoir and hydroelectric development, fires set by grazers, lodgepole pine encroachment on meadows, and

habitat loss on the wintering grounds (Serena 1982).

Habitat Relationships

Meadow Size and Topography

In agreement with Serena (1982), we found that most birds (104 of 110) were in meadows larger than 8 hectares. Moreover, the majority of the sites with more than one singing male were in meadows of the largest size class (>16 ha). This may occur because only large meadows contain enough willow cover in combination with open areas for foraging. Broad, flat areas seem to be preferred, as suggested by previous authors (Grinnell and Storer 1924, Gaines 1977). Very few singing males were observed in willow thickets on steep terrain.

Since large meadows can support larger populations, the absence of Willow Flycatchers from small meadows may actually represent a transient state in a colonization/extinction process. Serena (1982) suggested that small populations, (e.g. single breeding pairs), will die out more frequently than larger populations, and small population sites will be recolonized very slowly (especially given the present rarity of Willow Flycatchers). We found apparent evidence of turnover, though we emphasize that sampling errors could account for these changes as well. Seven sites which were occupied during 1982 had no birds during our survey; six of these sites had only one bird in 1982, the other had two. We found singing males at three sites which were not occupied in 1982; two sites had three birds, the other had two.

Water

Willow Flycatchers appear to prefer wet meadows, as noted by previous authors (Grinnell and Miller 1944, Serena 1982, Kings River Conservation District 1985). We found that sites with Willow Flycatchers were wetter than sites without them. Virtually all of the sites with more than one singing male had standing water. Only one of the singing males observed in this study (Summit Meadow 2, Sierra National Forest) was in a situation with no wet meadow, in this case a willow-alder thicket along a small stream, surrounded by dry grass and ferns. Serena noted that within meadows with substantial dry areas, Willow Flycatchers were invariably found in the wettest areas. She observed that the wetness within areas used by Willow Flycatchers was generally at least 40%. We found that Willow Flycatchers were twice as frequent at sites where the meadow was at least 40% than at sites where wetness was less than 40%. Some of the areas occupied by Willow Flycatchers were wetter early in the breeding season (Valentine and Stafford 1985, Sanders et al. 1986). Valentine and Stafford (1985) suggest that some areas which are suitable habitat may be fairly dry late in the season without negatively affecting the birds. The reasons why Willow Flycatchers prefer wet meadows are not clear, and deserve further study. The survey team noted a higher density of aerial insects, particularly mosquitos, at wet meadows, suggesting that meadow wetness could be related to prey density.

Much of the variability in meadow wetness data concerns the fact that portions of a meadow which are not used by Willow Flycatchers are included in estimates of overall meadow wetness. If these areas are dry, then the overall meadow wetness will be low even though the area occupied by Willow Flycatchers might be wet. This is related to the general problem of defining the sample unit, which also confounds data on percent cover of willows. Serena (1982) suggested that this was the reason that she found no relationship between meadow wetness and presence of Willow Flycatchers. There may also have been differences in meadow wetness between years that could confound such analysis. For example, in a wet year, many meadows which are otherwise unsuitable may be wet. In future surveys, we recommend that the wetness within some distance of willow thickets be measured, rather than overall meadow wetness. A suitable distance might be based on flycatcher biology, perhaps two standard deviations of the mean foraging distance. Further research is needed to determine such foraging distances, and their relationship to habitat structure.

Willow Characteristics

Willow Flycatchers are typically only found where willow thickets are present. Studies focusing on nesting territories suggest that a canopy cover of about 70% on the territory is optimal (Whitmore 1977, Stafford and Valentine 1985, Flett and Sanders 1987). The percent cover on a total meadow or meadow system is a poor predictor of Willow Flycatcher presence, largely because of its relation to meadow size (Serena 1982 and this survey). Many of the best meadows are very large, and have a small total percent willow cover, although the total amount of willow is considerable. We suggest that future surveys simply estimate the total area covered by willow.

Willow Flycatchers were only found where the willow cover was at least 2 m in height. We found the best relationship of willow percent cover to Willow Flycatcher numbers for willows greater than 3 m in height. This can be partly explained because only willows of at least 2m in height will have dense foliage at an appropriate height for nesting. Studies suggest that Willow Flycatchers generally nest between 0.6 and 1.75 m above the ground (King 1955, Walkinshaw 1966, Stafford and Valentine 1985, Flett and Sanders 1987). In addition, Willow Flycatchers often use the tops of willows as perch sites for singing and initiating foraging flights. We also frequently observed the use of lodgepole pines as perch sites during the survey.

Sites with Willow Flycatchers had higher foliage density than sites without them. Data from the survey and from Flett and Sanders (1987) suggest that a foliage density of at least 70% at ground level and at a height of 1.5 m should be goals for managment of meadows for Willow Flycatchers. Given the relationship between grazing and foliage reduction discussed above, foliage density should be a very useful measure for determining appropriate livestock grazing levels in Willow Flycatcher management areas. Meadows in which the willows were very arborescent (observed primarily in the Shaver Lake area), or in which willows had been severely "high-lined" by cattle, generally did not support Willow Flycatchers. The importance of foliage density is undoubtedly related to the use of the lowest 1.5 m of willows for nesting. Denudation of this portion of willows may make nest construction and support difficult or may reduce cover below requirements.

Willow Flycatchers apparently prefer meadows in which the willow cover is divided into clumps separated by openings, rather than solid masses of willow (Grinnell and Storer 1924, King 1955, Serena 1982, Kings River Conservation District 1985). This preference is perhaps related to the foraging methods of Willow Flycatchers: brief, short foraging flights from a perch to adjacent open areas. If this is the case, the perimeter of willow with respect to area might be the best direct measure related to habitat requirements. Our field observations are consistent with this view. However, quantifying these observations has proven to be difficult. Our attempt to quantify clump size distribution failed to support the hypothesis, perhaps because our method was inappropriate.

MANAGEMENT RECOMMENDATIONS

Status of the Willow Flycatcher

1. The Department of Fish and Game should prepare a petition and make a recommendation to the Fish and Game Commission to list the Willow Flycatcher as Endangered in the state because of its small population size, evidence of severe decline in numbers, and the concentration of the majority of the state's breeding Willow Flycatchers in only five isolated areas. This situation is critical because the Little Truckee River population appears to be declining and is vulnerable to weather fluctuations (Sanders and Flett, pers. obs.), the Shaver Lake population was recently threatened by hydroelectric development (though this threat has been abated for the time being),two dams have been proposed for the Santa Margarita River, which would flood much of the existing riparian habitat, and the Kern River Preserve population is heavily parasitized by Brown-headed Cowbirds (Harris, pers. obs.).

2. Management planning should take into account the status of all three of the recognized subspecies of Willow Flycatcher occurring in California, and should address the need for preservation of genetic variation in this species.

Future Survey Locations and Methods

1. Future surveys should attempt to clarify the status of the species in areas not previously surveyed, including north coastal California, the Klamath Mountains and Cascade Mountains, northeastern California in general, and portions of the Central Valley, particularly the San Joaquin Valley. Some specific areas are mentioned in the discussion above. Areas of concentration should continue to be surveyed periodically.

2. The sampling unit for habitat studies should not necessarily be an entire meadow or meadow system. We suggest that a sampling unit defined by Willow Flycatcher behavior rather than whole meadows be used. Such a sampling unit might include all the area within two standard deviations of an average foraging sally from willow cover. This would do much to rectify the problems discussed above with sampling meadow size, percent cover of willow, and meadow wetness, since these are habitat characteristics which are estimated relative to the entire sampling unit.

3. When assessing Willow Flycatcher habitat, the amount of area covered by willow at a particular site should be estimated rather than total meadow size or total percent cover of willow. However, it may still be desirable to estimate percent cover of willow, meadow wetness, or willow clump size and distribution within a sampling unit or singing male's territory.

Management of Willow Flycatcher Habitat

1. Existing meadow sites where Willow Flycatchers have nested should be protected from habitat loss. Aquisition of private parcels or purchase of conservation easements by governmental agencies or conservation organizations may be appropriate to provide needed protection.

2. Land-use planning within the range of the species should recognize that a site which is unoccupied during a given year should not be considered to be unsuitable, as it may be later reoccupied by breeding Willow Flycatchers. This may be especially important at small sites.

3. Sites of riparian vegetation known or suspected to support breeding Willow Flycatchers should be protected from livestock grazing wherever possible, particularly where it is reducing foliage density, or drying meadow sites by soil compaction and gullying. As a guideline, we suggest curtailment of any activities which reduce meadow wetness below 50% in the vicinity of willows, or which reduce willow foliage density below 70%.

4. As a general guideline, grazing in riparian zones known or suspected to support breeding Willow Flycatchers should be curtailed from 1 June through 15 August. This period could be adjusted depending on location. For the Tahoe National Forest, the above period is suggested (Flett and Sanders 1987), while for the Sierra National Forest, 1 July through 20 August would be appropriate (Valentine 1987).

5. Further studies are needed to clarify the effects of livestock grazing on Willow Flycatchers.

6. Further studies are needed on the responses of Willow Flycatchers to Brown-headed Cowbird nest parasitism, particularly at lower elevation sites such as the south fork of the Kern River. Experimental cowbird removal would provide useful data and might enhance Willow Flycatcher populations.

7. Response of Willow Flycatchers to revegetation and meadow restoration should be studied as a possible means of increasing the amount of available habitat and of attracting Willow Flycatchers to otherwise suitable habitat.

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Appendix 1. Location and number of singing male Willow Flycatchers at meadows surveyed in the Sierra Nevada, 1986. No dates are given for Lacey Valley and Perazzo Meadows, which were studied intensively through the breeding season. The appendix does not include singing males seen by other biologists: 14 on the south Fork of the Kern River, 8 elsewhere.

Site Number	Name	County	Legal Description	Elevation (ft)	Date	Willow Flycatcher
Lassen-1	Hay Meadow	Plumas	T29N R7E sec 27	6500	7/15	0
Lassen-2	Robbers Creek	Lassen	T30N R8E sec 22,27	5800	7/16	0
Lassen-3	Robbers Creek	Lassen	T29N R9E sec 19	5300	7/17	0
Lassen-4	Westwood	Lassen	T28N R9E sec 5,8	5100	7/17	6
Lassen-5	Humbug Creek	Plumas	T26N R7E sec 5,6,31	4300	7/15	1
Lassen-6	Battle Creek	Tehama	T29N R3E sec 30	4900	7/15	1
Lassen-7	Gurnsey Creek	Tehama	T28N R5E sec 4,9	4800	7/14	3
Lassen-8	Susan River	Lassen	T30N R8E sec 4	6000	7/16	0
Lassen-9	Duck Lake	Lassen	T29N R9E sec 20	5000	7/17	0
Lassen-10	Lake Almanor	Lassen	T28N R6E sec 18	4500	7/15	0
Plumas-1	Haskins Valley	Plumas	T23N R7E sec 11	5100	7/7	2
Plumas-2	McRae Meadow	Plumas	T22N R11E sec16,21	6000	7/10	2
Plumas-3	Indian Creek	Plumas	T27N R12E sec 15	5100	7/9	0
Plumas-4	Lone Rock Creek	Plumas	T27N R12E sec 15,16	5100	7/9	0
Plumas-5	Little Antelope	Plumas	T27N R12E sec 25	5200	7/9	0
Plumas-6	Little Antelope 2	Plumas	T27N R12E sec 30	5200	7/9	0
Plumas-7	Willow Creek	Plumas	T25N R14E sec 22,27	5600	7/9	0
Plumas-8	Indian Creek 2	Plumas	T27N R12E sec 27	5100	7/9	0
Plumas-9	Rnd. Vall. Res.W	Plumas	T26N R9E sec 16	4400	7/10	2
Plumas-10	Rnd. Vall. Res.E	Plumas	T26N R9E sec22,23	4400	7/10	0
Plumas-11	Feather River	Plumas	T21N R12E sec 25	4250	7/10	2
Plumas-12	Cedar Flat	Plumas	T23N R7E sec 15	5400	7/8	0
Stanislaus-1	Bell Meadow 1	Tuolumne	T4N R19E sec 31	6700	7/16	0
Stanislaus-2	Bell Meadow SW	Tuolumne	T4N R18E sec 35	6400	7/16	0
Stanislaus-3	Bell Meadow 2	Tuolumne	T4N R19E sec 31	6700	7/16	0
Stanislaus-4	Bell Meadow 3	Tuolumne	T4N R19E sec 31	6700	7/16	0
Stanislaus-5	Barn Meadow	Tuolumne	T5N R19E sec 14,15	7500	7/16	0
Stanislaus-6	Eagle Meadow	Tuolumne	T5N R19E sec 13	7600	7/16	0
Stanislaus-7	Saint's Rest	Tuolumne	T3N R17E sec 9	5200	7/15	0
Stanislaus-8	Ackerson Meadow	Tuolumne	T1S R19E sec 23,24	4400	7/17	2
Tahoe-1	Little Truckee R.	Sierra	T19N R14E sec 16	6600	6/27	2
Tahoe-2	Coppins Meadow	Sierra	T19N R14E sec 20	6700	6/27	0
Tahoe-3	Webber Lk. NE	Sierra	T19N R14E sec 21	6900	6/27	0
Tahoe-4	Austin Meadow	Sierra	T19N R12E sec 23	6800	7/2	0
Tahoe-5	Haypress Meadow	Sierra	T19N R13E sec 4	6300	7/2	0
Tahoe-6	French Meadow	Sierra	T19N R14E sec 19	6700	7/2	0
Tahoe-7	Sagehen Creek	Nevada	T18N R15E sec 4,5,6	6600	7/2	0
Tahoe-8	Little Truckee R.	Sierra	T19N R15E sec 13	6500	7/2	0
Tahoe-9	Bear Valley	Sierra	T20N R16E sec 20	6400	7/3	0
Tahoe-10	Webber Lake	Sierra	T19N R14E sec 28,29	6900	7/3	0
Tahoe-11	Little Truckee R.	Sierra	T18N R14E sec 24	6500	7/24	2
Tahoe-12	Little Lacey Valley	Sierra	T18N R13E sec 5	6700	7/24	0
Tahoe-13	Little Truckee R.	Sierra	T19N R14E sec 21,22	6600	7/25	0
Tahoe-14	Little Truckee R.	Sierra	T19N R14E sec 24	6500	7/25	3
Tahoe-15	Perazzo Meadows	Sierra	T19N R14E sec 26,27	6600		11
Tahoe-16	Lacey Valley	Sierra	T19N R14E sec 28	6900		7

Appendix 1. (continued)

Site Number	Name	County	Legal Description	Elevation (ft)	Date	Willow Flycatcher
Yosemite-1	Hodgdon Meadow	Tuolumne	T2S R19E sec 3	4400	7/17	1
Yosemite-2	Wawona	Mariposa	T5S R21E sec 2	4000	7/18	1
Yosemite-3	Westfall Meadow	Mariposa	T3S R21E sec 23	7000	7/18	2
Yosemite-4	Peregoy Meadow	Mariposa	T3S R21E sec 13,24	7000	7/18	0
Yosemite-5	McGurk Meadow	Mariposa	3S R21E sec12	7000	7/18	0
Kern-1	Slough Channel	Kern	T26S R34E sec 14,15	2630	7/9	4
Kern-2	Mariposa Marsh	Kern	T26S R34E sec 11	2650	7/10	12
Kern-3	Bloomfield Ranch	Kern	T25S R35E sec 24	2800	7/11	0
Kern-4	Prince Pond	Kern	T26S R34E sec 16	2600	7/12	7
Kern-5	Hafenfeld Ranch	Kern	T 26S R34E sec 15	2600	7/13	0
Kern-6	Main River Chan.	Kern	T 26S R34E sec 14	2645	7/9	2
Sierra-1	Beasore Meadow	Fresno	T5S R22E sec 5	6800	7/1	4
Sierra-2	Swanson Meadow	Fresno	T9S R25E sec 6	5800	7/2	0
Sierra-3	Poison Meadow 1	Fresno	T10S R25E sec 5	5600	7/2	0
Sierra-4	Poison Meadow 2	Fresno	T10S R25E sec4,5	5600	7/2	0
Sierra-5	Poison Meadow 3	Fresno	T10S R25E sec 5	5600	7/2	2
Sierra-6	Markwood Mead.	Fresno	T10S R25E sec 3	5920	7/2	0
Sierra-7	Summit Meadow 1	Fresno	T10S R25E sec 2	6160	7/2	0
Sierra-8	Summit Meadow 2	Fresno	T10S R25E sec 3	5920	7/2	1
Sierra-9	Dinkey Meadow	Fresno	T10S R26E sec 20	5680	7/3	3
Sierra-10	Lost Meadow	Fresno	T10S R25E sec 25	5840	7/3	0
Sierra-11	Long Meadow	Fresno	T11S R27E sec 10,11	6880	7/4	3
Sierra-12	Lily Pad	Fresno	T11S R27E sec 1	6550	7/4	0
Sierra-13	Miningtown Mdw.	Fresno	T9S R26E sec 13,24	8200	7/5	0
Sierra-14	Stvnsn. X Markwd.	Fresno	T9S R25E sec 33	5475	7/2	0
Sierra-15	Shaver Dam	Fresno	T9S R24E sec 13	5300	7/2	0
Eldorado-1	Forni Rd. 1	El Dorado	T11N R16E sec 10	7500	6/24	0
Eldorado-2	Forni Rd. 2	El Dorado	T11N R16E sec 11	7400	6/24	0
Eldorado-3	Forni Meadow	El Dorado	T11N R16E sec 11	7400	6/24	0
Eldorado-4	Kirkwood	Amador	T10N R17E sec 22,27	7750	6/27	0
Eldorado-5	Martin Meadow	Amador	T10N R17E sec 20	7550	6/27	0
Eldorado-6	Oyster Creek	El Dorado	T10N R17E sec 29	7400	6/27	0
Eldorado-7	Leeks Spring Val.	El Dorado	T9N R16E sec 18	7400	6/27	0
Eldorado-8	Indian Valley	Alpine	T9N R19E sec 34	7800	6/26	0
Eldorado-9	Grass Lake	El Dorado	T11N R18E sec 14,23	7600	6/25	0
Eldorado-10	Foster Meadow	El Dorado	T9N R16E sec 31	6700	6/27	0
Eldorado-11	Grass Lake Creek	El Dorado	T11N R18E sec 15	7500	7/22	0
Toiyabe-1	Sorenson's	Alpine	T11N R18E sec 25	6700	6/25	0
Toiyabe-2	Dangberg Camp	Alpine	T11N R18E sec 24	7000	6/25	0
Toiyabe-3	Faith Valley	Alpine	T10N R19E sec 30,31	7400	6/26	3
Toiyabe-4	Upper Charity Val.	Alpine	T9N R19E sec 5,8	7700	6/26	2
Toiyabe-5	88 X W.F. Carson	Alpine	T11N R18E sec 25	6900	6/27	0
Toiyabe-6	Hope Valley	Alpine	T10N R19E sec 6,7	7000	6/27	0
Inyo-1	Calvert Slough	Inyo	T11S R34E sec 13,14	4000	7/19	0
Inyo-2	Blk. Rock Fish.H.	Inyo	T12S R34E sec 11	3900	7/19	0
Inyo-3	Tinnemaha Res.	Inyo	T10S R34E sec 23,14	4000	7/19	0
Inyo-4	Green Creek	Mono	T3N R25E sec 17,18	7600	7/23	0
Inyo-5	Lee Vining Creek	Mono	T1N R26E sec 20	7500	7/24	2
Inyo-6	Parker Creek	Mono	T1S R26E sec 16,17	7200	7/24	0
Inyo-7	Aspendell	Inyo	T8S R31E sec 20	8400	7/26	0
Inyo-8	Sherwin Creek	Inyo	T3S R28E sec 6	7200	7/25	0

Appendix 1. (continued)

Site Number	Name	County	Legal Description	Elevation (ft)	Date	Willow Flycatcher
Inyo-9	Convict Creek	Inyo	T3S R29E sec 7	7000	7/25	0
Inyo-10	Owens River 1	Inyo	T7S R33E sec 3,10	4000	7/26	0
Inyo-11	Owens River 2	Inyo	T6S R33E sec 28	4000	7/26	0
Inyo-12	Owens River 3	Inyo	T6S R33E sec 19	4000	7/26	0
Inyo-13	Conway Summit	Mono	T3N R25E sec 23	7700	7/23	0
Inyo-14	Rush Creek	Mono	T2S R26E sec 8	7000	7/24	0
Inyo-15	Intake Dam	Inyo	T8S R31E sec 21	8000	7/26	0
Inyo-16	Gull Lake	Mono	T2S R26E sec 14	8000	7/24	0
Inyo-17	Reversed Creek	Mono	T2S R26E sec 21	7400	7/24	0
Inyo-18	Gray's Meadow	Inyo	T13S R34E sec 21	6200	7/18	0
Inyo-19	Pleasant Valley	Inyo	T6S R32E sec 19-24	4000	7/26	0
Sequoia-1	Zumwalt Meadow	Fresno	T13S R31E sec 14	5000	7/16	0
Sequoia-2	Grant Grove R.S.	Fresno	T13S R28E sec 32	6400	7/16	0
Sequioa-3	Long Meadow	Tulare	T22S R31E sec 36	6000	7/17	0
Sequoia-4	Troy Meadow	Tulare	T21S R35E sec 30	7700	7/18	1
Sequoia-5	Kennedy Meadow	Inyo	T22S R36E sec 7,18	6000	7/18	0
Sequoia-6	Hotel Creek	Fresno	T13S R30E sec 13	4800	7/16	0
Sequoia-7	Hitchcock Meadow	Fresno	T14S R28E sec 7	6200	7/16	0
Sequoia-8	Weston Meadow	Fresno	T14S R28E sec 12	6800	7/16	0
Sequoia-9	Burton Meadow	Fresno	T13S R29E sec 29	7400	7/16	0
Sequoia-10	Big Meadow	Tulare	T14S R29E sec 16,17	7600	7/16	0
Sequoia-11	Long Meadow	Tulare	T15S R30E sec 29	7400	7/16	0
Sequoia-12	Crescent Meadow	Tulare	T16S R30E sec 5	6800	7/16	0
Sequoia-13	Log Meadow	Tulare	T16S R30E sec 5	6800	7/16	0
Sequoia-14	Durwood Meadow	Tulare	T22S R33E sec 25	8800	7/17	0
Sequoia-15	Paloma Meadow	Tulare	T22S R33E sec 8	8800	7/17	0
Sequoia-16	Jackass Meadow	Tulare	T21S R35E sec 30	7000	7/17	0
Sequoia-17	Chimney Meadow	Inyo	T24S R37E sec 5,8	6200	7/18	0
Sequoia-18	Big Pine Meadow	Inyo	T23S R36E sec 10,11	6200	7/18	0