LEAST BELL'S VIREOS AND SOUTHWESTERN WILLOW FLYCATCHERS IN PRADO BASIN OF THE SANTA ANA RIVER WATERSHED, CA

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ABSTRACT. Multiple partnerships have led to a program of resource management in southern California's largest coastal watershed. Annual grants and a perpetual endowment built with mitigation money have paid for 500 acres of habitat restoration, through control of invasive giant reed (*Arundo donax*) in part and successful management of beleaguered species. Populations of endangered least Bell's vireos (*Vireo bellii pusillus*) and southwestern willow flycatchers (*Empidonax traillii extimus*) were studied and managed for the twenty-first consecutive year in the Prado Basin and environs during the 2006 breeding season. Data were taken on status, distribution, breeding chronology, reproductive success, and nest site characteristics. Additionally, brown-headed cowbirds (*Molothrus ater*) were surveyed and removed from vireo and flycatcher territories. Two hundred and nineteen of the 423 territorial male vireos detected in 2006 were found to be paired, producing a minimum of 361 fledglings. This compares with 386 pairs recorded in 2005 and just 19 pairs in 1986. Similar declines in vireo numbers occurred among other significant vireo subpopulations in 2006 (Barbara Kus, pers. comm.). One thousand and thirty-five cowbirds were removed from vireo and flycatcher habitat during the nesting season, following the fall/winter removal of 1,860 cowbirds from adjacent cattle operations. Cowbird parasitism rates of vireo nests have decreased from 39% in 1986 and 57% in 1993, to a third consecutive year of 5% in 2006. Three vireo nests were manipulated, cowbird eggs and young were removed, resulting in six vireo fledglings that almost certainly would not have survived. Seventy-seven percent of 111 vireo nests were placed in willows (*Salix* spp. – 5 species) and mulefat (*Baccharis salicifolia*). Only two territorial male willow flycatchers were detected in 2006, with one pair producing three young. Numerous other sensitive avian species have benefited from the habitat restoration and management efforts. For example, a minimum of 500 pairs of yellow warblers (*Dendroica petechia*) were estimated in the 4,500 ha (11,120 ac) study area. However, for the fifth consecutive year, no western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) was detected.

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INTRODUCTION

The Santa Ana River Watershed Program. The waterways in the watershed of the Santa Ana River have been greatly altered and the floodplain reduced for flood control and other human induced purposes. As a result, riparian habitat and the diversity of wildlife it supports have been reduced to unsustainable levels for some species. This led to the listing under State and Federal Endangered Species Acts of those species most intimately dependent upon southern California's riparian systems.

The habitat degradation continues today with the edge effects associated with the adjacency and encroachment of the growing human population. One of the most immediate threats to the remaining riparian habitat is its invasion and destruction by giant reed (*Arundo donax*). This bamboo-like grass occupies more than half of the floodplain formerly vegetated by willows and other native wetland species. Giant reed has little redeeming value as wildlife food or for secure nest sites. It forms impenetrable thickets, carries fire, consumes several times more water than native habitat, interferes with flood control, produces massive quantities of debris that costs millions of dollars to clean off the coast, and driven by floods has caused bridge failure.

The Santa Ana River Watershed Program was initiated to restore the natural functions of the river. The current foci are control of giant reed and other invasives, restoration of habitat and beleaguered species, and investing the public. The principal partners include the Santa Ana Watershed Association of Resource Conservation Districts (the 5 RCDs in the watershed), the Orange County Water District, U.S. Fish and Wildlife Service, Regional Water Quality Control Board, county flood control agencies, Army Corps of Engineers, and many land owners and other agencies. Annual activities are funded in part with the proceeds of an endowment and through competitive grants. The endowment is being built with mitigation money from water development projects on the river. The program supporters recognize the ongoing need to

counter-manage the effects of the burgeoning human population in order to recover endangered resources and perpetuate southern California's wildlife heritage.

Least Bell's Vireo. The Least Bell's Vireo (*Vireo bellii pusillus* [Coues]; "vireo") is a small, insectivorous bird of the family Vireonidae. This vireo was described by Dr. Elliot Coues (1903) and aspects of its life history are summarized in a recovery plan and final rule (U.S. Fish and Wildlife Service 1986a, 1986b).

Vireos typically occupy "[l]ow riparian growth either in the vicinity of water or in dry parts or river bottoms. The center of activity is within a few feet of the ground, in the fairly open twigs canopied above by the foliage of willows and cottonwoods. Foraging cruises may take the birds higher into the trees but territorial interest, with song perches and nest sites, is in the lowest stratum of vegetation. Nests frequently are placed along the margins of bushes or on twigs projecting into pathways. Most typical plants frequented are willows, guatemote [mulefat], and wild blackberry. Less commonly live and valley oaks, wild grape, poison oak and sumac in the margins of water courses are visited and may be nested in. On the desert slopes mesquite and arrowweed in canyon locations may be occupied" (Grinnell and Miller 1944).

The vireo was formerly described as common to abundant in riparian habitats from Tehama County, California to northern Baja California, Mexico (Grinnell and Storer 1924; Willett 1933; Grinnell and Miller 1944; Wilbur 1980). The vireo currently occupies a small fraction of its former range (Goldwasser *et al.* 1980; United States Fish and Wildlife Service 1986) and is a rare and local species. Grinnell and Miller (1944) noted that declines in southern California and the Sacramento-San Joaquin Valley coincided with increased cowbird parasitism. Numbers continued to decline until about 1986 when only 300 pairs were documented throughout the U. S. range (U. S. Fish and Wildlife Service 1986; RECON 1988).

The vireo's dramatic decline (Salata 1986; U. S. Fish and Wildlife Service 1986) has been attributed to the combined effects of the widespread loss of riparian habitat and brood parasitism by the Brown-headed Cowbird (*Molothrus ater*) (Garrett and Dunn 1981). The Least Bell's Vireo was listed as an endangered species by California in 1980 and by the U.S. Fish and Wildlife Service in 1986. Critical habitat was designated for the vireo in February 1994, including most of our study area. The enactment of protective measures and subsequent management led to steadily increasing vireo numbers and by 2000, there were approximately 2000 territorial male vireos (U.S. Fish and Wildlife Service, unpublished data).

Although known to be present along the middle reaches of the Santa Ana River much earlier (Goldwasser 1978), field studies of the vireo commenced in 1983 (Zembal *et al.* 1985; Zembal 1986) and continued annually (Hays 1986, 1987, 1988, 1989; Hays and Corey 1991; Pike and Hays 1992; The Nature Conservancy 1993a, 1993b, 1994, 1995, 1996, 1997; Pike and Hays 1998, 1999,2000; Pike *et al.*2001, 2002, 2003, 2004, 2005). This paper summarizes the results of intensive study and management, mostly since 1986.

Southwestern Willow Flycatcher. The Southwestern Willow Flycatcher (*Empidonax traillii extimus* [Phillips]) is a relatively small, insectivorous songbird. It is a recognized subspecies of the Willow Flycatcher (*Empidonax traillii*). Although previously considered

conspecific with the Alder Flycatcher (*Empidonax alnorum*), the Willow Flycatcher is distinguishable from that species by morphology (Aldrich 1951), song type, habitat use, structure and placement of nests (Aldrich 1953), eggs (Walkinshaw 1966), ecological separation (Barlow and MacGillivray 1983), and genetic distinctness (Seutin and Simon 1988). The Southwestern Willow Flycatcher is one of five subspecies of the Willow Flycatcher currently recognized, primarily by differences in color and morphology (Hubbard 1987; Unitt 1987; Browning 1993).

The breeding range of the Southwestern Willow Flycatcher includes the southern third of California, southern Nevada, Arizona, New Mexico, and western Texas (Hubbard 1987; Unitt 1987; Browning 1993). The species may also breed in southwestern Colorado, but nesting records are lacking. Records of breeding in Mexico are few and confined to extreme northern Baja California and Sonora (Unitt 1987; Howell and Webb 1995). Willow Flycatchers winter in Mexico, Central America, and northern South America (Phillips 1948; Ridgely 1981; AOU 1983; Stiles and Skutch 1989; Ridgely and Tudor 1994; Howell and Webb 1995). They are generally gone from breeding grounds in southern California by late August (The Nature Conservancy 1994) and are exceedingly scarce in the United States after mid-October (Garrett and Dunn 1981).

Southwestern Willow Flycatchers occur in riparian habitats along watercourses where dense growth of willows *(Salix* sp.), *Baccharis*, arrowweed (*Pluchea* sp.), buttonbush (*Cephalanthus* sp.) and other wetland plants provide dense thickets. Nests are built in thickets, 4-7 meters (13-23 feet) or more in height. Occupied habitat is usually canopied in willows or cottonwoods (Phillips 1948; Grinnell and Miller 1944; Whitmore 1977; Hubbard 1987; Unitt 1987; Whitfield 1990; Brown 1991; and U.S. Fish and Wildlife Service, 1993, 1995). The subspecies of Willow Flycatcher generally prefer nesting sites with surface water nearby (Bent 1960; Stafford and Valentine 1985; and Harris *et al.* 1986) and in the Prado Basin they virtually always nest near surface water or saturated soil (e.g., The Nature Conservancy 1994).

Like the vireo, the Southwestern Willow Flycatcher has suffered extensive loss, degradation, and modification of essential riparian habitat due to grazing, flood control projects, urban developments, and other land use changes (Klebenow and Oakleaf 1984; Taylor and Littlefield 1986; and Dahl 1990). Estimated losses of wetlands between 1780 and the 1980's in the Southwest are: California 91%; Nevada 52%; Utah 30%; Arizona 36%; New Mexico 33%; and Texas 52% (Dahl 1990).

This species is also impacted by brood parasitism by cowbirds (Unitt 1987; Ehrlich *et al.* 1992; U.S. Fish and Wildlife Service 1993, 1995). Parasitism rates of Southwestern Willow Flycatcher nests have recently ranged from 50 to 80 percent in California (Whitfield 1990; M. Whitfield and S. Laymon, unpublished data), to 100% in the Grand Canyon in 1993 (U.S. Fish and Wildlife Service 1993). Mayfield (1977) thought that a species or population might be able to survive a 24% percent parasitism rate.

Willett (1933) considered the Willow Flycatcher to be a common breeder in coastal southern California. Unitt (1987) concluded that these birds were once fairly common in the Los Angeles basin, the San Bernardino/Riverside area, and San Diego County. More recently, *E. t. extimus* was documented only in small, disjunct nesting groups (e.g., Unitt 1987, U.S. Fish and Wildlife Service 1995). Status reviews done prior to State or Federal listing of the flycatcher considered

extirpation from California to be possible, even likely, in the foreseeable future (Garrett and Dunn 1981; Harris *et al.* 1986). Unitt (1987) then reported the known population in California to be 87 pairs and estimated the total population of the subspecies to be under 1000 pairs, more likely 500. A total of only 104 pairs was recorded in California in 1996 (U.S. Fish and Wildlife Service, unpublished data).

With the decline in flycatcher numbers on the South Fork of the Kern River, only two California populations consisting of 15 or more pairs have been relatively stable in recent years, that being along the San Luis Rey River and the Santa Margarita River. Of eight other nesting groups known in southern California, all but one consisted recently of six or fewer nesting pairs (Unitt 1987, Fish and Wildlife Service, unpublished data).

The Southwestern Willow Flycatcher was listed as endangered on February 27, 1995 (59 *Federal Register* 10693) and critical habitat, which includes much of the Prado Basin, was designated for the species in 1997 (62 *Federal Register* 39129 and 44228). Breeding Willow Flycatchers were also State listed as endangered in California and Arizona.

Reported herein are the results of study and management of the vireo and flycatcher, mostly since 1986 in the Prado Basin and environs.

STUDY AREA

The Prado Basin is located behind Prado Dam about 40 miles from the Pacific Ocean. The dam was constructed for flood control on the Santa Ana River in 1941. The approximate center of the study area, 33 degrees and 55 minutes north latitude and 117 degrees and 38 minutes west longitude, is located about 70 kilometers east of Los Angeles and eight kilometers north of the City of Corona in the northwestern-most corner of Riverside County, California.

The climate is typically Mediterranean and consists of warm, dry summers and cool, wet winters. The weather during the most recent study period, March-September, 2006 was typical: early mornings were generally cool (approximately 13 degrees Celsius) in spring, increasing by about 3 degrees in later months, and ranging 29 to 35 degrees in midday. Winds typically began blowing around 10 a.m. and often reached a magnitude of Beaufort category four, or about 20 miles per hour by noon. Winds thereafter frequently continued unabated until sundown. Early mornings were occasionally cloudy or foggy and were frequently partly cloudy.

Prado Basin comprises some 4,500 ha (Zembal *et al.* 1985) including approximately 2,400 ha of wetland habitats (U. S. Fish and Wildlife Service 1986). Willow woodlands, freshwater marshes, and ponds dominate the Basin. However, understory is scarce in the lower elevations due to prolonged inundation. In addition, large tracts of willow woodland habitat have been invaded, degraded or destroyed by non-native plants, particularly giant reed (*Arundo donax*). Other potentially conflicting land uses in the Basin environs include: urban development, parks, an airport, livestock grazing, dairy farming, agriculture, oilfield operations, industry, and war games. In addition, much of the Basin is leased to hunting club operators for waterfowl, pheasant, and dove hunting, shooting sports, sportsmen's fairs, and dog training.

METHODS

Searches and monitoring visits were conducted almost daily for Least Bell's Vireos and Southwestern Willow Flycatchers in the Basin and environs, 13 March – 19 September 2006 for over 2,100 field-hours. Initially we concentrated in areas where vireos and flycatchers occurred in prior years, but suitable habitat over the entire accessible study area was eventually surveyed. The majority of the field time was spent at sites occupied in 2004 and 2005.

All individual birds or pairs were noted during each visit to each section of the Basin. Data were taken on bird location, movement, behavior, food preferences, nest placement, sex, and age. Singing vireos were identified as males. Non-singing, adult vireos were deemed to be females if they were either: 1) in the company of non-threatening males; or 2) conspicuously engaging with impunity in breeding behaviors within the boundaries of well-defended and well-defined home ranges. Fledgling young were identified on the bases of their plumages, behaviors, and vocalizations.

Nests of the endangered birds were intrusively monitored, although great care was taken to minimize visits, scent cues for predators, habitat damage, trailing, and disturbance. Nests were located from a distance when possible and the contents were checked with a mirror. Data were taken on reproductive timing and success, cowbird parasitism, and depredation. Cowbird eggs were removed or replaced with infertile ones and young cowbirds were removed. The eggs were taken with adhesive tape to avoid human contact with, and scent on the nest or contents. Nest monitoring was conducted as prescribed in memoranda and permits from the State and Federal wildlife agencies. However, no nest visits were conducted if: 1) there was a chance of inducing a nest "explosion" or premature departure by nestlings; 2) approaching the nest would result in habitat destruction or trailing; or 3) no additional significant information or benefit to the occupants would result from the visit.

Once fledglings had left a nest site or a nest was otherwise emptied or abandoned, data were taken on nest dimensions, placement, height above the ground, and supporting plant species. Unsuccessful nests were carefully examined for signs of parasitism or other disturbance. Nests were assumed depredated if all eggs or unfledged young were destroyed or removed. Cowbird parasitism events were classified as such only if a cowbird egg(s) or pieces were found in, or below, the affected nest.

Habitat management included trapping and removing cowbirds, 22 March - 4 August. Trapping continued through the winter season with at least two traps. Twelve modified Australian crow traps were deployed adjacent to habitats occupied by breeding vireos and flycatchers for a total of 1,139 trap-days. Each trap measured approximately 6' by 6' by 8' and superficially resembled a chicken coop (see Hays 1988). Cowbirds, attracted by live decoy cowbirds, ad libitum food and water, entered the traps through slots in the center of the traps' upper surfaces. Traps were checked 6-10 times per week, all non-target birds were released immediately, and cowbirds were humanely dispatched.

Several other beleaguered avian species occupied the Basin with the vireo and flycatcher and were studied opportunistically. Specific effort was made to census the Western Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*), a species designated as endangered by the State of California.

The standard definitions used herein of terms pertaining to avian breeding biology are those recommended by the Least Bell's Vireo Working Group: Adult, "an after hatch year bird"; Complete nest, "a nest built by a pair; capable of receiving young"; Expected fledglings, "number of nestlings seen on the last visit"; Failed nest, "a nest which had eggs but produced no known fledged young"; False or bachelor nest, "an incomplete nest built by a lone male"; Incomplete nest, "a nest built by a pair; abandoned prior to completion"; Juvenile, "a fledgling which has been out of the nest more than 14 days"; Known fledged young, "a fledgling seen out of the nest"; Manipulated nests, "... e.g., cowbird egg removed"; Presumed failure, "... apparently complete nest that did not receive an egg; no powdery pin feathers seen in the nest; adults seen without fledglings..."; Presumed successful (nest), "... powdery pin feathers seen in the nest; nest intact"; Productivity or breeding success (population), "the number of known fledglings divided by the number of known breeding (nesting) pairs..."; Successful nest, "a nest which fledged at least one known young"; Successful pair, "produced one [or more] successful nests".

Lastly, because "territory" has connotations not addressed in this study, we primarily use the broader term "home range" herein. "Territorial males", however, is commonly used in written reports of the vireo and retained herein, as well.

RESULTS AND DISCUSSION

Least Bell's Vireo. The first returning male vireo wasn't detected until the exceptionally late date of 8 April during the nineteenth focused survey of the season. By contrast, the first male vireo in 2005 was detected nearly a month earlier on 11 March. Further, while 110 male vireos had been detected by 31 March in 2005, and 135 by that date in 2004, only 164 had been found by 30 April in 2006.

Female vireos were equally late, with the first detection occurring on 13 April, and only three being found by 16 April. By contrast, 137 female vireos had been tallied by 16 April in 2005.

The first nest of the 2006 season was likely begun on 17 April, three weeks later than in 2005. Nestling young were first observed on 14 May and the first fledgling was found on 23 May. The last completed nest of the season was likely completed on or about the record early date of 20 June. In 13 of the previous fifteen seasons, the last completed nest occurred 30 June-8 July (Pike *et al.* 2004). The extreme date for last completed nest within the Basin is 18 July in 1990 (Hays and Corey 1991). Vireos had departed the Basin by about 19 September 2006, when only one male could be found. However, there have been 4 probable instances of vireos over-wintering in the Basin (The Nature Conservancy 1994, 1995; Pike and Hays 1998). Exceptions as noted above notwithstanding, average arrival dates for our vireos were more than a month earlier than documented for the eastern subspecies and fall departures were quite similar (Barlow 1962;

Garrett and Dunn 1981; Salata 1986, 1987; Hays 1987, 1988; Robbins 1991; Pike and Hays 1992).

Four hundred and twenty-three males, 219 females, and 361 fledged young were detected in Prado Basin in 2006 (Table 1). Following the unprecedented late arrival of birds to the basin in 2006, this total for male vireos represents a 30% decline from the 600 that were tallied in 2005. This is the first decline in numbers since a modest 3% decline experienced in 1999 (Pike and Hays 1999). Interestingly, the vireos were also unusually late in arriving that season, with only nine males present by 31 March (Pike and Hays 1999). Declines weren't limited to the Prado Basin, as vireo numbers dropped 20% elsewhere within the Santa Ana river watershed (Susan Hoffman, pers.comm.). Further, vireo numbers were down 13% along the Santa Margarita river and 9% along the San Luis Rey river (Barbara Kus, pers.comm.). To date, no proximal cause, such as inclement weather on the wintering grounds, has been posited for the decline.

It should be noted that prior to 2006, there has been a true expansion of the local, Prado population. While only 20 territorial males were found in 1987 (Hays 1987), 600 were detected in 2005 (Pike *et al.* 2005). Site fidelity is extremely strong in the vireo and of the hundreds of vireos banded at other locations, relatively few have been observed at Prado. Those that were include three color-banded males detected in the Basin during the 1992 breeding season, a male and a female in 1993, a male in 1994, and a female in 1995. All 7 were marked as nestlings in San Diego County: 2 were born on Marine Corps Base, Camp Pendleton; 2 came from the San Luis Rey River; and 3 fledged along the San Diego River. From 1996-2004, only six additional banded male vireos were detected. One of these males was present in a West Basin home range every breeding season from 1997 to 2002. Two other males found in 2002 had apparently been banded in Ventura County locales.

Table 1. Least Bell's Vireo Status And Management, Prado Basin, CA, 1989-2006.

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
A. Number of territorial males	36	47	70	112	138	188	217	249	274	345	336	357	444	429	447	590	600	423
B. Number of pairs [a]	31	42	64	99	123	149	164	195	201	270	224	281	336	312	339	413	386	219
C. Number of fledged young observed [a]	102	142	183	224	247	327	355	318	410	450	489	649	718	598	688	767	525	361
D. Projected total recruitment of vireo young	115	154	230	283	295	417	508	410	500	621	582	843	907	811	846	1115	1042	635
E. Average number of fledglings per pair (C/B)	3.3	3 4	2.9	2.3	2 0	2 2	2.2	1.7	2.0	1 7	2.2	2.3	2.1	1.9	2.0	1 9	1.4	1.6
F. Projected number of fledglings per pair (D/B)	3 7	3.7	3.6	2.9	2 4	2.8	3.1	2.1	2.5	2.3	2 6	3.0	2 7	2.6	2.5	2.7	2 7	2.9
G. Rate of nest depredation	26%	23%	36%	47%	41%	40%	41%	39%	40%	45%	36%	25%	34%	37%	40%	35%	39%	22%
H. Rate of cowbird nest parasitism	20%	36%	32%	29%	57%	36%	21%	35%	19%	13%	15%	8%	13%	7%	4%	5%	5%	5%
I. Numbers of cowbirds removed from study area	652	704	726	865	513	1068	888	1025	1314	2333	2860	2595	2785	2468	1810	1353	2128	1035
J. Number of cowbirds trapped in study area [b]	652	704	725	865	513	1068	888	1024	1312	2322	2839	2587	2780	2468	1810	1353	2126	1035
K. Number of trap days (1 operative trap in the field for 1 day=1 trap day)	704	859	924	909	1138	1091	1351	2060	2396	2265	2562	2623	2353	2769	2527	1883	1492	1139
L. Average number of cowbirds trapped per trap day (J/K)	0 9	0 8	0.8	1.0	0 5	1.0	0.7	0.5	0 5	1.0	1 1	1.0	1 2	0.9	0.7	0 7	1.1	0.9
M. Number of person hours in the field	715	850	900	1200	1240	1260	1350	2350	2200	2500	2100	2500	2600	2800	3000	2900	2500	2100

[a] Actual totals for pairs and fledglings are likely significantly higher than those stated. Intrusive nest monitoring is conducted less frequently in those portions of the Basin that are virtually free of cowbirds (e.g., South Basin).

[b] Totals reported from 1996-2006 reflect the number of cowbirds trapped and removed through early August (typically 2-5August) of each respective season. Trapping was conducted after those dates during all eleven years (see text). Two traps likely will continue in operation throughout the 2006-2007 fall and winter seasons.

Least Bell's Vireos typically nest in dense riparian understory dominated by mulefat (*Baccharis salicifolia*), willows, mugwort (*Artemisia douglasiana*), *Bidens* spp., mexican tea (*Chenopodium ambrosioides*), Hooker's evening primrose (*Oenothera hookeri grisea*), and stinging nettle (*Urtica holosericea*), among others (Wilbur 1980; Gray and Greaves 1981; Goldwasser 1981; Salata 1984, 1987; United States Fish and Wildlife Service 1986; Pike and Hays 2000). Extremely dense near-nest vegetation in the Prado Basin has occasionally precluded close examination of a nest (Pike and Hays 2000). Of the 111 nests that were examined in 2006, 28 (25%) were suspended in mulefat, 38 (34%) in black willow, 13 (12%) in arroyo willow (*Salix lasiolepsis*), and 8 (7%) in gum trees (*Eucalyptus* spp.). Overall, 51% (57 of 111) of vireo nests were placed in willows. On average, 52% (N=2,022) of all nests examined in the Basin, 1987-2006 were placed in willows and 35% (N=1,377) were in mulefat. Since 1987, 3,917 nests have been found in a minimum of 47 species of plants. Surprisingly, 185 of these nests have been placed in non-native gum trees and 32 in giant reed.

Nest cover was similar on the Santa Margarita River, Camp Pendleton where approximately 59% of 394 nests, 1981-1987 were located in willows (largely arroyo willow and sandbar willow, *Salix hindsiana*) (Salata 1987) and in the Gibraltar Reservoir Watershed of Santa Barbara County where 101 (47%) of 216 nests were also in willows (Gray and Greaves 1981). However, the vireo's preponderant use of black willow and mulefat was unique for the Prado Basin. The most inundation-tolerant of the willows is the black willow, which dominates the riparian habitat in Prado Basin because of the regularity of pooled water therein (Zembal *et al.* 1985). In some areas in the lower Basin there is little else growing that could provide suitable structure for nest support and cover. However, the consistent use of mulefat is disproportionate to its availability. Mulefat is not abundant in the Basin and occurs scattered in local stands (Zembal *et al.* 1985).

In years with heavy, late rainfall, water is conserved in Prado Basin and vireo habitat is inundated. Understory is submerged, and particularly if the water level varies, some of the vireos are forced into marginal habitat on the higher edges of their home ranges. In addition, given the strong breeding site fidelity of vireos (Pike and Hays 2000), some vireo males or pairs may elect to remain in territories that are substantially flooded for most, or even all, of the breeding season (Pike *et al.* 2003). This occurred in 2005, resulting in a minimum of 109 vireo males establishing territories in lower elevation flooded habitat (Pike *et al.* 2005). In 2006, a large volume of water was again retained behind Prado dam for nearly the entire season. However, in contrast to the previous season, far fewer birds were noted over water. This is likely a consequence of 30% fewer vireos (Table 1) being found in the basin in 2006, and the resultant diminished competition for preferred, more xeric upland habitat.

Vireo nests in the Prado Basin are often placed at the lower edge of a horizontal belt of dense foliage volume at about 1 m from the ground (Zembal 1986). Mean nest heights were measured in 1990 and 1989 of 1.18 m and 1.13 m, respectively that are higher than the corresponding values of 0.87, 0.64, and 0.99 m reported from other areas (Wilbur 1980; Gray and Greaves 1981; and Salata 1987, respectively). Moreover, four nests have been measured (or estimated) at being 4.6 – 4.1 m above the ground (Pike *et al.* 2005), including two in 2006. An additional eight have been recorded at being 4.0 – 3.0 m above the ground (Pike *et al.* 2005).

The vireos have frequently used synthetic materials in their nests. In 1995, 179 nests were examined for content after they were abandoned. About 60% (107 of 179) of the nests contained

thin, pliable plastics or papers, primarily on nest bottoms, and only 40% (72 of 179) included natural materials exclusively. Of the 107 nests containing synthetics, 89% (95) primarily used white plastic, and 11% (12) mostly contained other materials, usually clear plastic or white paper. Along Temescal Creek, where trash is very abundant, white plastics were incorporated into 88% (49 of 56) of all nests.

The mean clutch size was 3.7 eggs (N=61 clutches) in the Prado Basin in 2006 and 3.7 for 2,419 nests, 1986 – 2006. This is higher than reported for San Diego County sites with an average clutch size of 3.3 eggs in 303 clutches, 1981 – 1987 on the Santa Margarita River (Salata 1987), and an average of 3.4 eggs in 61 clutches on the Sweetwater River (Kus and Collier 1988). Barlow (1962) reported an average clutch size of 3.39 (N=25) for a population of *V. b. bellii* in northeastern Kansas. However, Greaves (1987) also reported an average clutch size of 3.7 for the Gibraltar Reservoir population during the 1987 breeding season.

In 1999, the mean clutch size in 97 nests found within the Basin in April and May was a high 3.88. Only 12 nests contained three eggs and no nest contained only two eggs. However, the vireos laid fewer eggs per nest during the second half of the breeding season. The average clutch in 62 nests in June and July, 1999 was 3.4, with 21 three-egg nests and 4 two-egg nests.

Although it is often difficult to document that nests containing two eggs represent completed clutches, only 59 two-egg nests have ever been found in Prado Basin. In contrast, 28 two-egg nests were found on the Santa Margarita River by 1987 (Salata 1987). In addition, 10 nests in the Basin have contained 5 vireo eggs but no five-egg nests were observed by Salata (1987). In one instance in the Basin, a 5-egg clutch with a cowbird egg was found in the home range of a male that was associated with two females over a 4-day period (Pike and Hays 1992).

A minimum of 365 fledged vireo young were produced in the Basin in 2006 (Table 2), a 30% decrease from 2005 (Pike *et al.* 2005). Reproductive success was a high 68% (70 of 103). This compares to the 54% recorded in 2005 (Pike *et al.* 2005), and the 41% in 1998 (Pike and Hays 1998).

The average number of fledglings per breeding pair (2.3) in 2006 is above the (1.7) average in 2005 (Pike *et al.* 2005) and (2.1) average in 2004 (Pike *et al.* 2004). The highest productivity detected in the Basin was during 1988-1991 when the fledglings-per-pair average was 3.1. This apparent decline in productivity may be partly attributable to the substantial increase in the vireo population since 1989 and our diminished ability to track all nests closely enough to document all fledglings. However, any actual long-term decline in productivity per pair may be associated with increased population density and reduced nesting attempts.

There was a minimum of 2.4 nests per pair in 1988 (Hays 1988), 2.1 nests in 1989 (Hays 1989), and 2.7 nests in 1990 (Hays and Corey 1991). However, in 1996 only 1.8 nests were built per well-monitored pair (The Nature Conservancy 1996), then 1.7 nests in 1997 (The Nature Conservancy 1997), and by 1999 and 2000, the average number of nests built per pair was down to 1.3 and 1.2, respectively. Interestingly, the vireos arrived an average of two weeks earlier in 2000 than in 1999. With adequate time available for multiple renests, the very high reproductive success rate of 70% in 2000 (Table 2) may have contributed to the observed decline in

reproductive persistence. Conversely, given the late arrival of birds in 2006, it is perhaps not surprising that the average this season was a record low of 1.1 nests per pair.

Eighteen of 31 pairs (58%) fledged young from two or three nests in 1989 (Hays 1989), 36 of 42 pairs (86%) fledged from two or three nests in 1990 (Hays and Corey 1991), and 23 of 64 pairs (36%) fledged from two or three nests in 1991 (Pike and Hays 1992). Whereas, from 1999-2001, only 4% of pairs in each season fledged from two nests (Pike *et al.* 2001). In year 2005, 9 of 386 pairs (2%) fledged from two nests. Additionally, in 1990 and 1991, young were fledged from third, fourth, or fifth nesting attempts in at least 15 and 16 home ranges, respectively. From 1996 to 2001 this occurred in just 7, 5, 6, 5, 4, and 6 home ranges, respectively. While eight vireo pairs fledged from their third nesting attempt during the 2003 season (Pike *et al.* 2003), this occurred in only 2 home ranges in 2004 (Pike *et al.* 2004) and in no home ranges in 2005 and 2006. Finally, a minimum of four home ranges accommodated 4 or 5 nests in 1991, and just two home ranges accommodated 4 nests in both 1997 and 1998. Since then, only one home range in 2003 has accommodated four nests (Pike *et al.* 2003).

Although two vireo pairs built five nests each during both the 1993 and 1994 seasons, no known pairs have built five nests since. Fifth (or sixth) nesting attempts within a given home range are exceedingly rare elsewhere as well (Greaves *et al.* 1988; Kus and Collier 1988; Salata 1983a,b). Although the average number of vireo nests produced per pair in 1998 (1.75) was low for the Basin, it was similar to averages for other locales. For instance, 1.6 nesting attempts/pair (21 pairs and 34 nests) in the Gibraltar Reservoir area of Santa Barbara County in 1988 (Greaves *et al.* 1988) and 1.7 nests per pair (19 pairs and 33 nests) in 1987 (Greaves 1987). Similarly, vireos on the Sweetwater River in 1987 produced an average of 1.5 nests per pair (Kus and Collier 1988).

Vireos on the Santa Margarita River apparently rarely renest if successful in their first breeding attempt of the season (Larry Salata, pers. comm.). Conversely, vireos in the Prado Basin, 1986-1991 invariably renested after successfully fledging from their first nest. However, 4 pairs in the Basin did not renest in 1992 after fledging three young from their first nests (The Nature Conservancy 1993a) and 13 pairs in 1994 failed to renest after fledging 3 or 4 young each on their first attempts in May. Similarly, in 2000, of the 43 pairs that produced 4 fledglings from their first nesting attempt in May or early June, only 1 (2%) renested. Furthermore, all 10 of the pairs that fledged from two nests in 2000 had fledged only one or two young from their initial nesting effort.

Table 2. Least Bell's Vireo nest placement preferences, Prado Basin, 1987-2006.

Number of Plants Containing Nests

Plant Species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Totals*
Black Willow (*Salix gooddingii*)	25 (36%)	27 (24%)	27 (17%)	56 (22%)	62[b] (26%)	43 (17%)	82[c] (32%)	69[c] (29%)	52[c,d] (20%)	71 (33%)	88 (37%)	124[a] (43%)	149[g] (53%)	105[g] (38%)	124 (41%)	70 (28%)	38 (34%)	1267 (32%)
Arroyo Willow (*Salix lasiolepsis*)	1 (1%)	6 (5%)	16 (10%)	57 (23%)	50 (21%)	55 (22%)	53 (21%)	52[a] (22%)	48[c] (18%)	18[a] (8%)	32 (13%)	20 (7%)	24 (9%)	15[h] (5%)	25 (8%)	32 (13%)	13 (12%)	522 (13%)
Red Willow (*Salix laevigata*)	0	5 (5%)	2 (1%)	7 (3%)	4 (2%)	7 (3%)	2 (1%)	3 (1%)	1 (<1%)	6 (3%)	2 (1%)	7 (2%)	8 (3%)	7 (3%)	4 (1%)	11 (4%)	6 (5%)	82 (2%)
Sandbar Willow (*Salix exigua*)	0	4 (4%)	0	3 (1%)	3 (1%)	2 (1%)	3 (1%)	4 (2%)	2 (1%)	2 (1%)	6 (3%)	2 (1%)	2 (1%)	2 (1%)	2 (1%)	0	0	37 (1%)
Yellow Willow (*Salix lucida* ssp. *lasiandra*)	0	0	0	0	3 (1%)	1 (<1%)	0	1 (<1%)	0	1 (<1%)	0	0	0	0	0	1 (<1%)	0	7 (<1%)
Unidentified willow species	0	0	0	0	1 (<1%)	0	1 (<1%)	0	0	2 (1%)	0	0	0	0	0	0	0	8 (<1%)
Fremont Cottonwood (*Populus fremontii*)	0	0	1 (1%)	1 (<1%)	1 (<1%)	0	0	0	0	0	0	1 (<1%)	0	0	0	0	0	4 (<1%)
Mulefat (*Baccharis salicifolia*)	41 (59%)	53 (48%)	95 (60%)	82 (32%)	88[e] (37%)	99 (40%)	102 (40%)	96 (40%)	108 (42%)	85 (40%)	68 (28%)	93[a] (32%)	63[h] (22%)	83 (30%)	88 (29%)	60 (24%)	28 (25%)	1377 (35%)
Coyote Bush (*Baccharis pilularis*)	0	1 (1%)	4 (3%)	0	0	0	0	0	1 (<1%)	0	0	2 (1%)	0	1 (<1%)	0	0	0	9 (<1%)
Gum (*Eucalyptus* spp.)	0	9 (8%)	3 (2%)	32 (13%)	7 (3%)	22 (9%)	5 (2%)	3 (1%)	13 (5%)	6 (3%)	2 (1%)	7 (2%)	9 (3%)	16 (6%)	14[f] (5%)	27 (11%)	8 (7%)	185 (5%)
Giant Reed (*Arundo donax*)	0	0	0	0	1 (<1%)	2 (1%)	2 (1%)	2 (1%)	4 (2%)	3 (1%)	3 (1%)	1 (<1%)	4 (1%)	3 (1%)	2 (1%)	2 (1%)	2 (2%)	32 (1%)

Table 2. Least Bell's Vireo nest placement preferences, Prado Basin, 1987-2006 (Continued).

Number of Plants Containing Nests

Plant Species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Totals*
Cocklebur (*Xanthium strumarium*)	1 (1%)	0	0	0	1 (<1%)	0	0	0	0	0	2 (1%}	1 (<1%)	1 (<1%)	0	0	0	0	7 (<1%)
Elderberry (*Sambucus mexicana*)	1 (1%)	2 (2%)	3 (2%)	4 (2%)	2 (1%)	6 (2%)	2 (1%)	1 (<1%)	10 (4%)	5 (2%)	9 (4%)	6 (2%)	4 (1%)	11 (4%)	15 (5%)	8 (3%)	4 (4%)	93 (2%)
Wild Grape (*Vitis girdiana*)	0	1 (1%)	1 (<1%)	1 (<1%)	1 (<1%)	3 (1%)	0	0	4 (2%)	4 (2%)	9[f] (4%)	3 (1%)	4 (1%)	4 (1%)	6 (2%)	4 (2%)	2 (2%)	47 (1%)
Stinging Nettle (*Urtica holosericea*)	0	2 (2%)	0	0	0	0	1 (<1%)	0	0	0	0	2 (1%)	0	0	0	0	0	5 (<1%)
Blackberry (*Rubus* spp.)	0	1 (1%)	0	1 (<1%)	0	2 (1%)	0	2 (1%)	0	0	1 (<1%)	2 (1%)	2 (1%)	1 (<1%)	4 (1%)	2 (1%)	1 (1%)	19 (<1%)
Thistle (*Cirsium* spp.)	1 (1%)	0	0	0	0	1 (<1%)	0	0	0	0	3 (1%)	0	1 (<1%)	2 (1%)	2 (1%)	0	0	10 (<1%)
California Pepper (*Schinus molle*)	0	0	1 (<1%)	0	0	0	0	1 (<1%)	1 (<1%)	0	1 (<1%)	0	0	2 (1%)	3 (1%)	1 (<1%)	0	10 (<1%)
Chinese Elm (*Ulmus parvifolia*)	0	0	1 (<1%)	0	0	0	0	0	0	0	0	1 (<1%)	1 (<1%)	0	0	0	0	3 (<1%)
Sunflower (*Helianthus annuus*)	0	0	1 (<1%)	3 (<1%)	5 (2%)	0	0	0	0	1 (<1%)	0	2 (1%)	1 (<1%)	0	0	1 (<1%)	0	14 (<1%)
Mustard (*Brassica* spp.)	0	0	1 (<1%)	0	2 (1%)	0	2 (1%)	2 (1%)	7 (3%)	2 (1%)	4 (2%)	7 (2%)	0	5 (2%)	5 (2%)	5 (2%)	2 (2%)	44 (1%)
Tree Tobacco (*Nicotiana glauca*)	0	0	1 (<1%)	1 (<1%)	0	0	0	1 (<1%)	1 (<1%)	0	0	0	0	1 (<1%)	0	0	1 (1%)	5 (<1%)

Table 2. Least Bell's Vireo nest placement preferences, Prado Basin, 1987-2006 (Continued).

	Number of Plants Containing Nests																	
Plant Species	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Totals***
Unidentified (dead material)	0	0	1 (<1%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1 (<1%)
California Sagebrush (*Artemisia californica*)	0	0	0	2 (1%)	0	0	0	0	1 (<1%)	0	1 (<1%)	1 (<1%)	0	0	0	1 (<1%)	0	6 (<1%)
Toyon (*Heteromeles arbutifolia*)	0	0	0	1 (<1%)	0	1 (<1%)	0	0	1 (<1%)	0	1 (<1%)	0	0	0	0	2 (1%)	1 (1%)	7 (<1%)
Cherry (*Prunus* spp.)	0	0	0	1 (<1%)	0	0	0	0	0	0	0	0	0	0	0	0	0	1 (<1%)
California Walnut (*Juglans californica*)	0	0	0	1 (<1%)	0	1 (<1%)	0	0	0	0	0	1 (<1%)	1 (<1%)	1 (<1%)	1[i] (<1%)	1 (<1%)	1 (1%)	8 (<1%)
Tamarisk (*Tamarix* spp.)	0	0	0	0	2 (1%)	3 (1%)	1 (<1%)	1 (<1%)	0	2 (1%)	0	2 (1%)	4 (1%)	4 (1%)	1 (<1%)	2 (1%)	1 (1%)	23 (<1%)
Broad-leaved Peppergrass (*Lepidium latifoluim*)	0	0	0	0	1 (<1%)	0	0	0	0	0	1 (<1%)	0	1 (<1%)	1 (<1%)	0	0	0	4 (<1%)
Mexican Tea (*Chenopodium ambrosioides*)	0	0	0	0	1 (<1%)	1 (<1%)	0	0	0	0	0	0	0	0	0	0	0	2 (<1%)
Arizona Ash (*Fraxinus velutina*)	0	0	0	0	1 (<1%)	0	0	0	1 (<1%)	0	3 (1%)	0	0	0	1 (<1%)	1 (<1%)	1 (1%)	8 (<1%)
Box Elder (*Acer negundo* ssp. *californicum*)	0	0	0	0	0	1 (<1%)	0	0	0	0	0	1 (<1%)	3 (1%)	3 (1%)	4 (1%)	2 (1%)	0	14 (<1%)
Brazilian Pepper (*Schinus terebinthifolius*)	0	0	0	0	0	0	1 (<1%)	0	0	0	0	0	0	0	0	0	0	1 (<1%)

Table 2. Least Bell's Vireo nest placement preferences, Prado Basin, 1987-2006 (Continued).

Number of Plants Containing Nests

Plant Species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Totals*
Castor Bean (*Ricinus communis*)	0	0	0	0	0	0	0	1 (<1%)	0	0	0	0	0	0	0	0	0	1 (<1%)
Wild Radish (*Raphanus sativus*)	0	0	0	0	0	0	0	0	1 (<1%)	0	0	0	0	1 (<1%)	0	1 (<1%)	0	3 (<1%)
Poison Hemlock (*Conium maculatum*)	0	0	0	0	0	0	0	0	1 (<1%)	3 (1%)	0	0	2 (<1%)	2 (1%)	3 (1%)	1 (<1%)	1 (1%)	13 (<1%)
Western Sycamore (*Platanus racemosa*)	0	0	0	0	0	0	0	0	1 (<1%)	0	0	1 (<1%)	0	1 (<1%)	0	0	0	3 (<1%)
Olive (*Olea europaea*)	0	0	0	0	0	0	0	0	1 (<1%)	1 (<1%)	0	0	0	1 (<1%)	2 (1%)	10 (4%)	0	15 (<1%)
Australian Pepper (*Schinus polygamus*)	0	0	0	0	0	0	0	0	1 (<1%)	0	0	0	0	0	0	0	1 (1%)	2 (<1%)
Curly Dock (*Rumex crispus*)	0	0	0	0	0	0	0	0	0	0	3 (1%)	1 (<1%)	0	0	0	0	0	4 (<1%)
Wild Rose (*Rosa californica*)	0	0	0	0	0	0	0	0	0	0	0	1 (<1%)	0	1 (<1%)	0	0	0	2 (<1%)
Clematis (*Clematis ligusticifloia*)	0	0	0	0	0	0	0	0	0	0	0	1 (<1%)	0	0	0	0	0	1 (<1%)
Western Ragweed (*Ambrosia psilostachya*)	0	0	0	0	0	0	0	0	0	0	0	0	1 (<1%)	0	0	0	0	1 (<1%)

Table 2. Least Bell's Vireo nest placement preferences, Prado Basin, 1987-2006 (Continued).

Number of Plants Containing Nests

Plant Species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Totals*
Coast Live Oak (*Quercus agrifolia*)	0	0	0	0	0	0	0	0	0	0	0	0	0	1 (<1%)	0	3 (1%)	0	4 (<1%)
Bush Mallow (*Malacothamnus fasciculatus*)	0	0	0	0	0	0	0	0	0	0	0	0	0	1 (<1%)	0	0	0	1 (<1%)
Common Sow Thistle (*Sonchus oleraceus*)	0	0	0	0	0	0	0	0	0	0	0	0	0	1 (<1%)	0	0	0	1 (<1%)
Tree of Heaven (*Ailanthus altissima*)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1 (<1%)	0	1 (<1%)
Black Sage (*Salvia mellifera*)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1 (<1%)	0	1 (<1%)
White Sage (*Salvia apiana*)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1 (<1%)	0	1 (<1%)
TOTALS	70	111	158	253	236	250	257	239	260	212	239	290	281	276	306	251	111	3917

[*] Totals include data from 113 nests found during the 1987-1989 season (Pike *et al.* 2004)

[a] One nest also attached to a strand of Stinging Nettle (*Urtica holosericea*).
[b] One nest also attached to a strand of Western Ragweed (*Ambrosia psilostachya*).
[c] One nest also attached to Wild Grape (*Vitis girdiana*).
[d] One nest also attached to a strand of Mulefat (*Baccharis salicifolia*)
[e] One nest also attached to a strand of Mexican Tea (*Chenopodium ambrosioides)*
[f] One nest also attached to Black Willow (*Salix gooddingii)*
[g] One nest also attached to Broad-leaved Peppergrass (*Lepidium latifolium)*
[h] One nest also attached to Blackberry (*Rubus* spp.)
[i] One nest also attached to Poison Hemlock (*Conium maculatum*)

In recent years, a number of unprecedented, breeding-related events have occurred in the Prado Basin. For example, in 1998 a nest on Temescal Creek containing 4 eggs on 3 May was found empty, depredated, but intact by 18 May. The affected pair moved to an adjacent area to renest. Then, by 29 May a second clutch of 4 eggs had been laid in the original nest by another, newly detected pair. Unfortunately, the nest was depredated for a second time. In 2001, another depredated nest that had been left empty and intact by 14 June was found to contain 4 eggs from the same vireo pair on 28 June. Once again, however, this nest was depredated. In 2003, a nest that had been used to fledge 4 vireo young in early May, was found to contain three eggs of the same pair on 25 June. In 2002, a Mill Creek pair that had failed on an initial nesting attempt, successfully raised young on the next attempt by reusing an intact, year 2001 nest. In 2004, a complete nest from the previous season was strangely incorporated into a new nest, with the mouth of the old, leaning nest being grafted onto the side of the new one. Lastly, a nest discovered in the South Basin in 1998 that had just fledged a vireo, still contained a large Brown-headed Cowbird nestling. Evidently this nest had been parasitized after incubation was well advanced. Otherwise, the likelihood of a vireo nestling surviving the competition with a much larger cowbird nestling would be extremely remote. This is the only observation of a vireo successfully fledging from a nest in the Basin that simultaneously contained a cowbird nestling.

Finally, two unique nesting predicaments have occurred in recent years within Mill Creek home ranges. In the first instance, in 2002, the depredation of an adult female vireo resulted in a detached nest containing four 5-day old nestlings landing upright in the vegetative substrate below. Prolonged observation revealed that the surviving vireo male was neither feeding nor brooding the young, either while the nest remained on the ground or after it had been replaced very near its original location. It was eventually determined that the best hope of survival for the nestlings was to individually place them in the nests of other vireo pairs. It was decided that candidate host nests should contain fewer than four nestlings and, ideally, that host nestlings should be of a similar age. Two of the Mill Creek nestlings were placed in two nests fitting these criteria, and one of the nestlings eventually fledged along with the 'foster' siblings. The remaining two nestlings were placed in an East Basin nest containing two older nestlings. Although the vireo hosts again apparently accepted the new arrivals, one nestling was evidently too weak to survive and the other was depredated on the nest subsequent to the fledging of the older 'foster' siblings. In the second case, in 2005, a nestling was found below a twisted, disintegrating nest that was being supported by the crossed stems of a mustard plant. In an attempt to save this nestling and the two young remaining in the nest, an intact depredated nest was procured from the territory of a different pair. The three nestlings were then placed in the new nest, which was attached near the original nest location. All three young eventually fledged from the 'substitute' nest.

Increasing breeding success and recruitment in the Prado Basin vireo population over the past 19 breeding seasons is probably due in large part to the active management program. Data collected in the Basin prior to the initiation of management efforts (Zembal *et al.* 1985; Zembal 1986) corroborate Jones' (1985) observations of extremely low reproductive success rates in 1984 at the unmanaged San Luis Rey, San Diego, and Sweetwater River sites. Jones (1985) reported an overall reproductive success of 14% for these three populations and average fledging rates of 0.25, 0.17, and 0.50 fledglings per nesting pair for the San Luis Rey, San Diego, and Sweetwater River locales, respectively. In the absence of effective cowbird control programs, cowbird parasitism rates ranged

as high as 80% at these San Diego County sites (Jones 1985), to 77% (Zembal 1986) and even 100% (Zembal *et al.* 1985) in the Prado Basin.

By 4 August 2006, 1,035 (330 males, 508 females, 197 juveniles) Brown-headed Cowbirds had been trapped and removed from vireo and flycatcher habitats in the Prado Basin. This signifies an unexpected 51% decrease from the 2,128 removed in year 2005 (Pike *et al.* 2005). The proximate cause for this decline is the wide-scale loss of prime feeding areas for cowbirds engendered by the continued closure of Chino Basin dairies.

A maximum of 12 traps were operated at any one time within the Basin in 2006. The most effective traps were those placed within three dairy operations. Cumulatively, these three traps captured 595 cowbirds. This accounts for 57% of all cowbirds removed during the 2006 breeding season. By contrast, nine 'field traps' (*i.e.*, those situated in or near riparian habitat in close proximity to nesting vireos) accounted for the removal of only 466 cowbirds. The most effective of the 'field' traps was one situated adjacent to a blackbird colony in a cattail marsh near Temescal creek that captured 226 cowbirds. Since 1986, 70,307 cowbirds have been trapped or otherwise collected in the Prado Basin.

Off-season cowbird trapping at dairies was first begun in August 1996 with the maintenance of two traps by OCWD personnel. This was the first time that trapping was conducted during the winter season and in locales removed from riparian habitats. During the first two winters of operation, a minimum of 5,682 cowbirds was removed. Two dairy traps were operated during the fall and winter of 2005/2006 and accounted for the removal of 1,860 cowbirds. Although it is not currently known what percentage of the wintering cowbird population remains to breed locally, continued winter trapping and a continuation of the ten-year decline in the parasitism rate of vireo nests is providing a partial answer.

Among 45 banded cowbirds discovered in the Basin through 2001, only 8 were females and most were banded in Riverside and San Diego Counties from about 76 km to 161 km away. A female and second-year male were recaptured in the Basin 4 days after they were banded on the coast, 40 km distant. The long-range record was a female banded in Ridgefield, Washington and recaptured in the Basin 2 months later on 18 April 1999.

Although the rate of cowbird parasitism of vireo nests has ranged from 4% to 57% within the Prado Basin since 1986, the rate declined significantly after the commencement of the cowbird trapping effort (Chi-square 2 x 2 contingency table; statistic = 20.3 [Yates correction factor applied]; $p < 0.00001$). It was also determined in 1996 that the parasitism rate for vireo nests on the fringes of the Basin, well removed from cowbird traps, was 85%. Basin-wide, the combined parasitism rate for vireo nests was 35% in 1996 (The Nature Conservancy 1996).

Based upon the current study and data collected elsewhere (Pitelka and Koestner 1942; Mumford 1952; Barlow 1962; Salata 1983a,b, 1984, 1986, 1987a, 1987b; Jones 1985; United States Fish and Wildlife Service 1986), we conclude that the Prado Basin population of vireos would have been subjected to much higher rates of cowbird parasitism and reproductive failure in the absence of an effective management program (Hays 1986, 1987, 1988, 1989, 1990; Hays and Corey 1991, Pike and Hays 1992, The Nature Conservancy 1993a, 1993b, 1994, 1995, 1996,

1997; Pike and Hays 1998, 1999, 2000; Pike *et al.* 2001, 2002, 2003, 2004, 2005). Other recent, published accounts of the efficacy of cowbird trapping programs as part of comprehensive vireo and flycatcher management efforts corroborate this fundamental assumption (Kus 1999, Whitfield and Sogge 1999, and Whitfield *et al.* 1999).

Despite the ongoing closure of dairies, cowbirds remain plentiful in the Prado Basin, compared to many other sites managed for endangered birds. The adjacent cattle, dairy, and agricultural operations are conducive of a large cowbird population and cowbird management is a relatively recent tool. Consequently, trapping techniques have been refined and improved over the course of this study. Optimum trapping results apparently are achieved if: 1) the appropriate ratio of male and female cowbirds are used in the decoy population; 2) field traps are placed in open areas immediately adjacent to occupied vireo habitats; 3) traps are placed in favored proximate cowbird feeding and roosting sites; and 4) the traps are free from disturbance. First, a maximum yield of female cowbirds is achieved if females comprise the large majority of the decoy population. We recommend the use of 4 or 5 females and 1 or 2 vocal males in a modified Australian crow trap, measuring 6' X 6' X 8'. Secondly, field traps should be positioned in the open, near riparian habitat but not enveloped in it. Third, as noted previously, significant decreases in cowbird parasitism can apparently be achieved by trapping in locales where cowbirds congregate, such as horse stables or dairy operations. Lastly, the traps must remain as undisturbed as possible (Hays 1986).

In addition to an ongoing effort to improve the methodology of removing cowbirds from the Prado Basin, an effort to age to the degree possible the population of male cowbirds captured in the traps was begun in 1996 and continued in 2006. Per Pyle (1997), "second (calendar) year males" were distinguished by pale brown to grayish greater underwing coverts, which contrast greatly with the adjacent blacker feathers. By contrast, those males with blackish greater underwing coverts showing only moderate contrasts between adjacent feathers were identified as "after second (calendar) year" males (*i.e.*, adults) (Pyle 1997). As the prebasic molt in juvenile Brown-headed Cowbirds can rarely be complete, males with wholly blackish greater underwing coverts but also showing brownish, contrasty feathers on the upperparts were excluded from the data base (Pyle 1997; *pers. obs.*). The aging of male cowbirds was once again terminated on 11 July after it had become apparent that feather molt had obscured previously observed (and readily apparent) plumage differences. In 2006, of the 136 male cowbirds that could be reliably aged, 9% (12) were judged to be adults and 91% (124) were judged to be second-year birds. In both 2004 and 2005, 11% had been judged to be adults (Pike *et al.* 2005). This compares with years 1996 and 1997, when the recorded percentages for adult males were 29% and 30%, respectively (The Nature Conservancy 1997). The data thus suggest that just a *quarter* as many adult male cowbirds are currently being found in the Basin during the vireo breeding season than occurred as recently as 1997. Notably, this span of time coincides with the advent of year-round trapping in dairy operations and, concurrently, the lowest percentages for cowbird parasitism rates since studies began (Table 2). It is believed that the continuation of this study in forthcoming years will yield additional useful data regarding the long-term impact of trapping efforts on the demographics and reproductivity of the cowbird population within the Prado Basin and environs.

Table 3. Least Bell's Vireo reproductive success and breeding biology data, Prado Basin Study Area, 2006

A. Number of pairs	219
B. Number of breeding (nesting) pairs	160
C. Number of breeding pairs that were well-monitored throughout the breeding season	.49
D. Number of `known fledged young' (a)	361
E. Number of `known fledged young' produced by pairs monitored throughout the breeding season	144
F. Average number of fledglings produced per breeding pair (minimum; D/B; = `productivity or breeding success')	2.3
G. Average number of fledglings produced by pairs monitored throughout the breeding season (E/C).	2.9
H. Number of nests that were discovered	111
I. Number of nests that were regularly monitored or"tracked"	103
J. Number of "tracked" nests that were successful [%= J/I x 100]	.70[68%]
K. Number of "tracked" nests that were depredated [%= K/I x 100]	24 [23%]
L. Number of "tracked" nests that were parasitized by cowbirds [%= L/87 x 100]{b}	.4 [5%]
M. Number of nests that failed as a result of reproductive failure{c}	8
N. Average clutch size (N= 61)	3.7
O. Number of cowbird eggs found in or near vireo nests	.4
P. Number of cowbird nestlings removed from "tracked" nests	1
Q. Number of cowbird young fledged by vireos	0
R. Number of `manipulated', parasitized nests	.3
S. Number of `successful, manipulated' nests [%=S/R x 100]	.3 [100%]
T. Number of vireos fledged from `manipulated', parasitized nests	.6

{a} This is minimum recruitment corresponding to Least Bell's Vireo Working Group definition of `known fledged young'.

{b} Sixteen of the 103 "tracked" nests were depredated before it could be determined if they had been parasitized. Therefore, these 16ests were excluded from the calculation of the rate of cowbird parasitism.

At least 23% (24 of 103) of all well-tracked nests were predated during the 2006 breeding season. As nest contents are not checked on a daily basis, it is not always possible to determine at what stage of the nesting cycle predation occurred. Nonetheless, in 2004, it was evident that 31% (16 of 52) of the nests were predated during the incubation phase, while 69% (36 of 52) of the nests were predated during the nestling phase. In 2006, as in previous years, most of the depredated nests found were intact and relatively undisturbed. Of 23 depredated nests, only 6 (23%) were on the ground or severely damaged, and another 2 (9%) remained suspended with some damage to the nest and/or branch support. The cumulative evidence suggests that snakes, avian predators, and, especially, small rodents (Salata 1987b), not large mammalian predators, are the primary nest predators in the Basin (Pike and Hays 2000).

Mice and rats are probable nest predators based upon droppings left in depredated nests, small neat holes in nest bottoms, and nests being domed over (Hays 1986; The Nature Conservancy 1993a, 1997; Pike and Hays 2000). Further, a mound of adult vireo feathers was found below a recently depredated nest which contained a rat dropping in 2001. In 2003, two additional depredated nests were found with rodent droppings on the rim. A lack of evidence precludes a thorough understanding of the amount of nest depredation for which reptiles are responsible. However, five species of snakes have been found in or near occupied vireo habitats. Further, in 2005, a Common Kingsnake (*Lampropeltis getulus*) was observed in the act of swallowing a vireo nestling near a West Basin nest and was evidently responsible for predating the remaining nestling and egg later the same day. Notably, in 6 of eight recent studies utilizing video cameras at the nests of New World passerine birds, snakes were found to be the most important nest predators (Weatherhead and Blouin-Demers 2004). Lastly, in 2000, a Southern Alligator Lizard (*Elgaria multicarinata*) was detected on a branch directly above a recently depredated, intact vireo nest (Pike and Hays 2000).

The Greater Roadrunner (*Geococcyx californianus*), American Crow (*Corvus brachyrhynchos*), and Western Scrub-Jay (*Aphelocoma californica*) have been considered as the likeliest avian predators of vireo nests and fledglings. Among these three, the Greater Roadrunner is suspected of being responsible for the largest number of depredated nests. Crows, although plentiful in the Basin, most frequently hunt in more open habitat and are rarely observed in the riparian vegetation at the low height of a vireo nest. Scrub jays, although fairly common along much of the Santa Ana River, are only rarely found within the Basin, and then only around the periphery. Roadrunners on the other hand, are common throughout the Basin and have been implicated in repeated depredation events (Hays 1988). In 1991, for example, a roadrunner was probably responsible for the disappearance of two fledglings from a vireo home range and was observed pursuing the third, and only remaining fledgling of that brood (Pike and Hays 1992).

Southwestern Willow Flycatcher. As in the previous season, just two Southwestern Willow Flycatcher home ranges were detected in the Prado Basin in 2006. These follow the five flycatchers recorded during the 2004 season (Pike *et al.* 2004) and record nine recorded during the 2003 season (Pike *et al.* 2003). As in 2005, the first Willow Flycatcher male was detected on 8 May. The second male was discovered on 21 May, and was present on territory until mid-June. The last flycatcher of the season was noted on 28 July.

Both of the male flycatchers detected were in home ranges that were occupied during the previous season. Successful breeding was detected in one of the home ranges, resulting in three fledglings. This was only the 21st time that successful flycatcher breeding has been documented in the Basin.

All known flycatcher territories in the Basin have been in close proximity to water-filled creeks or channels. In addition, territories have usually consisted of overgrown clearings containing varying amounts of nettles with a few to many moderately tall, often dense, willows. Of the thirty nests discovered from 1996-2006, 13 (43%) have been found in willows, with 8 (27%) of these being in arroyo willow (*Salix lasiolepsis*). Interestingly, a total of 9 (30%) nests have been found in tamarisk, despite the fact that tamarisk is relatively scarce in those areas that the flycatchers have bred. Further, the lone nest discovered in 2006 was situated in a wild grape vine (*Vitis giridiana*) that was partially supported by tamarisk. The heights of 30 nests have ranged from 0.61 m to 4.27 m, with an average of 1.85 m. Although flycatcher home ranges have been detected nearly throughout the surveyed portions of the Basin, successful breeding prior to 1991 had been detected just once in the North Basin. Since then, successful breeding has been documented 20 times, with the majority of these nestings occurring in two particular locales in the South Basin and one locale in the West Basin.

In both the 2003 (Pike *et al.* 2003) and 2004 (Pike *et al.* 2004) seasons, it was discovered that a flycatcher male had paired with two females simultaneously. Neither pairing successfully produced young. This represented just the second and third time that bigyny among Willow Flycatchers had been recorded in the Basin (The Nature Conservancy 1996). Polygyny has previously been documented as a breeding strategy occasionally utilized by this species (Prescott 1986a; Sedgwick and Knopf 1989).

Given that only two territorial Southwestern Willow Flycatcher males produced just three young in 2005, and only 43 fledged young were observed over the past eighteen breeding seasons, it appears that this species remains in imminent danger of extirpation from the Basin.

Other Sensitive Avian Species. For the fifth consecutive year, no state-endangered Western Yellow-billed Cuckoo was found in the Prado Basin during 2006.

Yellow-billed Cuckoos have not been a primary focus of this study. They are extremely secretive and little has been learned of the size, behavior, or reproductive success of this small population. However, prior to 1995, the small local population appeared somewhat stable, with 3 (Zembal 1985) to 7 (Hays 1987) cuckoos being recorded annually. Then, in 1995, a widespread portion of the Basin was inundated in the spring and since then, only one or two cuckoos has usually been detected each year. Hopefully, the fact that, once again, no cuckoo was recorded in 2006 doesn't signify that the Western Yellow-billed Cuckoo has been permanently extirpated from the Prado Basin and environs.

Several other species designated by the California Department of Fish and Game as "Bird Species of Special Concern" (Remsen 1978) bred or attempted to breed within the Prado Basin and environs. Included among these were the Tricolored Blackbird (*Agelaius tricolor*), Least Bittern (*Ixobrychus exilis*), Burrowing Owl (*Speotyto cunicularia*), Cooper's Hawk (*Accipiter*

cooperi), Yellow Warbler *(Dendroica petechia*), Yellow-breasted Chat (*Icteria virens*) and White-faced Ibis (*Plegadis chihi*). These and several other local breeders, including the Common Ground Dove (*Columbina passerina*), Marsh Wren (*Cistothorus palustris*), Swainson's Thrush (*Catharus ustulatus*), Blue Grosbeak (*Guiraca caerulea*), and Lazuli Bunting (*Passerina amoena*) have declined in southern California as a result of habitat destruction and brood parasitism by the Brown-headed Cowbird (Garrett and Dunn 1981).

Many of these species may benefit from the management program that has been focused upon the vireo and flycatcher. For example, Yellow Warblers breed in proximity to the vireos and were also quite scarce in the Basin in the early 1980s (Zembal *et al.*1985). It is believed that fewer than 15 pairs occurred in the Basin as recently as 1987. However, a 1992 survey revealed 75 -100 pairs, and the 2004 estimate was 500 pairs.

The vireo population itself has increased from 19 to a high of 413 pairs over the course of this study, giving hope that this species may some day be recovered in this watershed. However, there is no reason to believe that the vireo would continue to prosper without these management efforts and little hope for the many other imperiled species receiving no effort. Most other vireo populations in the state are declining, maintaining, or just moderately increasing. Other than Prado, only the populations on the Santa Margarita and San Luis Rey Rivers have sustained significant increases in size due to intensive management since the Least Bell's Vireo was Federally listed.

The management of wildlife in southern California is lagging far behind critical needs. Many environmental advocates are busy trying to get land set aside and as important as those efforts are, they are very slow because of the great complexities and land costs. In the meantime the effects of so many millions of people cohabiting is eroding habitat carrying capacity and long term viability to such a daily degree that the potential for recovery and persistence of a full, intact southern California wildlife heritage is in question. The Santa Ana River Watershed Program and other similar programs demonstrate that wildlife management works for some species. Whether or not it will work for entire ecosystems remains to be determined over a very long period of time. The longer it takes us to prioritize habitat and wildlife restoration to the degree necessary to get on with ecosystem reparation, the less likely are the chances for ultimate success.

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