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IS BROWN-HEADED COWBIRD TRAPPING EFFECTIVE FOR MANAGING POPULATIONS OF THE ENDANGERED SOUTHWESTERN WILLOW FLYCATCHER?

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Abstract. We examined the effectiveness of cowbird trapping as a management tool for the recovery of a central California population of the endangered Southwestern Willow Flycatcher (*Empidonax traillii extimus*). After trapping Brown-headed Cowbirds (*Molothrus ater*), the parasitism rate on Willow Flycatchers decreased from an average of 65% (4 years prior to cowbird trapping) to 22% (during 5 years of cowbird trapping). As a result, flycatcher nest success increased from an average of 23% prior to cowbird control to an average of 39% after cowbird trapping. More importantly, the number of young fledged per female increased from an average of 1.04 prior to cowbird control efforts to 1.72 with cowbird control. The number of Willow Flycatcher pairs declined from 44 in 1989 to 27 in 1992. After trapping began in 1993, the decline stopped and the population stabilized at an average of 34 pairs, peaking in 1997 at 38 pairs. Despite increased flycatcher reproductive success, there has been little increase in the number of breeding Willow Flycatchers in the study area. A demographic analysis indicates that in all but one of the 9 years of this study, Willow Flycatchers have not produced enough young for the population to grow. Despite the significant increase in reproductive success due to cowbird trapping, it appears that parasitism rates may still be high enough to suppress the growth of this Willow Flycatcher population. In addition, other factors besides cowbird parasitism are likely affecting reproductive success and consequent population growth. Nevertheless, continued cowbird control efforts seem prudent as these efforts may eventually result in a large increase in flycatchers.

Key Words: brood parasitism, Brown-headed Cowbird, cowbird trapping, *Empidonax traillii, Molothrus ater,* reproductive success, Willow Flycatcher

Brood parasitism by Brown-headed Cowbirds (*Molothrus ater*) has been suggested as an important factor in the decline of many species of songbirds throughout the United States (Mayfield 1965, Gaines 1974, Rothstein et al. 1980, Brittingham and Temple 1983, Terborgh 1989, Robinson 1992). It has been implicated in the decline of a number of endangered species and subspecies: Kirtland's Warbler (*Dendroica kirtlandii*) (Mayfield 1965), Black-capped Vireo (*Vireo atricapillus*) (Gryzbowski et al. 1986), Golden-cheeked Warbler (*Dendroica chrysoparia*)(Ehrlich et al. 1988), Least Bell's Vireo (*Vireo bellii pusillus*)(Goldwasser et al. 1980), and Southwestern Willow Flycatcher (*Empidonax traillii extimus*) (Unitt 1987, Whitfield and Sogge *this volume*). As a result, cowbird trapping and removal has become a popular management tool for increasing populations of small, endangered hosts.

Currently, there are several cowbird trapping programs throughout the United States for managing populations of endangered songbirds such as the Kirtland's Warbler (Mayfield 1977), Least Bell's Vireo (Beezley and Rieger 1987), Black-capped Vireo (Hayden et al. in press), Golden-cheeked Warbler (K. Terpening, pers. comm.), and Southwestern Willow Flycatcher (Rothstein 1994, Whitfield in press). Despite the increasing use of cowbird trapping, relatively little has been published on the effectiveness of trapping for target host populations (but see Kepler et al. 1996, DeCapita in press, Griffith and Griffith in press, Hayden et al. in press, Rothstein and Cook in press, Whitfield in press).

In this paper, we examine the effectiveness of cowbird trapping on a population of the endangered Southwestern Willow Flycatcher in central California. The goals of our cowbird trapping control program were to reduce the cowbird population and cowbird parasitism of the flycatchers, which should lead to increased reproductive success and ultimately increase the Willow Flycatcher population size. In addition to comparing Willow Flycatcher numbers and population trends at our study site from 1989 to 1992 before the initiation of cowbird control with numbers from 1993 to 1997 after control, we also assess data on flycatcher population trends collected by other workers (Serena 1982, Harris et al. 1987) in the same area from 1982 to 1986, before our study began.

METHODS

STUDY AREA

The study area is located on The Nature Conservancy's (now managed by Audubon California) Kern River Preserve (KRP) and the adjoining USDA Forest Service's South Fork Wildlife Area (SFWA), Kern County, California (Fig. 1). The KRP was established in 1981 to protect and enhance existing riparian habitat. Since then, portions of the land have been reforested and habitat has been improved by the elimination of

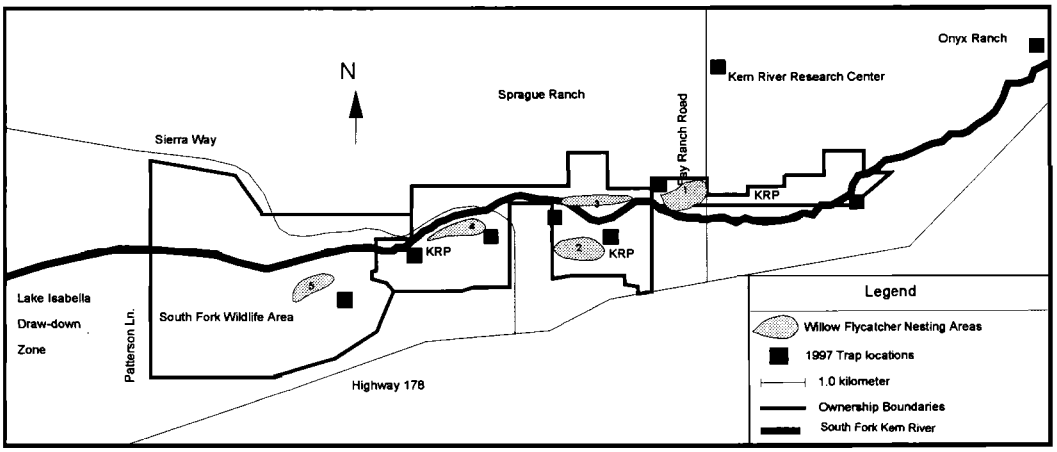

FIGURE 1. Study area and location of the main Willow Flycatcher nesting areas and cowbird traps in 1997, South Fork Kern River, California. Two traps not shown are located 5 km and 14 km east of the study area.

grazing. The SFWA was established in 1977 as a result of concern over the loss of 1300 ha of habitat due to the construction of Isabella Dam (Fleshman and Kaufman 1984). The SFWA is periodically flooded when the reservoir level rises. Large portions (60% or greater) of the SFWA have been flooded, on average, from approximately May to September in 4 of the 9 years of this study (1993,1995, 1996 and 1997). At elevations between 762 and 805 m, the study area encompasses approximately 500 ha of cottonwood-willow forest. The riparian woodland is dominated by three tree species: red willow (*Salix laevigata*), Goodding's black willow (*Salix gooddingii*), and Fremont cottonwood (*Populus fremontii*). The forest is interspersed with open areas that are often dominated by mulefat (*Baccharis salicifolia*) and hoary nettle (*Urtica dioica holosericea*), and flooded areas that support freshwater marshes dominated by cattails (*Typha* spp.) and tules (*Scirpus* spp.). Hoary nettle and mulefat are also common understory plants in the forest. Pastures for cattle grazing and cultivated fields border the riparian forest.

Cowbird Monitoring and Control

Starting in 1991, we surveyed Brown-headed Cowbirds using 10-min point-count surveys at 60 stations throughout the study area. In 1994, we added 15 stations. The stations were located 200 m apart, along the forest edge. We counted male and female cowbirds seen or heard at each station and visited each station three times between late April and mid-July. The April/May survey was completed before the cowbird traps were opened. The last surveys were completed by mid-July because cowbirds in the Sierra Nevada and along the South Fork Kern River show a noticeable decline in detectability by late July (Rothstein et al. 1980; M. Whitfield, pers. obs.). To reduce observer bias in the data, an average of 86% (range 72% to 93%) of the counts were conducted by M. Whitfield each year. With the exception of two to six of the stations per year, each station was visited at least twice in a given year by this observer. There were a total of six other observers and no more than three were used in a given year. We tested whether there was a correlation between the number of cowbirds counted in the first surveys and the year the count was made in order to see whether trapping cowbirds reduced the cowbird population from one year to the next.

There were no cowbird control efforts from 1989 through 1991. In 1992, we addled cowbird eggs by shaking them and removed cowbird nestlings found in Willow Flycatcher nests. During that same year, between 10 June and 10 July, we shot approximately 30 female cowbirds found near Willow Flycatcher nesting areas but did not trap cowbirds. Therefore, this was an intermediate year between no cowbird control in 1989–1991 and intensive cowbird control from 1993–1997. As a result, 1992 was not included in the analysis of the effects of cowbird control on the reproductive success of Willow Flycatchers.

In 1993, we set up four cowbird traps (2 × 2 × 2.5 m, modified Australian Crow traps). Three traps were located near Willow Flycatcher nesting areas at KRP and one was located at a Brown-headed Cowbird feeding area at the Kern River Research Center. The SFWA was a "non-trap" area until 1996 when we added one trap into the area. We baited each trap with wild bird-

TABLE 1. SUMMARY OF BROWN-HEADED COWBIRDS TRAPPED ALONG THE SOUTH FORK KERN RIVER, KERN CO., CALIFORNIA, 1993–1997

Year	Number of Traps	Females	Males	Males released[a]	Juveniles	Total
1993	4	343	193	227	287	1050
1994	7	152	104	132	62	450
1995	8	141	136	28	71	376
1996	9	87	98	22	131	338
1997	11	225	164	17	115	521
Totals		948	695	426	666	2735[b]

Note: These numbers do not accurately reflect the local cowbird sex ratio because males and females were treated differently in 1993 and 1994, see text for details. In addition, the sex ratio determined by point counts is two males per female.
[a] Some males were temporarily marked (1993) or banded (1994) and released; from 1995–1997, the banded males were recaptured and released.
[b] When the recaptured banded birds (1995–1997) are not counted, the total number of individuals captured is 2668.

seed (made up of millet, milo, wheat hearts, and sunflower seed), water, and live cowbirds (three females and two males). We checked the traps daily to release non-target birds and to euthanize cowbirds. In 1993, we cut small pieces off the two outer tail feathers and released 227 male cowbirds. We banded and released 132 male cowbirds in 1994. However, from 1995–1997, we did not band any new cowbirds and we euthanized all unbanded cowbirds.

Each year since 1993, we increased our trapping effort (Table 1). In 1997, we expanded our trapping effort to 11 traps including three additional traps east of the KRP (Fig. 1). In all trap years, we addled cowbird eggs and removed cowbird nestlings found in Willow Flycatcher nests throughout the study area.

WILLOW FLYCATCHER MONITORING

We monitored Willow Flycatchers from 1989 to 1997 to determine population trends, reproductive success, and cowbird parasitism rates. Each year, we started surveying for the flycatchers and searching for their nests during the last week in May when their breeding season begins. We surveyed all portions of the study area that contained suitable nesting habitat using a playback recording of a singing male Willow Flycatcher. We checked nests daily during the egg-laying stage and then every 2 or 3 days during incubation and nestling stages. A nest was categorized as depredated when it was found empty before the young could have fledged from it, when the number of eggs in the nest were reduced or damaged (and no cowbird egg was subsequently laid in the nest), or a nestling (or nestlings) disappeared from the nest, thus causing abandonment. We estimated nest success using the Mayfield method, which calculates the probability of survival at each nesting stage (Mayfield 1975). A successful nest was defined as one that fledged at least one Willow Flycatcher young and an active nest was a nest in which at least one egg (flycatcher or cowbird) had been laid.

We used Chi-square tests of homogeneity to compare the parasitism and predation rates between years with and without cowbird control. A t-test was used to compare differences between number of young fledged per female in years with and without cowbird control. We used the method devised by Hensler and Nichols (1981) and Hensler (1985) to test for differences in Mayfield nest success between years with and without cowbird control.

RESULTS

COWBIRD CONTROL AND MONITORING

From 1993 to 1997, we caught 2,735 individual cowbirds: 948 females, 1121 males, and 666 juveniles (Table 1). Only 12 females were caught in the trap in the SFWA (6 in 1996, 6 in 1997). In contrast, the two new easternmost traps outside the study area (5 and 14 km from the study area) captured 61% (138) of the females caught in 1997. These traps were not located in the original trap area (KRP) and when cowbirds caught only in the original trap area are considered, the number of female cowbirds trapped decreased each year (Fig. 2).

Since trapping began, the female cowbird population has decreased in the trap area each year between May and July (Table 2). In addition, the number of females trapped and the number of females detected during the first survey on the KRP has significantly decreased from one year to the next ($r^2 = 0.943$, $N = 5$, $P = 0.001$). However, the number of cowbirds detected in the SFWA (prior to 1996, the nontrap area) remained fairly stable until 1995 (Table 2).

WILLOW FLYCATCHER MONITORING

During times of high cowbird parasitism and low nest success, the number of nesting Willow Flycatcher pairs declined from 1989 to 1992 (Table 3). The number of flycatchers has in-

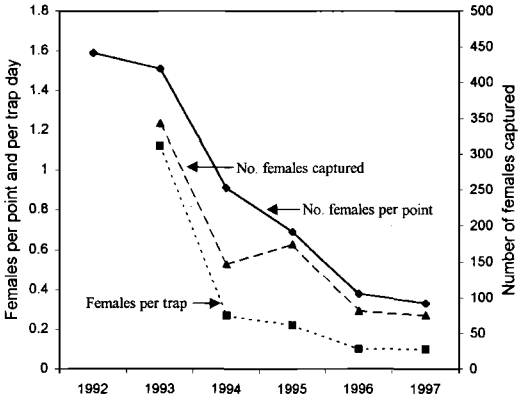

FIGURE 2. Comparison of Brown-headed Cowbird trap rates (number of females caught per year 1993–1997), capture rates (number of females caught per trap day 1993–1997), and detections per 10-min point count (females per point, 1992–1997) on the Kern River Preserve, Kern Co., California. The number of traps increased from four traps in 1993 to 11 in 1997.

creased since 1992, but is still below the population levels of 1989 and 1990. We compared five parameters (parasitism and predation rates, nest success, total number of young fledged, and number of young fledged per female) before and after cowbird control to directly test the effect of cowbird control on the flycatcher's reproductive success. Since 1992, cowbird parasitism rates have declined from an average of 64% (prior to cowbird trapping), to 22% after cowbird trapping. These rates were significantly lower during the four years of cowbird control than the three years without cowbird control (Table 3) ($\chi^2 = 62.5$, df = 1, $P < 0.001$). However, there were no significant differences in the predation rate between the years before and after cowbird control ($\chi^2 = 0.24$, df = 1, $P = 0.63$). Nest success increased from an average of 23% (1989–1991) to 32% in 1992, when there were low-level cowbird control efforts. During the period of intense cowbird control (1993 to 1997), nest success averaged 39%. Furthermore, the number of young fledged per nest and the number fledged per female over the whole season were significantly higher in the cowbird control years (1.24 and 1.72) than the years prior to cowbird control (0.63 and 1.04) (number of young fledged per nest: $t = -3.67$, df = 287, $P < 0.001$; young fledged per female: $t = 2.86$, df = 192, $P = 0.005$) (Table 3).

In addition, the overall Mayfield nest success rate was significantly higher in years with cowbird control (0.3894) than without cowbird control (0.2284) (Table 4). However, when Mayfield nest success was broken into three different stages, only the nestling stage had significantly higher success in the cowbird control years (0.7356) than in the years prior to control (0.5422). Nonetheless, the laying stage was close to being significantly higher in the years with (0.8715) than without cowbird control (0.7745), and all three stages showed a trend of being higher in years with control than years without control.

DISCUSSION

All indices of cowbird abundance significantly declined since we started trapping cowbirds on the KRP portion of our study area. In contrast, other cowbird trapping programs have shown relatively constant trapping rates each year due to immigration of cowbirds each breeding season (DeCapita in press, Griffith and Griffith in press, Hayden et al. in press, Rothstein and Cook in press). However, the immigration rate into our study site is probably low because the site is surrounded by arid mountain habitats

TABLE 2. BROWN-HEADED COWBIRD POINT COUNT RESULTS (MEAN NUMBER OF FEMALES PER POINT ± SE), FOR THE PRE-TRAP (MAY) AND POST-TRAP (JULY) COUNTS 1992–1997 (SAMPLE SIZES IN PARENTHESES)

Year	Month	Kern River Preserve	Number of traps	SF Wildlife Area	Number of traps
1992[a]	May	1.59 ± 0.14 (41)	0	1.58 ± 0.17 (19)	0
	July	1.37 ± 0.17 (41)		1.74 ± 0.18 (19)	
1993	May	1.51 ± 0.16 (41)	4	2.00 ± 0.22 (19)	0
	July	0.71 ± 0.13 (14)		2.22 ± 0.18 (18)	
1994	May	0.91 ± 0.13 (45)	7	1.93 ± 0.21 (30)	0
	July	0.40 ± 0.09 (45)		1.60 ± 0.19 (30)	
1995	May	0.69 ± 0.11 (45)	8	1.33 ± 0.15 (30)	0
	July	0.24 ± 0.08 (45)		1.20 ± 0.11 (30)	
1996	May	0.38 ± 0.09 (45)	9	0.90 ± 0.16 (30)	1
	July	0.27 ± 0.07 (45)		0.57 ± 0.12 (30)	
1997	May	0.33 ± 0.09 (45)	11	0.40 ± 0.09 (30)	1
	July	0.18 ± 0.07 (45)		0.37 ± 0.11 (30)	

[a] Thirty female cowbirds shot from 10 June to 10 July.

TABLE 3. BREEDING AND DEMOGRAPHIC PARAMETERS FOR WILLOW FLYCATCHERS ALONG THE SOUTH FORK KERN RIVER, CALIFORNIA (1989–1997)

Year	Number of pairs	Number of nests[a]	Predation Rate	Parasitism Rate	Mayfield nest Success	Total number of young fledged	Number of young fledged per female
			No cowbird trapping				
1989	44	34	33%	50%	24%	25	1.04
1990	41	38	42%	61%	24%	21	0.88
1991	31	45	35%	78%	17%	25	1.14
Means	39	116[b]	37%	63%	23%	24	1.04
			No cowbird trapping, 30 female cowbirds removed				
1992	27	36	14%	69%	32%[c]	33	1.83
			Cowbird trapping				
1993	34	33	37%	38%	33%[c]	37	1.76
1994	34	32	47%	16%	39%[c]	42	2.10
1995	34	32	34%	19%	43%[c]	40	1.90
1996	29	29	28%	11%	61%[c]	58	2.42
1997	38	51	57%	20%	30%[c]	37	1.09
Means	34	178[b]	40%	22%	39%	43	1.74

[a] In all years, we did not find nests for all pairs of Willow Flycatchers in the study area.
[b] Total instead of mean.
[c] This rate reflects investigator intervention by removing Brown-headed Cowbird eggs and nestlings from Willow Flycatcher nests.

with few cowbirds (Rothstein and Cook in press).

We have also seen a decrease in the number of cowbirds on the SFWA, but this decline has been more recent, smaller, and more complex than the one at KRP. We believe that the lower number of cowbirds on the SFWA was mostly due to the inundation of habitat rather than the effects of cowbird trapping. The inundation coincided with declines in the densities and numbers of all host species, with the exception of the Yellow Warbler (*Dendroica petechia*), in most of the SFWA (M. Whitfield, unpubl. data). As a result, we believe the cowbirds moved to other areas to find enough nests to parasitize.

Our data indicated that the reduction in cowbird numbers led to a reduction in cowbird parasitism of Willow Flycatchers. Consequently, nest success significantly increased. It is interesting to note that most of the difference in nest success occurred from the nestling stage and laying stage rather than from the incubation stage. These are the two stages that are affected the most from cowbird parasitism. The laying stage is affected by increased abandonment rates due to parasitism, and the nestling stage is affected by the competition of cowbird young (Whitfield 1990, Hill and Sealy 1994, Goguen and Matthews 1996, Rogers et al. 1997, Payne and Payne 1998, Whitfield and Sogge *this volume*). In contrast, cowbird parasitism rarely causes total failure of the nest during the incubation stage (M. Whitfield, unpubl. data).

Willow Flycatcher females have produced an average of 1.72 young per female with trapping compared to an average of 1.04 young prior to trapping. This increase in production could be due to manipulation of parasitized nests (i.e., addling cowbird eggs and removing cowbird chicks) rather than trapping alone or, most likely, a combination of the two. However, data in Whitfield and Sogge (*this volume*) indicate that the egg-to-fledging ratio for manipulated parasitized nests (23%) is not significantly higher than unmanipulated parasitized nests (18%). Therefore, most of the increased production can be attributed to trapping cowbirds rather than manipulating parasitized nests.

TABLE 4. MAYFIELD NEST SUCCESS FOR SOUTHWESTERN WILLOW FLYCATCHERS BEFORE COWBIRD TRAPPING (1989–1991) AND AFTER COWBIRD TRAPPING (1993–1997) ON THE SOUTH FORK KERN RIVER, CALIFORNIA

	Laying		Incubation		Nestling		Overall	
	Success	SD	Success	SD	Success	SD	Success	SD
No Trapping	0.7745	0.053	0.5648	0.052	0.5422	0.074	0.2284	0.039
Trapping	0.8715	0.036	0.6177	0.040	0.7356	0.044	0.3894	0.039
Z	1.51		0.80		2.24		2.93	
P	<0.15		>0.42		<0.025		<0.003	

The cowbird control program was successful in achieving the immediate goals of reducing cowbird numbers, reducing cowbird parasitism, and increasing Willow Flycatcher reproductive success. Unfortunately, the proximate success of the control program has not translated into an ultimate success of a larger population of Willow Flycatchers in the study area. It is likely that other factors besides cowbird parasitism are preventing this population of Willow Flycatchers from increasing and/or we have not reduced the parasitism rate enough.

Possible limiting factors may be habitat loss and/or pesticide use on the Willow Flycatcher's wintering grounds and/or migratory stopover sites. Yet, the return rates of both the adult (males: 53%, females: 35.5%) and juvenile (34%) Willow Flycatchers are average to above average for this species (Stoleson et al. in press), suggesting that over-winter survival is not a limiting factor for this population. Alternatively, the Willow Flycatchers on the South Fork Kern River may not have declined but may have moved out of the study area onto adjacent private lands where we are not allowed to survey. To investigate this possibility, we examined aerial photos of riparian habitat upstream of the study area to get an estimate of the amount of suitable habitat outside our study area. With the exception of the Canebrake Ecological Reserve (CER), located on the easternmost end of the valley, there appeared to be no more than 20 ha of suitable Willow Flycatcher habitat. Furthermore, we have surveyed for Willow Flycatchers on the CER the past 3 years, but have never found more than two pairs on the property. Thus, we doubt that there has been an increased number of Willow Flycatchers breeding outside of our study area along the South Fork Kern River.

Habitat quality and quantity in the study area does not appear to be a limiting factor for this population. Each year, many areas that appear to be suitable habitat are not used. Willow Flycatchers have bred successfully in many of these areas, abandoned them for a year or two, and then returned to the area in subsequent years. Furthermore, there are no apparent changes in the habitat on the KRP, but there have been some changes in the SFWA due to flooding. However, the number of Willow Flycatchers in the SFWA has never been high (average of five pairs for seven years), and an average of two pairs have used the area in the past two years when most of it was flooded.

A recent demographic analysis for this population by Uyehara et al. (in press) indicates that, for all but 1 of the 9 years of this study, Willow Flycatchers have not produced enough young for the population to grow. Furthermore, data from Stoleson et al. (in press) indicate that the nest success for this population is low compared to other populations of Willow Flycatchers. Predation was the largest cause of nest failure during the 9 years of the study (M. Whitfield, unpubl. data). In addition, unparasitized, nondepredated nests produced 3.02 offspring on average (M. Whitfield, unpubl. data), indicating that the flycatchers can produce enough young for the population to grow in the absence of parasitism and predation. It should be noted, however, that prior to cowbird control, egg losses due to parasitism sometimes exceeded those lost to predators. In addition, the demographic analysis by Uyehara et al. (in press) indicated that this population of Willow Flycatchers can increase only if the parasitism rate remains below or at approximately 10%. The parasitism rate has approached that figure only once (11% in 1996), and in that year, Willow Flycatcher reproductive success was the highest ever documented for this population. We suspect that this resulted in the population growth from 29 pairs in 1996 to 38 pairs in 1997. At least 12 of the 38 nestlings (32%) that were banded in 1996 came back to breed in 1997. If the nestlings that we were not able to band returned at similar rates, then as many as 18 young from 1996 were recruited to the 1997 population. In addition, Uyehara et al. (in press) calculated a population growth rate of 1.25 for 1996, which indicated a growing population.

An assessment of Willow Flycatcher population estimates for our study area in the 1980s complicates the demographic picture and interpretations regarding the extent to which cowbird trapping has influenced the number of the locally breeding flycatchers in the 1990s. Serena (1982) found 26 singing males in 1982, using tape playback. The population appeared to be stable in 1984 and 1985 when other surveyors found 23 and 29 males, respectively (Harris et al. 1987), without using tape playback. When Harris et al. (1987) surveyed the area in 1986 using tape playback and some sightings from local researchers, they found 39 singing males, an apparent increase in the population from 1982. However, both tape playback surveys (1982 and 1986) involved only one site visit, and none of the surveys from 1982 to 1986 covered the entire area that we have surveyed since 1989. The 1982 to 1986 surveys also had small differences among themselves in the amount of area they covered. Thus, these early surveys did not have consistent efforts or methods and it is difficult to tell whether there was an actual increase in the Willow Flycatcher population.

However, it appears that the Willow Flycatcher population was at least stable in the 1980s

even without cowbird control. This apparent paradox might be explained due to changes in land management in the early 1980s and the regeneration of over 150 ha of riparian forest in the SFWA due to floods in 1983 and 1986. Spring and summer cattle grazing was eliminated from the KRP and the SFWA in the early 1980s. Thus, throughout the 1980s, approximately 100 ha of willow forest grew along the river corridor and in low-lying areas on the KRP. This increased the available nesting areas for the Willow Flycatchers and possibly decreased cowbird parasitism pressure.

None of the surveys in the 1980s were comparable to our more intensive survey efforts from 1989–1997 that involved multiple site visits and tape playback. However, using consistent and intensive survey efforts throughout the riparian habitat bordering 7 miles of the South Fork Kern River, we found a population decline prior to trapping and a relatively stable post-trapping population size. The population stability during the trapping years is likely in response to lowered parasitism rates and increased reproductive success, although one cannot exclude the possibility that stability would have occurred without cowbird trapping. In addition, it is unlikely that the parasitism rates would have significantly decreased without trapping; therefore trapping cowbird control probably kept this population from declining in the 1990s.

In summary, Willow Flycatcher reproductive success has increased significantly as a result of cowbird trapping. It appears, however, that parasitism rates are still high enough to suppress population growth. Besides cowbird parasitism, other factors such as predation are likely affecting reproductive success and consequent population growth. Nevertheless, continued cowbird control efforts seem prudent for the foreseeable future as it is possible that these efforts will eventually result in a large increase in flycatchers.

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