Least Bell's Vireo Surveys and Nest Monitoring at Anza Borrego Desert State Park in 2000

Final Report

January 2001

U.S. Geological Survey
Western Ecological Research Center
San Diego Field Station

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Final Report

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INTRODUCTION

The least Bell's vireo (*Vireo bellii pusillus*) is a small migratory songbird and an obligate summer resident of riparian habitat in southern California and northwestern Baja California, Mexico. Historically considered a common breeding resident in lowland riparian areas throughout California from the northern Sacramento River Valley south into northwestern Baja California, Mexico (Franzreb 1989), the least Bell's vireo began to decline throughout most of its range during the mid-1900's in response to alteration of natural river systems and extensive habitat destruction associated with agriculture and urban development. With the loss of over 90 percent of California's riparian habitat, as well as brood parasitism by the brown-headed cowbird (*Molothrus ater*), the least Bell's vireo experienced dramatic population declines, and by the mid-1970's was found only in small localized populations within seven California counties (Goldwasser et al. 1980). First listed as an endangered species by the state of California in 1980, the species was listed as federally endangered in 1986 with an estimated statewide population of 300 territorial males. After receiving endangered status, intensive management efforts including habitat restoration, cowbird control, and nest monitoring were instituted to reverse the decline of the vireo population within California. These efforts, coupled with the protection and subsequent natural recovery of riparian habitat, lead to a dramatic increase in the vireo population, and by 1999, there were approximately 1800 males documented in California (L. Hays, U.S. Fish and Wildlife Service, pers.comm.).

Approximately the size of a small sparrow, with olive gray upper parts and a light pearl gray breast, the least Bell's vireo is indistinctly marked. The male is readily identified by its distinctive song, and is highly vocal throughout the breeding season. The female, indistinguishable from the male in plumage, does not sing and is generally silent and more secretive than the male. Dependent upon riparian habitat during the breeding season, the vireo prefers willow-dominated woodland or scrub that typically exists along streams and rivers. Other habitat types are also used, including *Baccharis* scrub, mixed oak/willow woodland, mesquite woodland, and elderberry scrub. Habitat characteristics that appear to be essential for vireo occupation include dense cover from one to two meters (3-6 feet) in height for nesting and foraging, and a stratified canopy providing both foraging habitat and song perches for territorial advertisement. Primarily insectivorous, the vireo takes a wide variety of prey species, including caterpillars, beetles, bugs, and moths (U.S. Fish and Wildlife Service 1998). Least Bell's vireos begin to arrive on the breeding grounds in California from mid-March through May, with the majority of birds arriving during the latter half of April. Upon arrival, males establish and begin to defend territories ranging in size from 0.2 to 3.0 ha (0.5 to 7.5 acres), with an average size of less than one hectare (U.S. Fish and Wildlife Service 1998). After pair establishment, nest building typically takes from five to seven days. The small cup nest made up of dried plant material is woven into a fork or support stem, usually at about one m (three feet) in height. Eggs are laid at one-day intervals, with a typical clutch numbering three to four eggs. Incubation lasts for 14 days, and the young fledge from the nest 11-12 days after hatching. Fledglings remain with the adults for from two to several weeks. Vireos will attempt to renest following unsuccessful nests, and will occasionally raise two broods in the same season. The nesting season extends from early April through late July. Vireos typically remain on the breeding grounds until September or early October, and then migrate to their winter grounds in southern Baja California, Mexico.

This report summarizes the results of the year 2000 least Bell's vireo survey and nest monitoring study at Anza Borrego Desert State Park, California. The primary objectives of this study were to (1) determine the number and location of vireos within Anza Borrego Desert and (2) to collect information on nest success and productivity by monitoring the nesting activities of three discrete vireo populations. Information from this study, when combined with data from other years, will provide a current assessment of the vireo population and assist biologists and Park managers in determining future management needs for this species within Anza Borrego Desert State Park.

STUDY AREA AND METHODS

Study Area

The study area includes 14 individual riparian sites within or adjacent to the borders of Anza Borrego Desert State Park (hereafter, the "Park"). Located almost entirely within San Diego County, the Park encompasses over 242,800 ha (600,000 acres) between the eastern slopes of the peninsular ranges to Imperial County and from Riverside County to just north of the Mexican border (Figure 1). Distributed from near sea level to over 1,800 m (6,000 feet) in elevation, riparian habitat within the Park is restricted to a few of the larger drainages, canyons, springs, and cienegas where permanent surface or sub-surface water occurs. Primary drainages within the region include Coyote, San Felipe, Vallecito, and Carrizo Creeks. These drainages, which flow in an easterly direction from the peninsular ranges into the Anza Borrego Desert, support the largest riparian habitat areas in the Park, and were the location of 12 of the 14 sites visited during this study.

Riparian habitat in the study area occurs within three types of areas differing in water availability, topography and geologic conditions. The first type occurs within the larger drainages where permanent surface or shallow sub-surface water flows through relatively broad, low-gradient streambeds, creating soil conditions that support a wide zone of riparian vegetation. Coyote Creek within Upper, Middle and Lower Willows, and San Felipe Creek upstream of Sentenac Canyon, are examples of this type of riparian area. Riparian vegetation within these areas can span over 75 m (225 feet) in width and is dominated by willow (*Salix* sp.), cottonwood (*Populus fremontii*), arroweed (*Tessaria sericea*), and mule fat (*Baccharis salicifolia*). A transition zone of mixed scrub or mesquite (*Prosopis* sp.) may also be present within these areas, providing additional habitat for many riparian wildlife species.

The second type of riparian area found within the Park is associated with narrow, high-gradient streams located within steep rocky canyons, or riparian habitat that exists within small, localized areas in association with springs. Riparian habitat within these areas is typically narrow (< 20 meters (seven feet) wide), and restricted to the immediate streambed or location of surface water. In contrast to the first type of riparian area, the transition zone from riparian habitat to sparsely vegetated desert scrub is minimal or absent. Riparian vegetation within these areas is varied and depending upon location, can include slender willow (*S. exigua*), cottonwood, sycamore (*Platanus racemosa*), white alder (*Alnus rhombifolia*), California fan palm (*Washingtonia filifera*), mesquite, and arroweed. Borrego Palm Canyon, Sentenac Canyon, and Agua Caliente Springs are all representative of this type of riparian area.

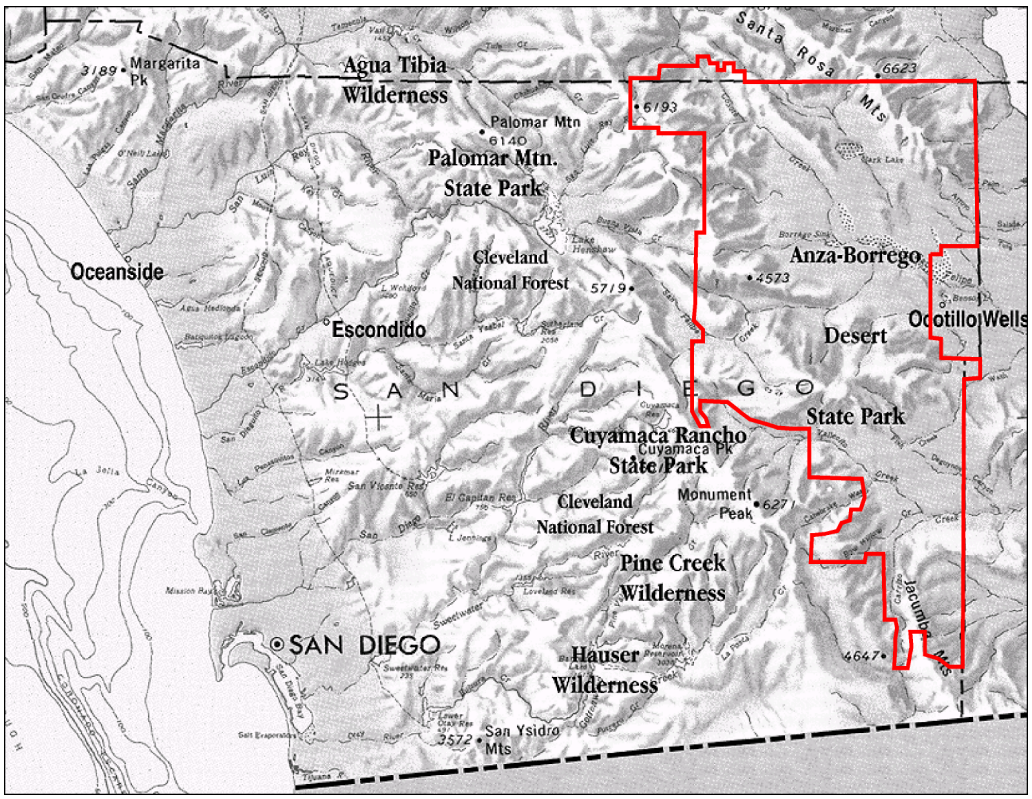


Figure 1. Location of Anza Borrego Desert State Park, California.

The third type of riparian area is found where large drainages flow into broad level areas or sinks and sub-surface water flows are at levels allowing the establishment of dense mesquite-dominated thickets. These bosques or mixed scrub woodlands are located at lower elevations of the Anza Borrego Desert and are typically without permanent surface water, although they are subject to inundation during high rainfall or flooding. Dominant plant species include honey mesquite (*P. glandulosa*), catclaw (*Acacia greggii*), saltcedar (*Tamarix* sp.), and saltbush (*Atriplex* sp.). Examples of this habitat are located within Vallecito Valley near the Vallecito Stage Station County Park, and Vallecito Wash at the southern end of Mason Valley.

Human activities and associated disturbance within riparian areas of Anza Borrego Desert State Park are minimal and limited to the more accessible areas that provide recreational opportunities. Hiking is popular within many of the canyons, particularly where surface water is present, and mountain bike riding and horseback riding are popular within the Coyote Creek area. Grazing within the Park is limited to the activities of wild horses, which are present within the upper section of Coyote Creek. Sections of both Upper and Middle Willows showed evidence of grazing and trampling, particularly within areas of younger emergent riparian vegetation. Impacts outside of the Park boundaries on private lands include grazing, agriculture, and ground water pumping. Activities on adjacent County Park lands within the study areas include camping and hiking.

Additional disturbances to riparian habitat throughout the study area include establishment of exotic plant species. Saltcedar or tamarisk is found throughout the Anza

Borrego Desert region and was present within all the major drainages surveyed. An on-going tamarisk removal program by the State Park has made substantial progress in eliminating this exotic from Park property on both Coyote and San Felipe Creeks. Giant reed (*Arundo donax*) was also noted in Lower Willows, but was not found at other areas surveyed during this study.

Field Surveys and Nest Monitoring

Between 15 April and 13 July 2000, a total of 34 field days were spent conducting survey and nest monitoring activities at 14 sites within the Anza Borrego Desert, including ten on State Park property, two within County Park lands (Vallecito Stage Station and Agua Caliente County Parks), and two on private property (Vallecito Valley and Campbell Grade) (Table 1, Figures 2-5). Selection of survey locations was based on review of historical vireo survey information, identifying areas where vireos occur and for which comparisons over time could be made. Nest monitoring was conducted at four sites, including Lower Willows, San Felipe Valley, Sentenac Canyon, and Vallecito Valley (Cienega), selected on the basis of the number of vireo territories they support, as well as their site characteristics and distribution within the study area. Survey effort at the non-monitored sites ranged from between one and three visits, with limited time spent in determining breeding or nesting status of vireos detected. Survey effort at the four nest monitoring locations was more comprehensive and ranged from six to nine visits per site. Field surveys were performed by Jeff Wells, with assistance from Paul Jorgensen, Mark Jorgensen and Robert Theriault of California State Parks. Nest monitoring was conducted by Jeff Wells. In addition to the surveys and monitoring conducted under this study, volunteers conducting bighorn sheep counts and San Diego Natural History Museum personnel provided information on five locations not visited as part of this study. Survey dates, times, and weather conditions are presented in Appendix I.

Field surveys were initiated in the early morning hours when vireo behavior as well as weather conditions are the most conducive to species detection. Surveys were performed by walking along or through all suitable riparian habitat, observing and listening for the vireo's distinctive song and other vocalizations. A taped playback of a male vireo song was used to aid in vireo detection or confirmation of presence. Once an individual vireo was detected, an effort was made to determine its breeding status. Individual locations or vireo territories within the nest monitoring areas were visited every 7-21 days, depending on the breeding or nesting status of individuals. Nests were located, and visited as infrequently as possible to avoid disturbance or possible attraction of predators to nest sites. Depending on the stage of the nest at discovery, nests were visited from two to three times. Typically, the first nest visit was performed to determine the status of the nest and record its contents. The second visit was timed to evaluate hatching success and determine the age and number of any nestlings present. A third or final visit was made to confirm nest outcome and document the number of fledglings. In addition to documenting nest status at each visit, cowbird eggs and/or nestlings were removed from vireo nests when discovered. Once a nest was determined to have fledged or been abandoned, several nest site characteristics were recorded. These measurements included the nest height, nest cup diameter and depth, host plant species, host plant height and diameter, distance from nest to nearest open space or edge of vegetation clump, and distance from nest to habitat edge. General information recorded for each vireo location included habitat type, dominant vegetation species present, current habitat condition, and any disturbances within the area. Habitat type was

classified into one of three types, including willow-dominated riparian woodland or scrub, mixed willow and mesquite scrub, and mesquite-dominated woodland or scrub.

Table 1. Least Bell's vireo survey and monitoring locations, Anza Borrego Desert State Park region, 2000.

Drainage	Location	No. visits	Comments / Survey Dates
COYOTE CREEK	*Upper Willows*	2	May 10,11
	Middle Willows	3	May 3,4,11
	Lower Willows	7	monitored population
BORREGO PALM CANYON	*Borrego Palm Canyon* [1]	4	April 22, July 1,2,3
SAN FELIPE CREEK	*Angelina Spring*	1	June 3
	Yaqui Well	1	May 13
	Tamarisk Grove	1	May 13
	San Felipe Valley	8	monitored population
	Sentenac Cienega	3	April 24, May 13, June 3
	Sentenac Canyon	6	monitored population
VALLECITO CREEK	*Campbell Grade*	3	May 31, July 1,12
	Vallecito Cienega	9	monitored population
AGUA CALIENTE SPRINGS	*Agua Caliente Co. Park*	1	June 2
CARRIZO CREEK	*Carrizo Marsh* [2]	1	April 27
	Carrizo Canyon [3]	1	April 23
	Jacumba Jim Canyon [3]	1	May 13
BOW WILLOW CREEK	*Bow Willow Creek* [3]	2	April 19, May 17
	Bow Willow Palms [3]	2	April 25, May 12
FISH CREEK WASH	*Fish Creek Wash* [3]	1	April 13

[1]July 1,2,3 information from Lori Hargrove while conducting bighorn sheep census.
[2]Carrizo Marsh survey conducted by Paul Jorgensen.
[3]Observations from San Diego Natural History Museum's Bird Atlas survey personnel D. Seals, L. Hargrove, S. Martin, and B. Mulrooney.

Analyses

Nest success was calculated as the fraction of observed nests that fledged at least one vireo young. Productivity estimates are based on nests observed with eggs, with average clutch size based upon unparasitized nests believed to contain complete or finished clutches. Seasonal distribution of both vireo and cowbird nesting periods are based upon the laying date of the first vireo egg in a nest, using the following nest chronology for least Bell's vireos: egg laying stage: one egg per day, with a typical clutch of 3-4 eggs; incubation stage: 14 days, beginning with second to last egg laid; nestling stage: young fledge at 11-12 days. Brown-headed cowbird nesting chronology is based upon egg-laying occurring two days after the first vireo egg deposition date, hatching within 12 days, and fledging at 11 days (Scott 1979, Woodward and Woodward 1979).

Figure 2. Least Bell's vireo survey and monitoring sites, Coyote Creek, Anza Borrego Desert, 2000.

Figure 3. Least Bell's vireo survey and monitoring sites, Borrego Palm Canyon, San Felipe Creek, Angelina Spring, Yaqui Well, Tamarisk Grove, Anza Borrego Desert, 2000.

Figure 4. Least Bell's vireo survey and monitoring sites, Campbell Grade, Vallecito Valley, Agua Caliente County Park, Carrizo Marsh, and Fish Creek Wash, Anza Borrego Desert, 2000.

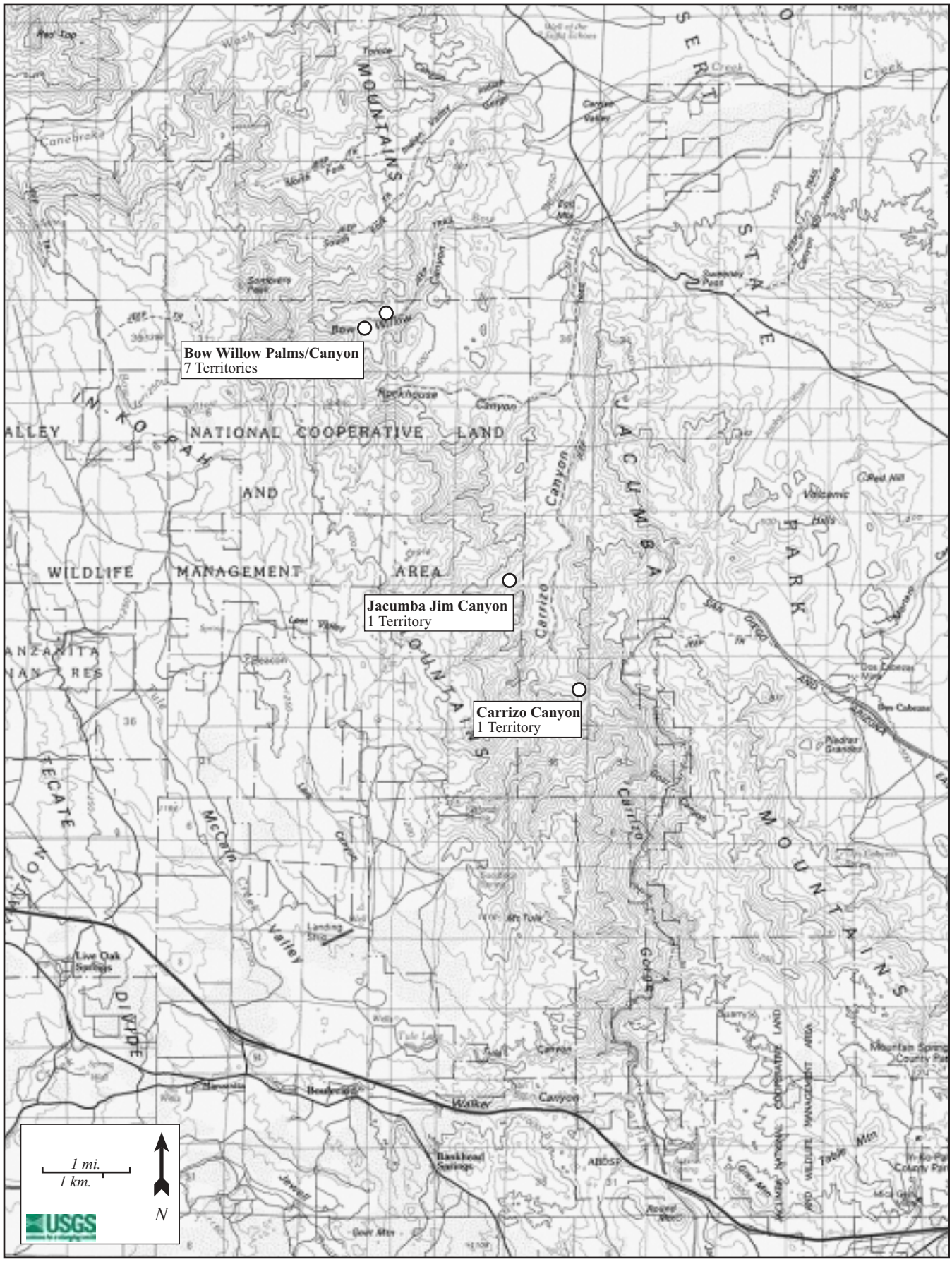


Figure 5. Least Bell's vireo survey and monitoring sites, Bow Willow Palms/Canyon, Jacumba Jim Canyon, Carrizo Canyon, Anza Borrego Desert, 2000.

RESULTS

Population Size and Distribution

A total of 91 singing male least Bell's vireos were documented within the study area during the 2000 survey period, including 78 males detected during this study, and 12 reported by other observers (Table 2, Figures 6-15). These 91 males included 45 confirmed breeding pairs, 12 single territorial males, and 34 territorial males of unknown breeding status. Least Bell's vireos were detected at 11 of 14 sites surveyed, including eight sites within Anza Borrego Desert State Park, two sites on private property, and one site on County Park land. Additional locations where vireos were reported by other observers included five sites within Anza Borrego Desert State Park.

Table 2. Number and breeding status of least Bell's vireos, Anza Borrego Desert, 2000.

Drainage	Location	Breeding Pairs	Territorial Males	**Total Territorial Males**
COYOTE CREEK	*Upper Willows*	1		**1**
	Middle Willows	5		**5**
	Lower Willows	10	8	**18**
BORREGO PALM CANYON	*Borrego Palm Canyon*	3	3	**6**
SAN FELIPE CREEK	*Angelina Spring*			**0**
	Yaqui Well			**0**
	Tamarisk Grove			**0**
	San Felipe Valley	5		**5**
	Sentenac Cienega / Canyon	4	5	**9**
VALLECITO CREEK	*Campbell Grade*	4	9	**13**
	Vallecito Cienega	11	9	**20**
AGUA CALIENTE SPRINGS	*Agua Caliente Co. Park*	1	1	**2**
CARRIZO CREEK	*Carrizo Marsh*		2	**2**
	Carrizo Canyon		1	**1**
	Jacumba Jim Canyon		1	**1**
BOW WILLOW CREEK	*Bow Willow Creek*		2	**2**
	Bow Willow Palms	1	4	**5**
FISH CREEK WASH	*Fish Creek Wash*		1	**1**
Total territorial males		44	25	**91**

[1] Three additional singing males documented on July 1st, 2nd and 3rd by L. Hargrove.
[2] Survey conducted by P. Jorgensen.
[3] Least Bell's vireo sightings by San Diego Natural History Museum personnel.

Sixty of the 91 vireo territories occurred on State Park property, 29 on private property, and two on County property. Over 75 percent (71) of the male vireos were located on three drainages, including 33 on Vallecito Creek, 24 on Coyote Creek, and 14 on San Felipe Creek.

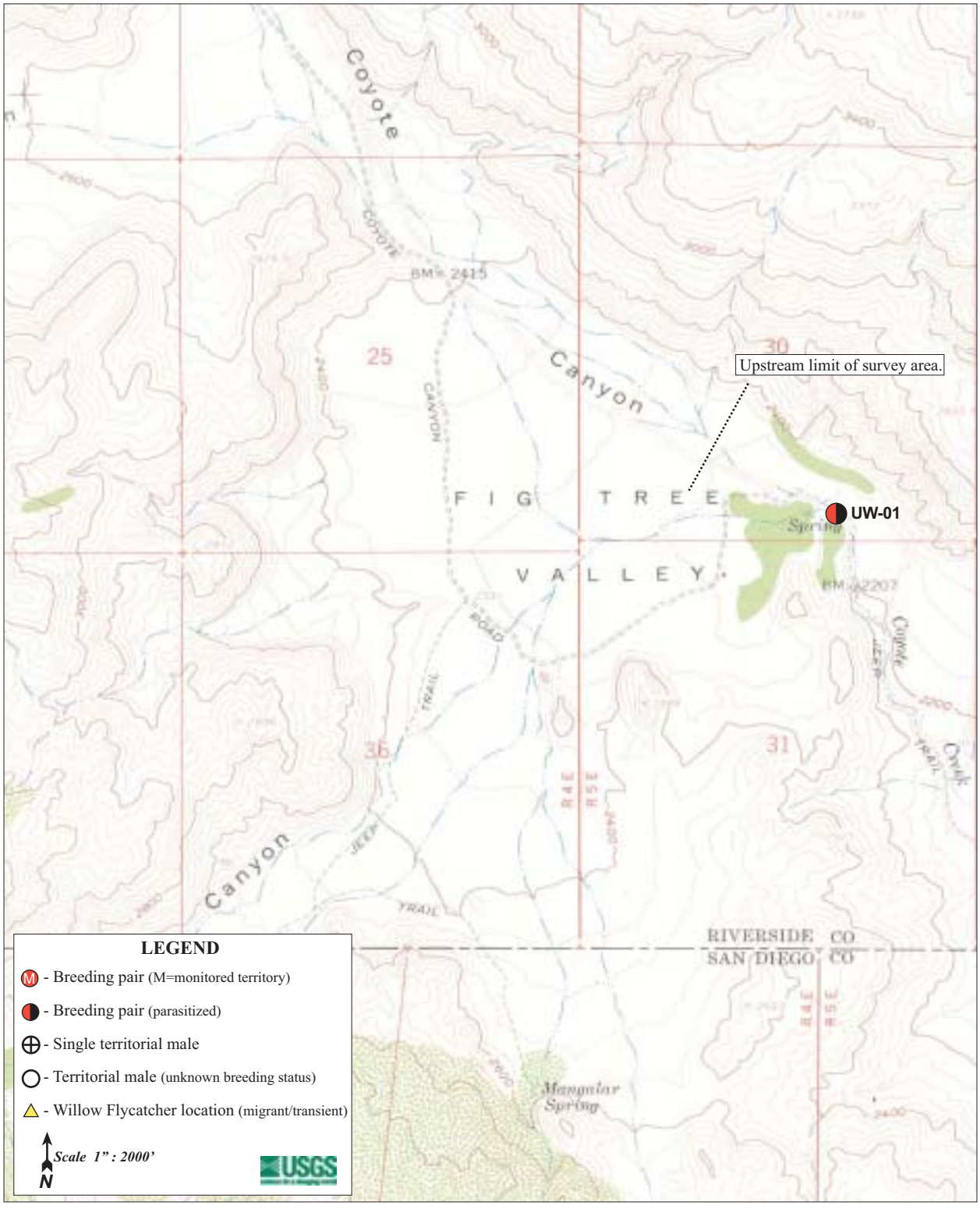


Figure 6. Year 2000 Least Bell's Vireo locations, Coyote Creek (Upper Willows), Anza Borrego Desert State Park, California.

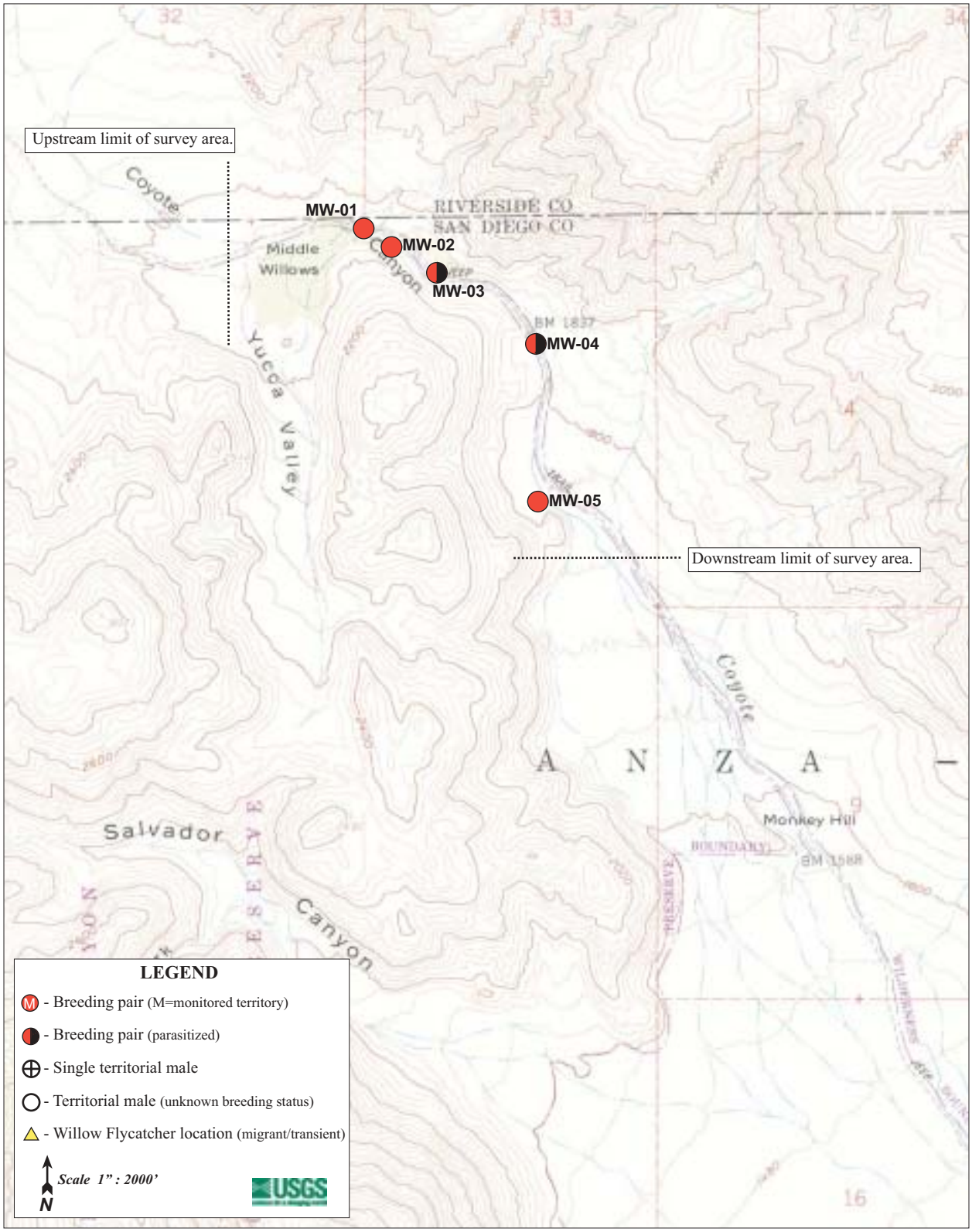


Figure 7. Year 2000 Least Bell's Vireo locations, Coyote Creek (Middle Willows), Anza Borrego Desert State Park, California.

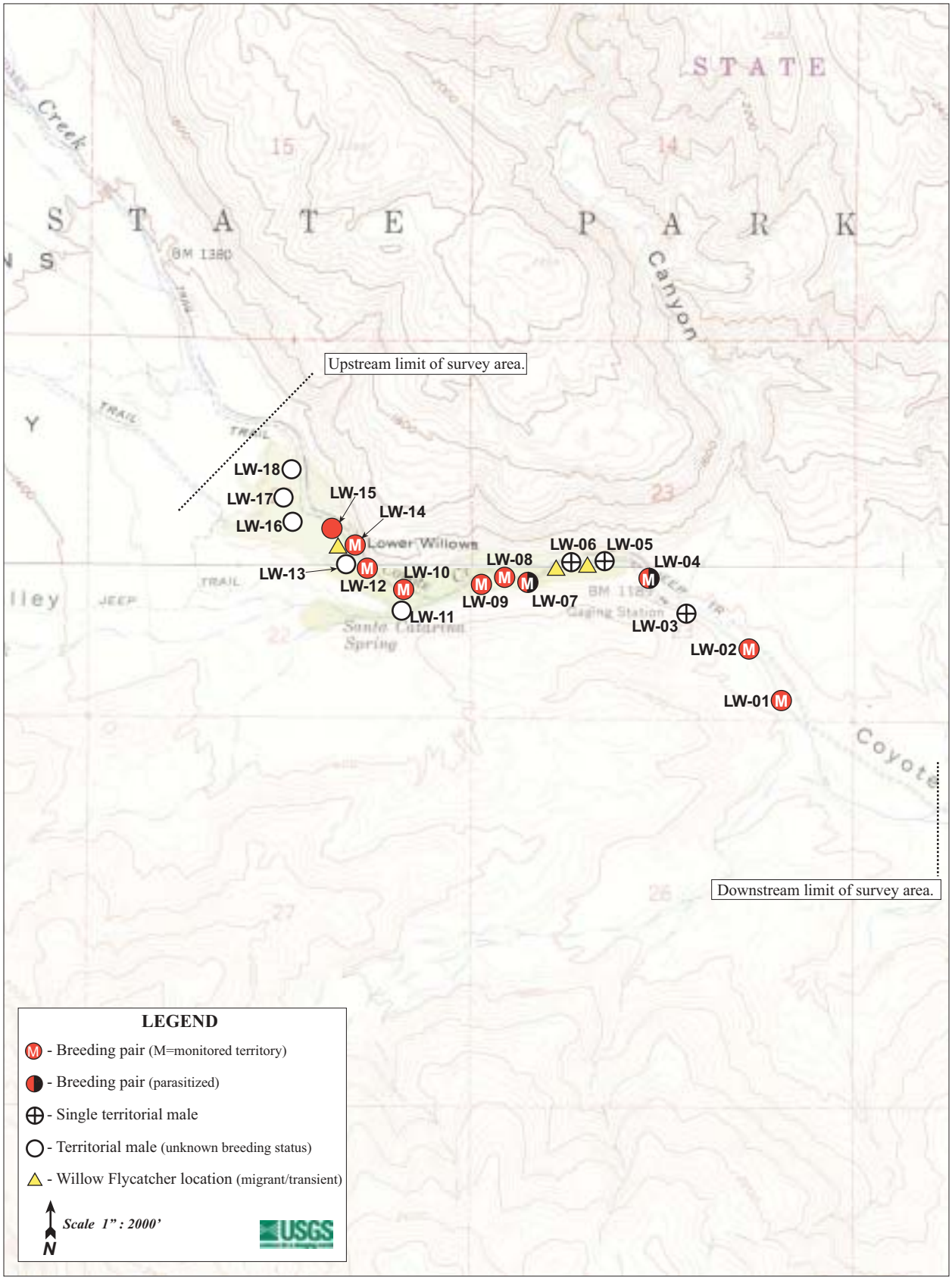


Figure 8. Year 2000 Least Bell's Vireo locations, Coyote Creek (Lower Willows), Anza Borrego Desert State Park, California.

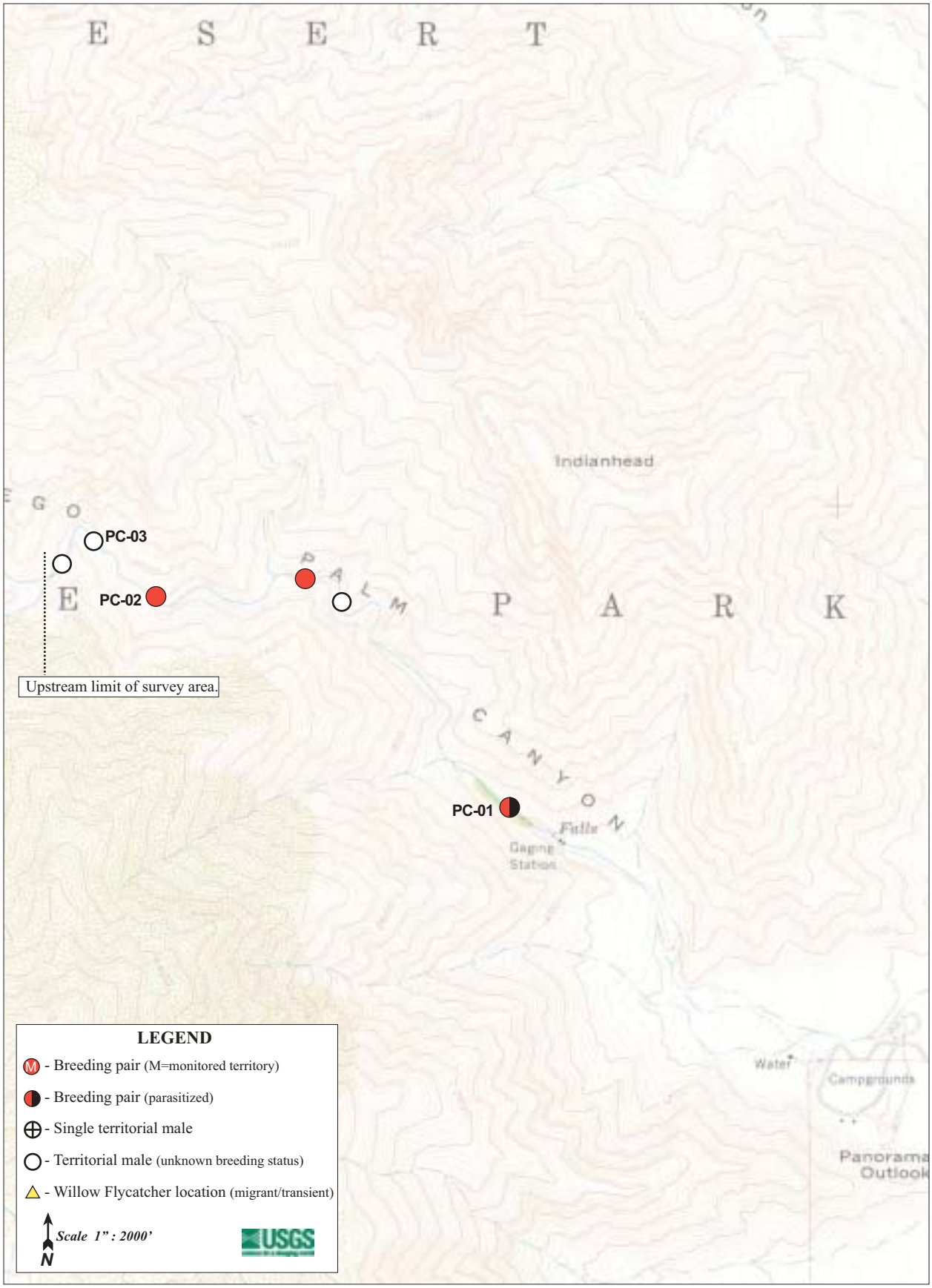


Figure 9. Year 2000 Least Bell's Vireo locations, Borrego Palm Canyon, Anza Borrego Desert State Park, California.

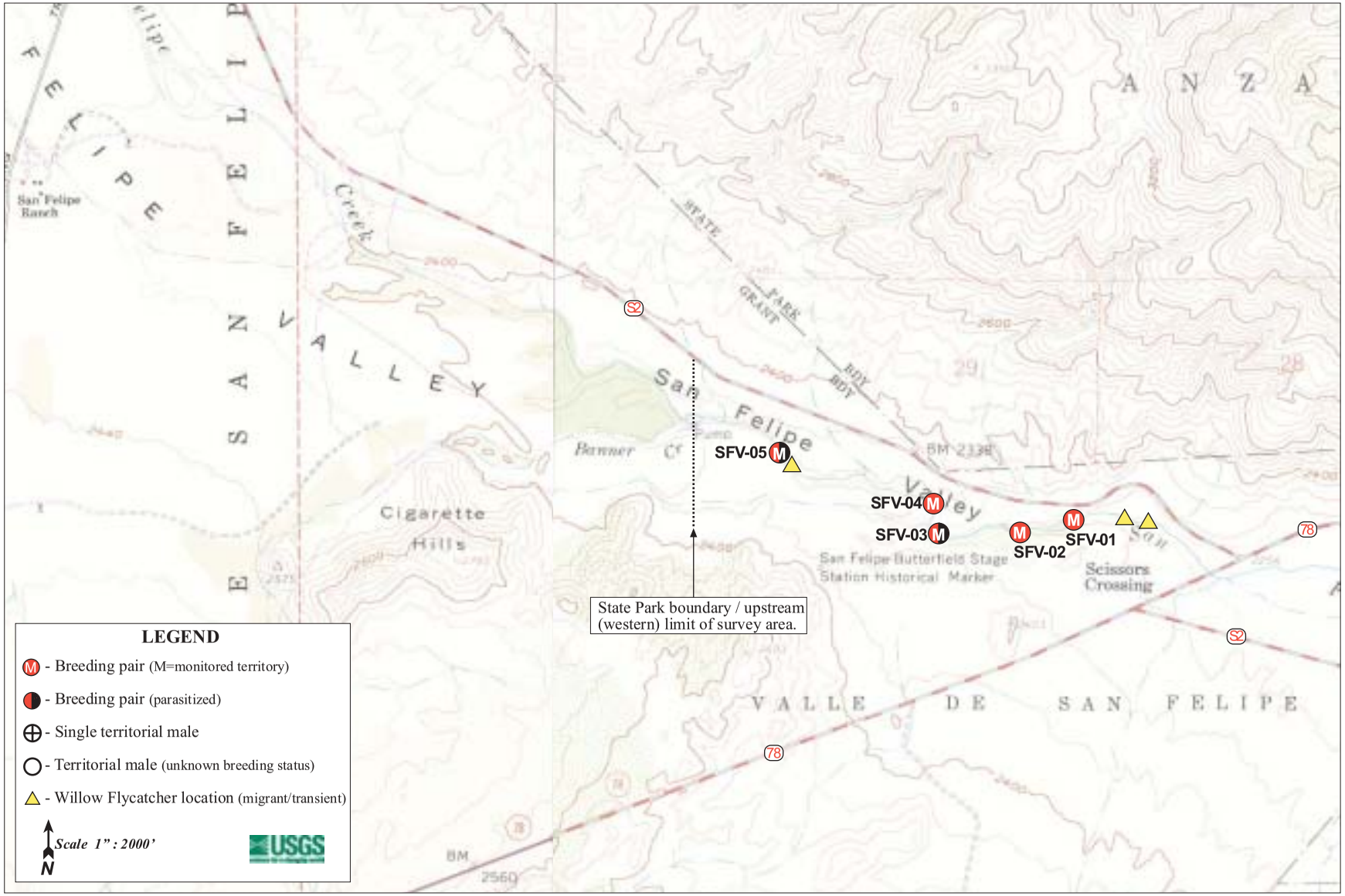


Figure 10. Year 2000 Least Bell's Vireo locations, San Felipe Valley, Anza Borrego Desert State Park, California.

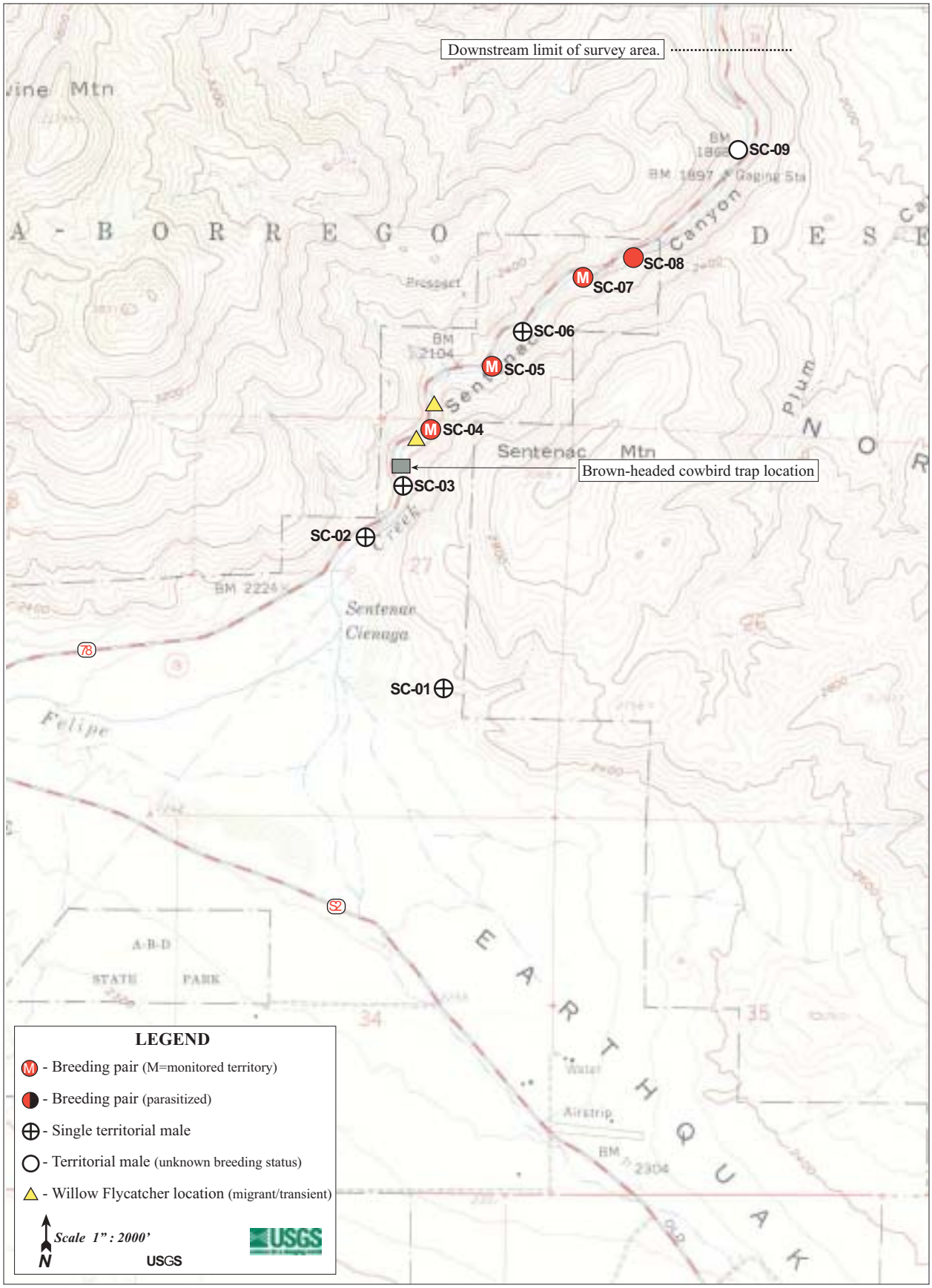


Figure 11. Year 2000 Least Bell's Vireo locations, Sentenac Cienega and Sentenac Canyon, Anza Borrego Desert State Park, California.

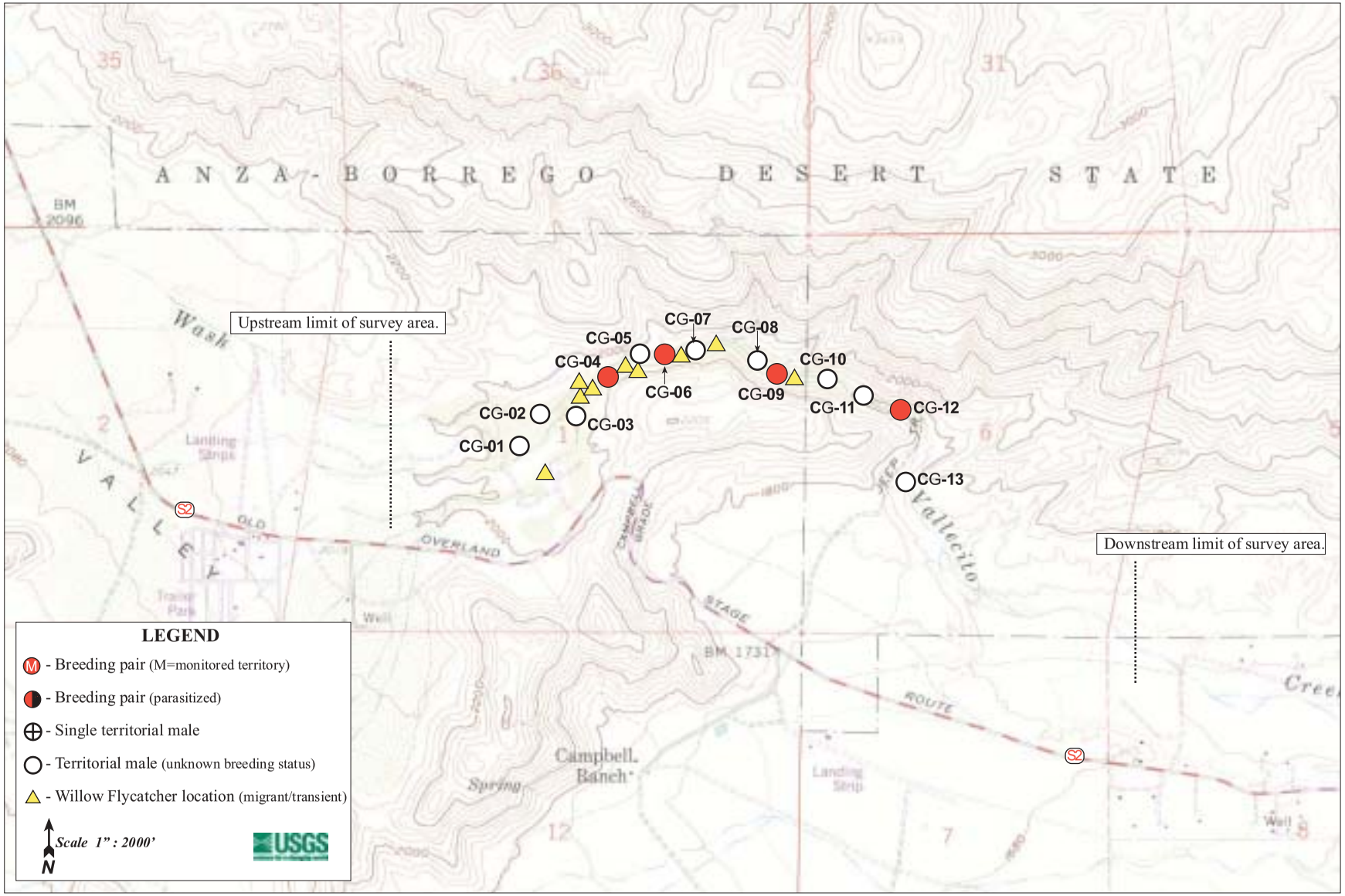


Figure 12. Year 2000 Least Bell's Vireo locations, Vallecito Creek (Campbell Grade), Anza Borrego State Park, California.

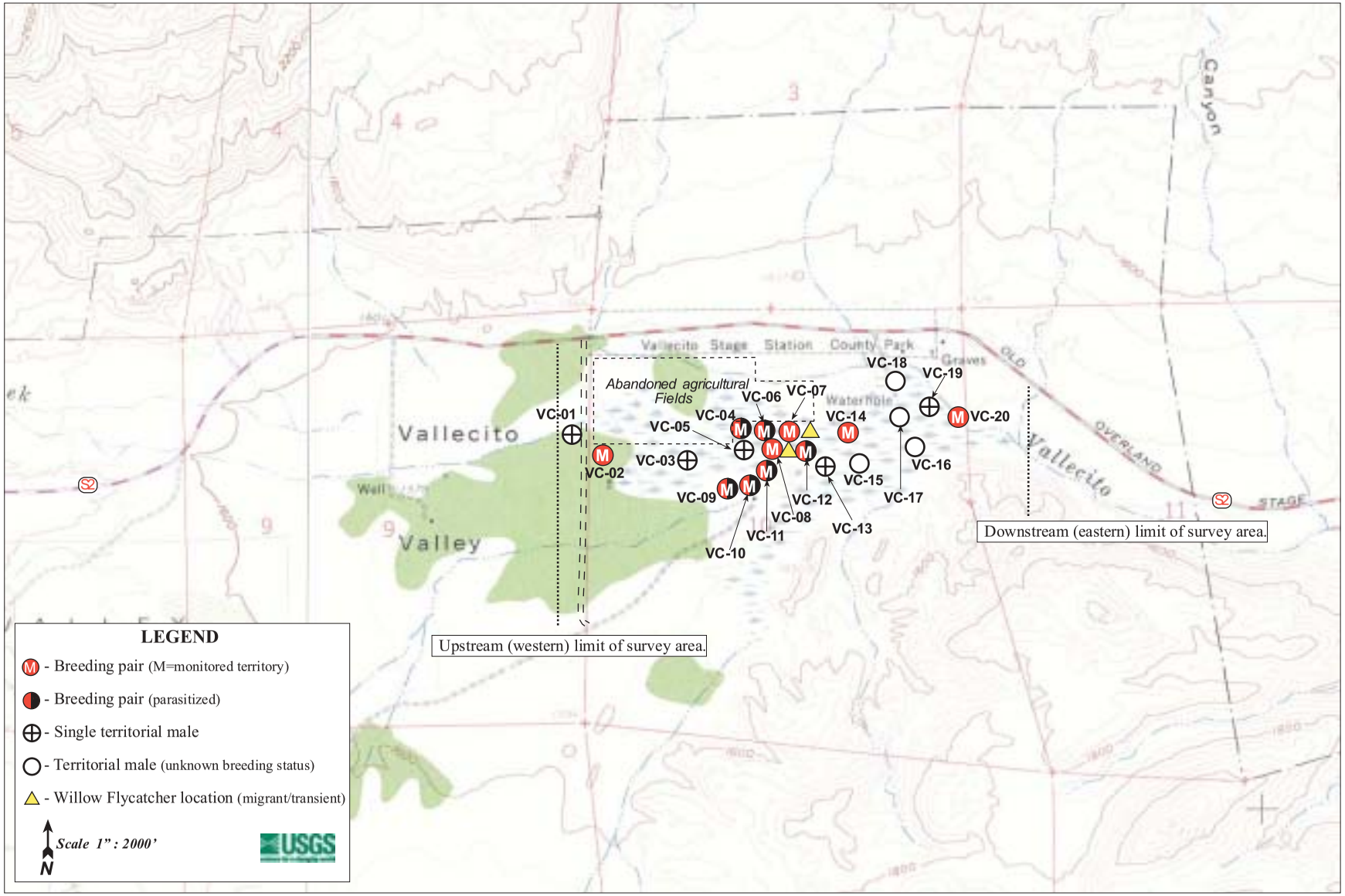


Figure 13. Year 2000 Least Bell's Vireo locations, Vallecito Valley (Cienega), Anza Borrego Desert , California.

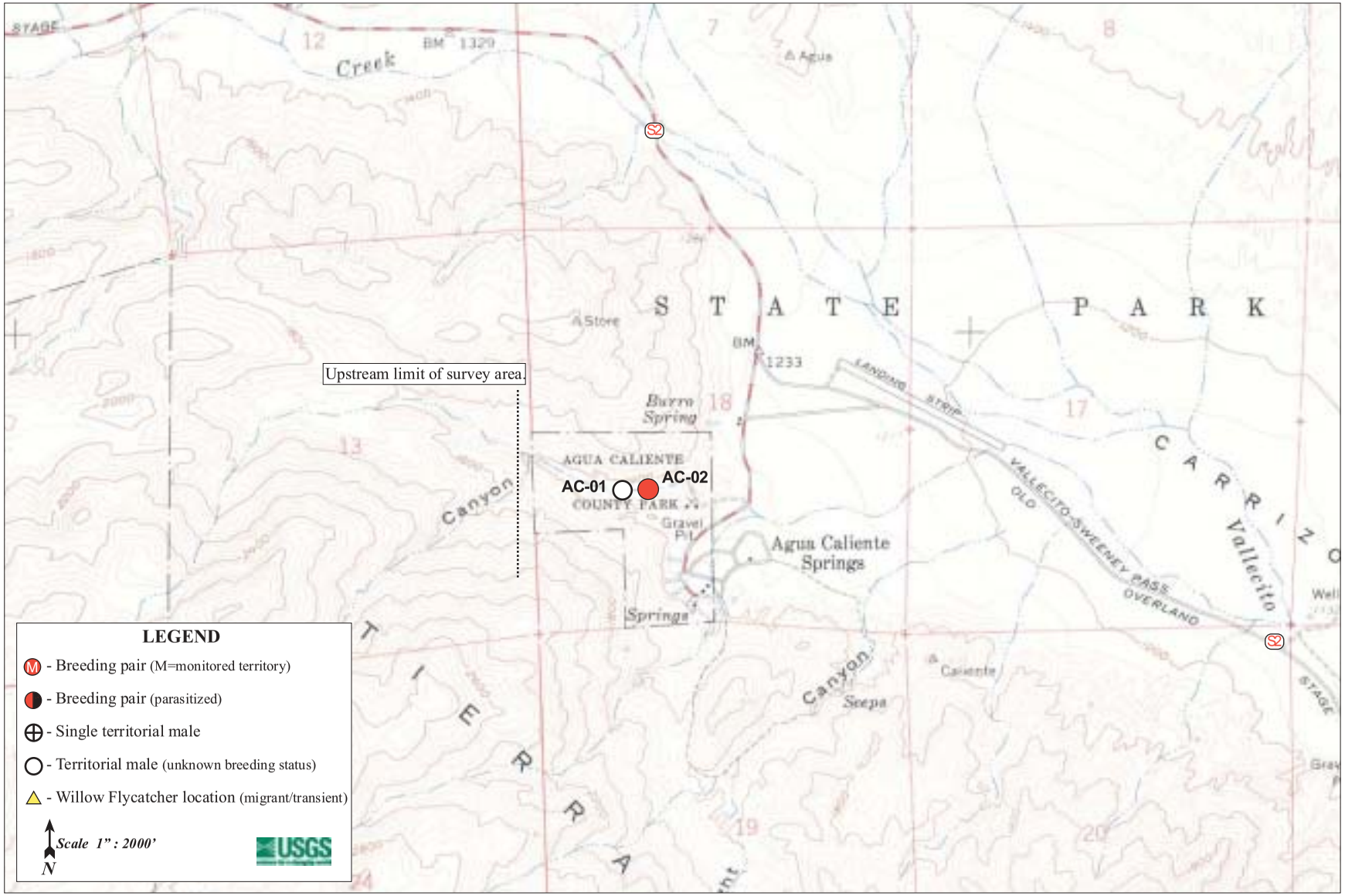


Figure 14. Year 2000 Least Bell's Vireo locations, Agua Caliente Springs (County Park), Anza Borrego Desert, California.

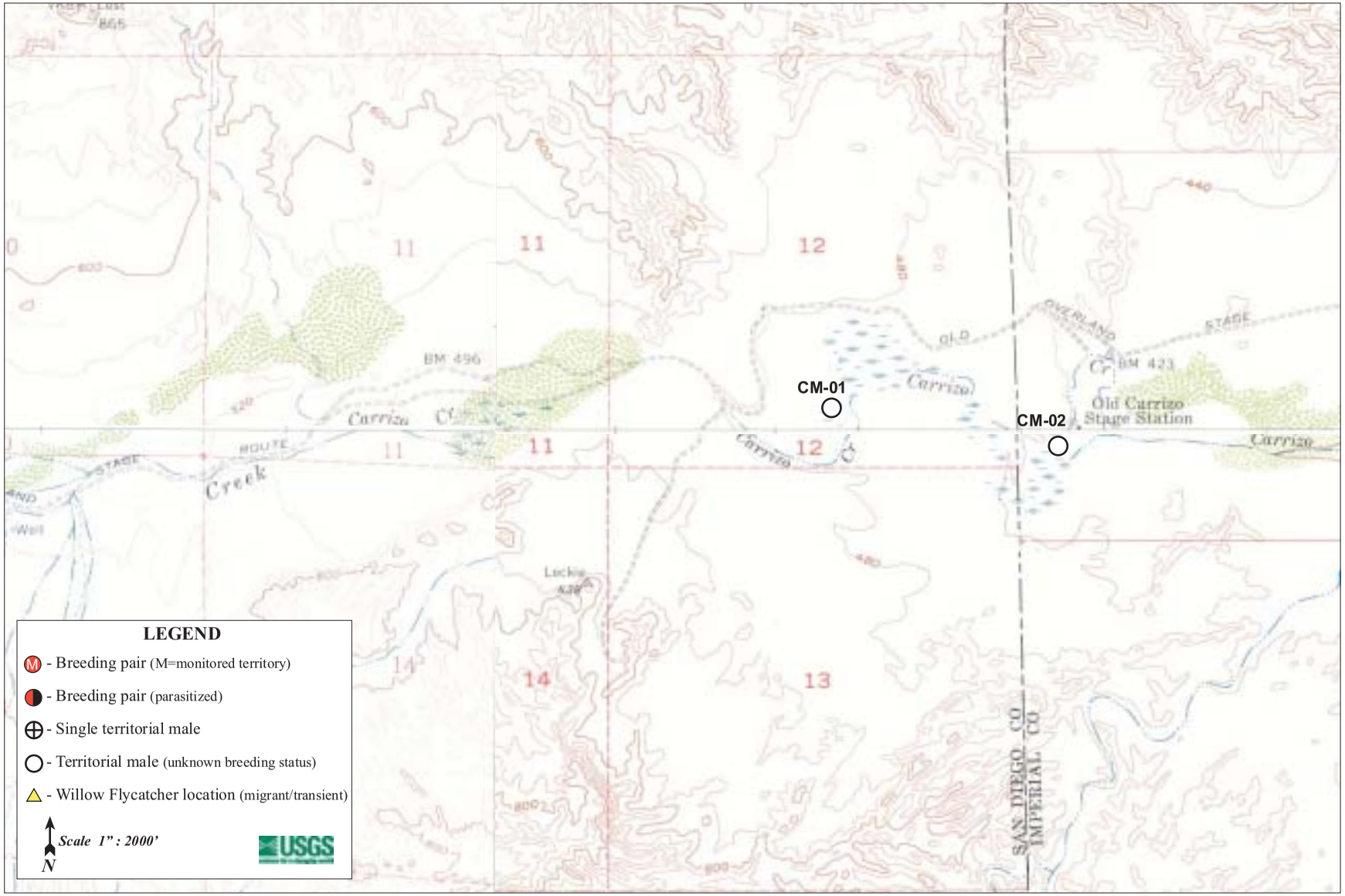


Figure 15. Year 2000 Least Bell's Vireo locations, Carrizo Creek (Marsh), Anza Borrego Desert State Park, California.

The largest population was at Vallecito Valley or Cienega, with 20 territorial males. Populations at other sites ranged from 1-18 territories.

The majority of territories within the Coyote, San Felipe, and Vallecito Creek drainages were in mixed willow and mesquite riparian scrub (45 percent, 32/71), followed by mesquite-dominated woodland (37 percent, 26/71), and willow-dominated riparian woodland or scrub (18 percent, 13/71).

Band presence/absence was confirmed for 104 of the 118 adult vireos observed during this study. No banded adult vireos were observed within the study area.

Nest Success and Productivity

Documentation of breeding behavior varied across the study area and was dependent upon the number and timing of individual site visits. Evidence of nesting included observations of active nests, and/or fledglings or juveniles in close proximity to adult vireos. Breeding activity was documented at nine of the 14 sites visited during this study. Of the 45 total vireo pairs, 36 (80 percent) were known to have attempted at least one nest. Evidence of successful nesting was documented for 25 of the 36 pairs (69 percent), resulting in the successful fledging of a minimum of 56 young within the entire study area (Table 3).

Twenty-eight vireo pairs were monitored to obtain data on nest success and productivity (Table 3), including nine pairs at Lower Willows on Coyote Creek (Figure 8), eight pairs at San Felipe Valley and Sentenac Canyon on San Felipe Creek (Figures 10 and 11), and 11 pairs at Vallecito Valley on Vallecito Creek (Figure 13). Of the 28 vireo pairs monitored throughout the nesting season, 19 (68 percent) were successful in producing young, including 15 pairs that attempted and successfully fledged a single nest, three pairs successful on their second nest attempt, and one pair fledging at least one young from an undiscovered nest. Five pairs were unsuccessful in their initial and only nest attempt, and four pairs were unsuccessful after two attempts. None of the monitored pairs were observed attempting a second nest after successfully fledging their first.

A total of 34 nest attempts by the 28 monitored pairs were observed, 18 (53 percent) of which were successful in producing at least one fledgling. Eight (24 percent) of the 34 nest attempts failed as a result of parasitism or destruction of eggs by brown-headed cowbirds, four (12 percent) were lost to predation, and four (12 percent) were abandoned for unknown reasons. All four of the predated nests were lost during the incubation stage. Nest site evidence indicated that three of the predated nests were lost to snakes, small mammals, or birds, and one nest was lost to a large- or medium-sized mammal such as coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), or raccoon (*Procyon lotor*). Abandoned nests included one that was abandoned during the nest-building stage, and three that were abandoned or possibly predated after nest completion or during the egg-laying stage. Three of 29 (10 percent nests with eggs contained single unhatched vireo eggs, and two nests had a single egg removed by unknown predators during incubation.

Table 3. Nest information for least Bell's vireo pairs, Anza Borrego Desert, 2000.

Territory ID		Nest Summary			Nest Number 1					Nest Number 2				
Drainage	Section and Map ID	No. nests observed	No. Successful	Monitored Y / N	No. Eggs	No. Nestlings	No. Fledglings	No. BHCO eggs/nestlings	Comments	No. Eggs	No. Nestlings	No. Fledglings	No. BHCO eggs/nestlings	Comments
Coyote Cr.	UW-01	1	U	N	2	U	0	1e	Unk. nest fate					
Coyote Cr.	MW-01	1	0	N	2	0	0	0	predation					
Coyote Cr.	MW-02	1	U	N	3	U	0	0	Unk. nest fate					
Coyote Cr.	MW-03	1	U	N	2	U	0	1e	Unk. nest fate					
Coyote Cr.	MW-04	1	0	N	2	0	0	0	parasitized					
Coyote Cr.	LW-01	1	1	Y	4	4	4	0						
Coyote Cr.	LW-02	1	1	Y	3	3	3	0						
Coyote Cr.	LW-04	2	0	Y	0	0	0	0	abandoned	2	0	0	0	parasitized
Coyote Cr.	LW-07	1	1	Y	3	3	3	1e	parasitized					
Coyote Cr.	LW-08	1	1	Y	4	4	4	0						
Coyote Cr.	LW-09	2	1	Y	4	0	0	0	predation	3	2	2	0	1 unh. egg
Coyote Cr.	LW-10	1	1	Y	U	U	1+	U	nest not found					
Coyote Cr.	LW-12	1	1	Y	3	3	3	0						
Coyote Cr.	LW-14	2	0	Y	3	0	0	0	predation	U	0	0	0	abandoned
Coyote Cr.	LW-15	1	1	N	U	U	1+	U	1 juv. obs.					
Borrego Palm Cyn.	BPC-01	1	U	N	U	U	U	1f	1 cowbird juv.					
San Felipe Cr.	SFV-01	2	1	Y	2	0	0	0	predation	4	4	4	0	
San Felipe Cr.	SFV-02	1	1	Y	3	2	2	0	1 unh. egg					
San Felipe Cr.	SFV-03	2	1	Y	1	0	0	0	parasitized	4	3	3	0	1 unh egg
San Felipe Cr.	SFV-04	1	0	Y	U	0	0	0	abandoned					
San Felipe Cr.	SFV-05	1	1	Y	4	3	3	1n	1 egg missing					
San Felipe Cr.	SC-04	1	1	Y	3	3	3	0						
San Felipe Cr.	SC-05	1	1	Y	3	3	3	0						
San Felipe Cr.	SC-07	1	1	Y	2	2	2	0						
San Felipe Cr.	SC-08	0	U	N	unknown nesting status									
Vallecito Cr.	CG-06	1	1	N	U	U	2+	U	2 juvs. obs.					
Vallecito Cr.	CG-12	1	1	N	U	U	1+	U	1 juv. obs.					
Vallecito Cr.	VC-02	1	1	Y	3	2	2	0	1 egg missing					
Vallecito Cr.	VC-04	2	0	Y	1	0	0	0	parasitized	1	0	0	1n	parasitized
Vallecito Cr.	VC-05	2	0	Y	2	0	0	1e	parasitized	3	0	0	0	predation
Vallecito Cr.	VC-07	1	1	Y	1	1	1	0						
Vallecito Cr.	VC-08	1	1	Y	3	3	3	0						
Vallecito Cr.	VC-09	1	1	Y	3	3	3	1e	parasitized					
Vallecito Cr.	VC-10	1	0	Y	1	0	0	1e	parasitized					
Vallecito Cr.	VC-11	1	0	Y	U	U	0	1n	parasitized					
Vallecito Cr.	VC-12	1	0	Y	2	0	0	0	parasitized					
Vallecito Cr.	VC-14	1	1	Y	3	3	3	0						
Vallecito Cr.	VC-20	1	0	Y	0	0	0	0	abandoned					

A total of 78 vireo eggs were deposited in 29 nests observed with eggs. Fifty-one (65 percent) of these eggs hatched. Of the 51 nestlings, all survived to fledge for an average of 1.8 fledglings per nest. Seasonal pair productivity (total fledglings per pair) was slightly higher,

with 28 pairs producing 52 fledglings or 1.9 fledglings per pair. Average clutch size for the three monitored populations combined was 3.3 ± 0.6 eggs per nest (N=18 unparasitized nests).

San Felipe Creek. Seven of eight vireo pairs monitored at the San Felipe Valley and Sentenac Canyon sites of San Felipe Creek were successful in producing at least one fledgling. Of 10 total nest attempts observed, seven (70 percent) successfully fledged young (Table 4), the highest nest success observed among the three monitoring sites. Hatching rate, at 77 percent, was also high, with the result that pairs at San Felipe Creek fledged more young over the season than those at either of the other two sites. Of the three nest failures, one was predated during the incubation stage, one was abandoned after cowbird parasitism, and one was abandoned or predated during egg laying or shortly after nest completion. Cowbird parasitism was documented in 2 of 10 (20 percent) monitored nests, including one that contained a single cowbird egg, and one that contained a single cowbird nestling.

Table 4. Least Bell's vireo reproductive rates for San Felipe, Coyote, and Vallecito Creek monitoring sites, 2000.

	San Felipe Creek	***Coyote Creek***	***Vallecito Creek***
No. monitored pairs	8	9	11
No. monitored nests	10	11	13
Percent and (N) successful nests	70% (7)	55% (6)	38% (5)
Total No. eggs	26	29	23
Percent and (N) eggs hatched	77% (20)	66% (19)	52% (12)
Percent and (N) nestlings fledged	100% (20)	100% (19)	100% (12)
Percent and (N) nests parasitized	20% (2)	18% (2)	54% (7)
Percent (N) nests predated/abandoned	20% (2)	36% (4)	7% (2)
Ave. clutch size ± std. dev. (N)=unparasitized	3.9 ± 0.8 (7)	3.4 ± 0.5 (7)	3.0 ± 0.0 (4)
Fledglings per monitored nest observed with eggs	2.2	2.1	1.1
Fledglings per monitored pair	2.5	2.1	1.1

Coyote Creek. Seven of nine vireo pairs monitored at the Lower Willows site of Coyote Creek were successful in producing at least one fledgling. Of 11 total nest attempts observed, six (55 percent) successfully fledged young (Table 4). Of the five nest failures, two were abandoned for unknown reasons during or shortly after nest building, two were predated during the incubation stage, and one was abandoned after the eggs were destroyed by a cowbird. Brood parasitism and/or egg destruction by brown-headed cowbirds was documented in two of 11 or 18 percent of the monitored nests, including one that was abandoned after a cowbird punctured the vireo eggs, and one that contained a single cowbird egg.

Vallecito Creek. Five of 11 vireo pairs monitored at the Vallecito Valley site of Vallecito Creek were successful in producing at least one fledgling. Of 13 total nest attempts observed, five (38 percent) successfully fledged young (Table 4), the lowest success rate observed among the monitoring sites. Nest failures included four caused by cowbird parasitism, two from egg destruction by cowbirds, one from predation during the incubation stage, and one abandoned for unknown reasons. Cowbird parasitism was nearly three times that at the other two monitoring sites, and was documented in 7 of 13 (54 percent) monitored nests, including three that contained cowbird eggs, two that contained cowbird nestlings and two that were abandoned after cowbirds punctured the vireo eggs.

Brown-headed Cowbird Parasitism

Brood parasitism was documented at six of the 11 sites occupied by vireos, including Upper, Middle, and Lower Willows on Coyote Creek, Borrego Palm Canyon, San Felipe Valley, and Vallecito Valley. Brood parasitism and/or cowbird-induced nest abandonment was documented in 32 percent or 11 of 34 total monitored nests and ranged from a low of 18 percent (two of 11 nests) at Coyote Creek to a high of 54 percent (seven of 13 nests) at Vallecito Valley. Parasitism within the San Felipe Creek monitoring area was 20 percent (two of 10 nests), all of which were located within San Felipe Valley. No parasitism was observed at the Sentenac Canyon site. Differences in cowbird parasitism rates among the nest monitoring areas are probably attributable to differences in cowbird control across the three sites, with trapping conducted at Lower Willows and San Felipe Creek, but not at Vallecito Valley.

Incidental observations of brood parasitism were documented within the non-monitored survey areas as well. At Upper Willows, a female cowbird was observed depositing an egg in a vireo nest on 10 May. At Middle Willows, two of four nests discovered were parasitized, including one on 3 May when a male cowbird was observed at a vireo nest (MW-04 pair) that was subsequently abandoned with small punctures in both vireo eggs, and another on 11 May when a single cowbird egg was removed from the nest of MW-03 pair. In Borrego Palm Canyon, Lori Hargrove observed a pair of adult vireos (BPC-01 pair) feeding a cowbird juvenile on 3 July.

The seasonal distribution of cowbird parasitism events, based upon nine estimated egg deposition dates, ranged from 25 April to 10 June (Figure 16). Vireo nest initiations, based upon 32 first egg deposition dates, ranged from 14 April to 16 June, with peak nest initiations occurring during the last week of April (Figure 16). Overall nest initiations by vireos was relatively late within the Anza Borrego study area during 2000, and with the exception of a single nest initiation on 14 April, vireo nesting did not begin until 22 April. There were no known nesting attempts by vireos after mid-June, and the last active nest successfully fledged on 12 July.

Adult brown-headed cowbirds were observed at eight of 14 sites surveyed, including Upper, Middle, and Lower Willows, San Felipe Valley, Sentenac Cienega, Sentenac Canyon, Tamarisk Grove, and Vallecito Valley (Appendix II). The number of cowbirds observed at each site varied and was dependent upon several factors, including but not limited to the number of visits per site, seasonal timing, and size of survey area. Sites with the largest number of

cowbirds included Vallecito Valley and the San Felipe Creek monitoring sites. Cowbirds were also noted within all three sites at Coyote Creek, although the number and frequency of cowbird observations within the Lower Willows and San Felipe Creek monitoring areas declined dramatically after mid-May, most likely a result of cowbird trapping efforts within those areas. The number of cowbirds observed within Vallecito Valley was consistently high throughout most of the study period and did not decline until mid- June. This apparent decline in cowbird numbers may have been the result of natural cowbird seasonal movements, or the removal of cattle grazing from the immediate area during mid-summer. While an accurate quantification of cowbird populations within the study area is not possible based upon simple cowbird observations during site visits, the number and behavior of individuals observed provide an indication of at which sites parasitism is likely to be high and whether current cowbird control efforts are providing adequate protection for nesting vireos.

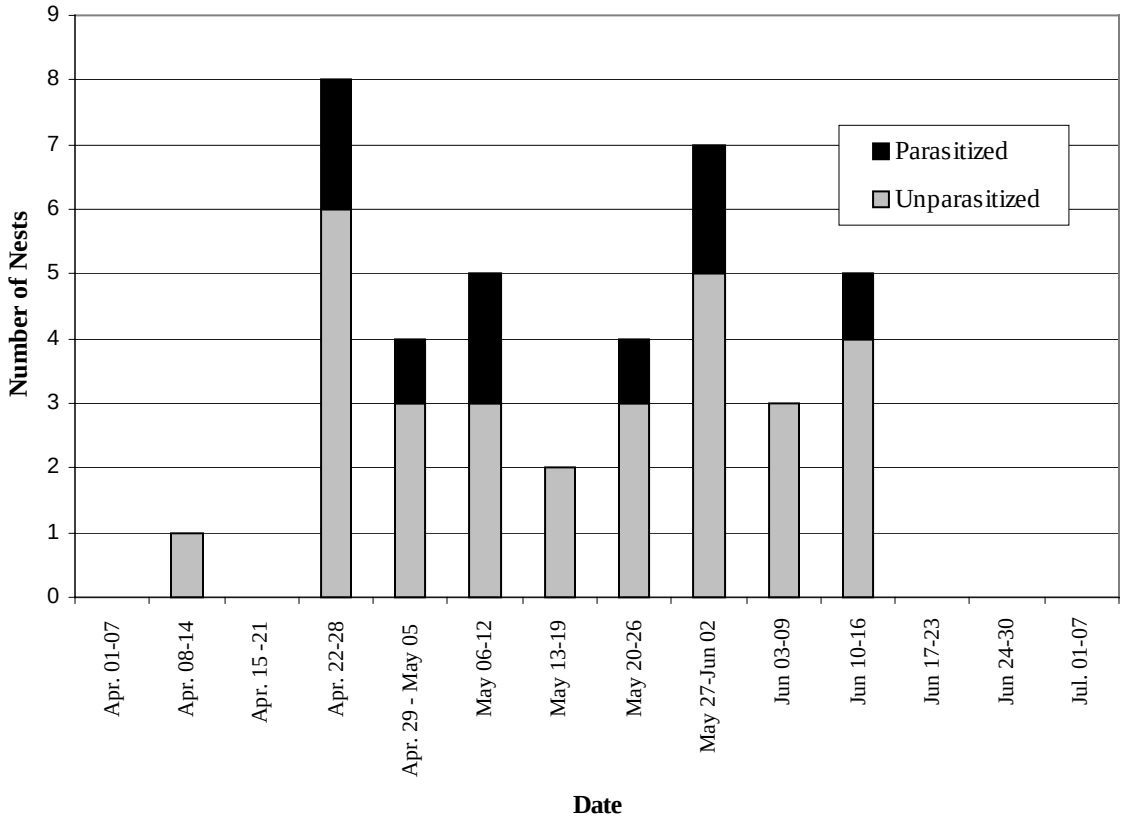


Figure 16. Seasonal distribution of vireo nest initiations and cowbird parasitism events within Anza Borrego study area, 2000.

Nest Site Characteristics

Eleven plant species were used as nest hosts by vireos within the study area (Table 5). Over 75 percent (29) of the 38 recorded nest sites were placed in mesquite, willow, or tamarisk. Additional species used include arrowweed (*Tessaria sericea*), saltbush, white alder, sycamore,

mule fat, and Mexican elderberry (*Sambucus mexicanus*). Nest height ranged from 0.58 to 2.50 m, with an average of 1.02 ± 0.34 m (N=35.

Table 5. Least Bell's vireo nest and host plant characteristics, Anza Borrego Desert, 2000.

		Nest Measurements			Host Plant Measurements			Distance from nest to:		
Territory ID No.	Nest no.	Ht. (m)	Dia. (cm)	Depth (cm)	Host Species	Ht. (m)	Dia. (m)	Host Edge (m)	Clump Edge (m)	Habitat Edge (m)
UW-01	1	-	-	-	Arroyo willow	6.00	-	-	3.50	10.0
MW-01	1	1.20	4.8	3.6	Arrowweed	3.50	0.85	0.20	6.00	20.0
MW-02	1	-	-	-	Arroyo willow	6.00	-	0.40	2.00	30.0
MW-03	1	-	-	-	Arroyo willow	-	-	-	4.00	10.0
MW-04	1	0.88	5.0	4.0	Slender willow	1.50	0.80	0.35	2.30	2.3
LW-01	1	0.85	5.2	4.6	Slender willow	2.25	1.00	0.30	2.50	6.0
LW-02	1	0.65	5.0	4.1	Slender willow	3.50	1.20	0.25	1.00	11.0
LW-04	1	1.35	-	-	White alder	7.50	3.50	0.40	1.00	4.0
LW-04	2	0.80	4.7	4.0	White alder	7.50	3.50	2.00	4.00	5.0
LW-07	1	0.85	5.1	4.0	Honey mesquite	3.00	6.00	2.50	3.00	45.0
LW-08	1	1.05	5.3	4.6	Honey mesquite	5.00	6.00	0.60	3.50	15.0
LW-09	1	1.10	-	-	Arroyo willow	4.00	2.00	0.18	4.00	40.0
LW-09	2	0.95	4.5	4.7	Tamarisk	3.00	5.00	1.00	3.00	50.0
LW-12	1	0.78	4.8	4.2	Slender willow	3.00	1.00	0.30	2.00	8.0
LW-14	1	0.83	-	-	Arrowweed	1.30	1.00	0.25	2.00	20.0
LW-14	2	1.10	4.4	4.0	Mulefat	1.50	0.80	0.20	1.20	35.0
SFV-01	1	0.80	4.7	3.8	Mesquite sp.	3.00	6.00	1.10	2.00	9.0
SFV-01	2	0.88	5.1	4.2	Mexican elderberry	4.50	3.00	0.40	3.00	45.0
SFV-02	1	1.15	5.0	4.1	Honey mesquite	6.00	4.00	1.50	4.00	35.0
SFV-03	1	1.00	4.6	3.8	Mesquite sp.	6.00	6.00	2.50	2.50	0.0
SFV-03	2	0.80	4.9	4.0	Tamarisk	5.00	3.00	0.40	0.80	2.0
SFV-04	1	1.40	-	-	Tamarisk	6.00	5.00	0.30	2.00	2.0
SFV-05	1	0.58	5.2	3.9	Sycamore	3.00	1.30	0.40	0.40	40.0
SC-04	1	1.03	4.8	4.2	Slender willow	3.00	0.70	0.20	3.00	6.0
SC-05	1	0.60	4.4	3.9	Arroyo willow	6.00	3.50	0.80	2.00	2.5
SC-07	1	1.20	-	-	Honey mesquite	3.00	5.00	1.70	2.50	8.0
VC-02	1	1.18	5.2	4.7	Honey mesquite	6.00	8.00	5.00	5.00	5.0
VC-04	1	0.80	4.8	3.5	Tamarisk	5.00	7.00	2.00	5.00	12.0
VC-04	2	2.50	-	-	Honey mesquite	6.50	8.00	3.00	6.00	20.0
VC-06	1	1.10	4.6	3.8	Honey mesquite	4.00	5.00	0.80	3.00	40.0
VC-06	2	1.40	4.4	3.8	Honey mesquite	6.50	8.00	1.10	5.00	35.0
VC-07	1	0.68	5.0	3.6	Honey mesquite	3.00	2.00	1.00	2.50	60.0
VC-08	1	0.80	-	-	Atriplex sp.	3.00	4.00	2.00	3.00	70.0
VC-09	1	0.92	5.3	4.7	Mesquite sp.	4.50	4.00	1.20	4.00	7.0
VC-10	1	1.10	4.7	4.5	Honey mesquite	5.00	6.00	2.50	4.00	5.0
VC-11	1	1.25	4.4	4.7	Saltbush	3.00	3.00	0.20	4.00	15.0
VC-12	1	0.93	4.6	3.7	Honey mesquite	7.00	7.00	4.00	4.00	40.0
VC-20	1	1.40	4.6	3.5	Tamarisk	5.00	5.00	2.00	5.00	12.0

Willow Flycatcher Observations

While no focused survey or monitoring efforts were performed for southwestern willow flycatchers (*Empidonax traillii extimus*), all observations of willow flycatchers were noted and mapped. When individual willow flycatchers were encountered, an effort was made to document their status and whether they were breeding residents. A total of 28 willow flycatchers were

detected within the study area, including 12 at Campbell Grade on 31 May, six at Vallecito Valley on 24 May, three at Sentenac Canyon on 3 June, two at San Felipe Valley on 5 June, and five at Lower Willows on 8 June. Follow-up surveys at these locations failed to detect any resident willow flycatchers. Based upon the known migration period for this species, it was determined that all of the individuals observed were likely migrating through the area. Because of this, it was not possible to verify whether the flycatchers observed were *E. t. extimus* or another subspecies (e.g. *E.t. adastus*).

DISCUSSION

Historical Survey and Monitoring Efforts

Least Bell's vireo survey and monitoring efforts within the Anza Borrego Desert have varied over the years in both effort and scope. Information on vireos within Anza Borrego Desert prior to 1986 is nominal, and apparently limited to surveys conducted by Sharon Goldwasser at Lower Willows, Sentenac Canyon, and Campbell Grade in 1978 (Goldwasser 1978), and by Art Morley within the Coyote Creek drainage, Hellhole Canyon and Borrego Palm Canyon between 1979 and 1985 (Wier and Jones 1986). The first comprehensive surveys and nest monitoring were conducted in 1986 by Harold Wier and Barry Jones, who documented a total of 32 singing male vireos within the Anza Borrego Desert State Park (Wier and Jones 1986). There were no recorded vireo surveys during 1987, and in 1988, vireo surveys were limited to a single-day survey on 31 May which documented a total of 17 singing male vireos within Lower Willows, Borrego Palm Canyon, Hellhole Canyon, and Sentenac Canyon (Griffith and Griffith 1988). In 1989, a more comprehensive survey and monitoring effort was initiated, documenting 31 singing males at seven of eight sites surveyed. While nest monitoring was conducted at six of these sites, premature cessation of these efforts on 20 June resulted in incomplete nesting data for many of the breeding pairs (Griffith and Griffith 1989). In 1990, eighteen male vireos were documented at four of five sites surveyed, with nest monitoring conducted at three sites (Jones 1990). In 1991, twenty-eight male vireos were documented at five of seven sites surveyed, with nest monitoring conducted at four sites (Pluff 1991). Between 1992 and 1999, vireo surveys were conducted by State Park personnel and volunteers. Survey efforts during this period were typically limited to single-day visits per site during April or May. While overall annual survey coverage was relatively consistent within the larger sites, smaller, less accessible sites were visited on an irregular basis. Nest monitoring between 1992 and 1999 was limited to Sentenac Canyon during 1992 and 1993, and anecdotal observations of nesting activity noted during surveys (Pluff 1992,1993; P. Jorgensen 1994, 1995, 1996; Jorgensen and Jorgensen 1997,1998,1999).

Cowbird Trapping Efforts

In addition to vireo surveys and nest monitoring, annual cowbird trapping was initiated within Anza Borrego Desert State Park in 1986 (Table 6). From 1986 to 1988, a total of six traps were operated annually, with efforts primarily targeting the Lower Willows site. During 1989 and 1990, trapping was expanded to include the Borrego Palm Canyon area. In 1991, the number of traps was increased to eight, and included traps at Lower Willows, Borrego Palm Canyon, Sentenac Canyon, Campbell Grade, Vallecito Valley, and Borrego Springs. During 1992, the number of traps was reduced to six as a result of the elimination of the Borrego Springs trap and the single trap operated within the Lower Willows riparian area. Cowbird trapping during 1993 was unchanged, with the exception of the Campbell Grade trap, which was shut down after only six days of operation. Trapping operations from 1994 to 1997 were relatively consistent from year to year, with two traps located near Lower Willows at the Vern Whitaker Horse Camp, one trap at Sentenac Canyon, and one trap at Vallecito Valley. Changes included the elimination of the Borrego Palm Canyon trap and the addition of a foraging area trap within Borrego Springs in 1995, as well as the addition of a trap at San Felipe Valley in 1997. From 1998 to 2000, a total of seven traps were operated, including two at the Vern Whitaker Horse

Camp, two to three traps within Borrego Springs, one trap at Sentenac Canyon, and one to two traps at San Felipe Valley. The Vallecito Valley trap was not operated after 1997, and there have been no traps south of the San Felipe Creek drainage since then.

Table 6. Number of cowbird traps, trapping locations, and total captures from 1986 to 2000, Anza Borrego Desert.

Year	Number of Traps within :	Cowbird Trapping Target Areas							Total Traps	Captures per habitat area	Total BHCO captures	Trapping Period
		Lower Willows	*Borrego Springs*	*Borrego Palm Cyn.*	*Sentenac Cyn.*	*San Felipe Valley*	*Campbell Grade*	*Vallecito Valley*				
	Riparian habitat	4							4	28		12-May
1986	Cowbird foraging area	1[a]	1[b]						2	28	56	29-Jun
	Riparian habitat	4							4			
1987	Cowbird foraging area	2[a]							2		50?	
	Riparian habitat	4							4	22		15-Mar
1988	Cowbird foraging area	2[a]							2	148	170	15-Jul
	Riparian habitat	3							3	16		12-Apr
1989	Cowbird foraging area	2[a]		1[c]					2	114	130	15-Jun
	Riparian habitat	3							3	6		15-Mar
1990	Cowbird foraging area	1[a]		2[c]					3	96	96	15-Jun
	Riparian habitat	1			1		1	1	4	109		6-Apr
1991	Cowbird foraging area	2[a]	1[b]	1[c]					4	143	252	*15-Jun
	Riparian habitat				1		1	1	3	95		5-Apr
1992	Cowbird foraging area	2[a]		1[c]					3	172	267	*15-Jun
	Riparian habitat				1		1**	1	2	118		10-Apr
1993	Cowbird foraging area	2[a]		1[c]					3	62	180	*15-Jun
	Riparian habitat				1			1	2	43		1-Apr
1994	Cowbird foraging area	2[a]							2	34	77	*10-Jun
	Riparian habitat				1			1	2			
1995	Cowbird foraging area	2[a]	1[d]						3		248	
	Riparian habitat				1			1	2			
1996	Cowbird foraging area	2[a]	1[d]						3		320	
	Riparian habitat				1	1		1	3	54		*24-Mar
1997	Cowbird foraging area	2[a]	1[d]						3	344	398	*1-Jun
	Riparian habitat				1	1			2	34		17-Apr
1998	Cowbird foraging area	2[a]	3[d]						5	162	196	29-Jun
	Riparian habitat				1	2			3	72		*22-Mar
1999	Cowbird foraging area	2[a]	2[d]						4	139	211	*13-Jun
	Riparian habitat				1	2			3			
2000	Cowbird foraging area	2[a]	1[d]						3			

Sources: Wier and Jones 1986; Griffith and Griffith 1987, 1988, 1989; Jones 1990; Pluff 1991, 1992, 1993; Jorgensen and Jorgensen 1994, 1995, 1996, 1997, 1998, 1999, 2000.

* Approximate start and end dates, traps operated for varying periods, averaging 60-65 days.

** Trap closed permanently after six days of operation.

[a] Cowbird foraging area trap(s) at Vern Whitaker Horse Camp, approx. four km (2.5 mi.) from Lower Willows.

[b] Cowbird foraging area trap at Riviera Farms, Borrego Springs.

[c] Cowbird foraging area trap near Park Headquarters and mouth of Borrego Palm Canyon.

[d] Cowbird foraging area traps at Circle K Ranch and Emu Farm, Borrego Springs.

Current Least Bell's Vireo Population

Recent Population Trends

The total number of male least Bell's vireos detected within the study area during 2000 was 26 percent higher than the total recorded in 1999 (Table 6). This increase is largely attributable to an increase in the number of vireos detected at Vallecito Valley, and the addition of vireo sightings in new locations provided by the San Diego County Bird Atlas personnel.

Table 7. Least Bell's vireo populations within Anza Borrego Desert from 1978 to 2000.

Drainage	Location / Section	Survey year and number of territorial male vireos															
		1978	1985	1986[a]	1988	1989[a]	1990[a]	1991[a]	1992[a]	1993[a]	1994	1995	1996	1997	1998	1999	2000[a]
Coyote Creek	*Upper Willows*			0						2	1		0	1	0	2	1
	Middle Willows			0		0	0	0		5	5		2	4	5	5	5
	Lower Willows	8	13	9	8	10	10	12	17	11	16	14	16	14	21	19	18
	Horse Canyon										1	1	0	0	1		
	Alder Canyon			0													
	Salvador Canyon									0			1	0	0		
	Sheep Canyon		1	0						0	1		1	0		1	
	Cougar Canyon		1	0						0	0			0			
	Indian Canyon			1						0	2						
Hellhole Canyon	*Hellhole Canyon*		2	5	1	2	2	0	0			0	2	1	2	1	
Borrego Palm Canyon	*Borrego Palm Canyon*		6	7	6	4	4	4	5	5	2	3	1	5	3	3	6
San Felipe Creek	*Angelina Spring*											0			0	0	0
	Yaqui Well										1	1	1	0	1	1	0
	Tamarisk Grove											1	0	0	1	0	0
	San Felipe Valley[1]			1		2								1	3	4	5
	Sentenac Cienega/Canyon[2]	1		5	2	2	2	2	5	8	4	12	13	8	18	10	9
Vallecito Creek	*Campbell Grade*	1		2		5		6	7	18	12	12	19	13	17	14	13
	Vallecito Valley[3]			2		5		3	11	8	14	23	33	27	29	9	20
Agua Caliente Springs	*Agua Caliente Co. Park*			0									2	2	2	2	2
Carrizo Creek	*Carrizo Marsh*								3	1	0	1	1	5	1	1	2
	Carrizo Canyon			0													1
	Jacumba Jim Canyon												1			0	1
Bow Willow Creek	*Bow Willow Creek*			0							0					0	2
	Bow Willow Palms																5
Fish Creek Wash	*Fish Creek Wash*																1
Canebrake Canyon	*Canebrake Canyon*												1		0		
Total territorial males		**10**	**23**	**32**	**17**	**31**	**18**	**28**	**48**	**58**	**59**	**68**	**94**	**81**	**104**	**72**	**91**

Gray shading denotes years with cowbird control.
Sources: Goldwasser 1978; Wier and Jones 1985, 1986; Griffith and Griffith 1988, 1989; Jones 1990; Pluff 1991, 1992, 1993; Jorgensen 1994, 1995, 1996, 1997, 1998, 1999; Wells and Kus 2000.
[a] Years in which some level of nest monitoring occurred.
[1] San Felipe Valley area: San Felipe Creek from current State park boundary downstream to Scissors Crossing.
[2] Sentenac Canyon and Cienega: San Felipe Creek from Scissors Crossing downstream to gaging station.
[3] Vallecito Valley: including areas known as Vallecito Wash, Vallecito Cienega, and Vallecito Stage Station County Park.

While determining accurate vireo population trends is complicated by year-to-year inconsistencies in site coverage, observer effort, and seasonal timing of surveys, the least Bell's vireo population within Anza Borrego Desert appears to have increased steadily from 1991 to 1996, and then stabilized at approximately 100 territorial males (Table 6). With the exception of Vallecito Valley, the number of vireos within the most consistently surveyed areas has remained relatively stable over the last eight years (Figure 17). Apparent fluctuations within the Vallecito Valley population between 1998 and 2000 are most likely the result of a combination of factors, including variable survey effort, removal of habitat from a portion of the area during early 1999 (M. Jorgensen, Anza Borrego State Park, pers. comm.), and the exceptionally late Spring arrival of vireos rangewide in 1999 (pers. obs., P. Beck, USGS, pers. comm., P. Famolaro, Sweetwater Authority, pers. comm.), which may explain the low numbers recorded at that site during the single 9 May survey.

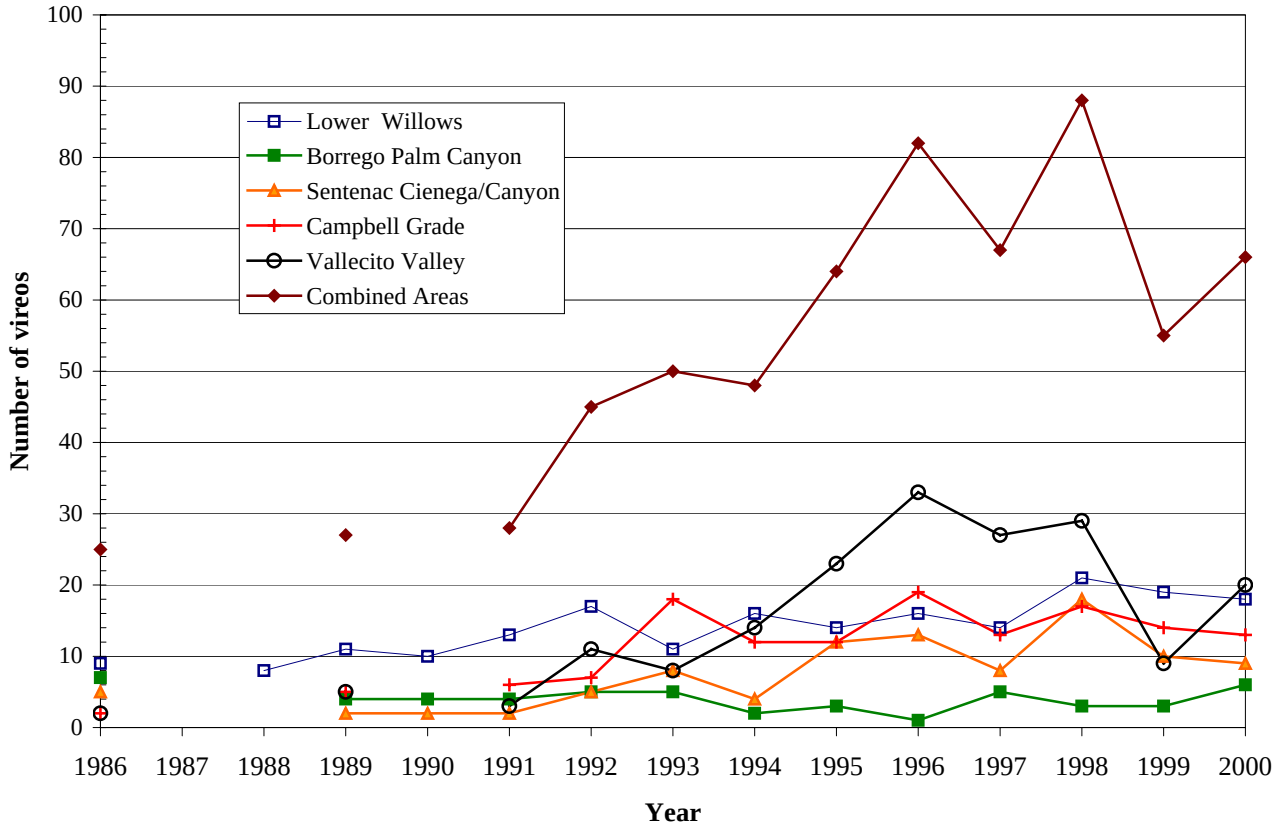


Figure 17. Least Bell's vireo population trends at five sites within the Anza Borrego Desert from 1986 to 2000.

Potential Factors Limiting Population Growth

Possible reasons for the apparent population stabilization within Anza Borrego Desert include limitations on habitat availability, productivity, and recruitment, as well as the effect of rangewide factors unrelated to site conditions within Anza Borrego Desert.

Habitat Availability. Population trends within the most consistently surveyed sites indicate that some of these areas may have reached carrying capacity and that habitat availability is the principal factor determining the current size of the Anza Borrego Desert vireo population. At sites such as Borrego Palm Canyon, Sentenac Canyon and Campbell Grade, physical factors influencing habitat availability such as topography, geology, and hydrology are easily recognized as factors limiting vireo populations. At larger sites such as Vallecito Valley, San Felipe Valley, and to some extent, Coyote Creek, habitat availability appears to be adequate for some level of continued vireo population growth. Historical information on vireo populations within Anza Borrego Desert indicate that while vireo populations were small and limited in distribution, unoccupied and apparently suitable habitat was available within many of the survey areas (Wier and Jones, Griffith and Griffith 1989). While annual habitat availability and suitability was, and still is, subject to natural as well as human-caused impacts such as grazing, recreational activities, fires, annual precipitation, drought, and scouring by floods, overall habitat availability did not appear to be a limiting factor for many of the historical vireo populations within Anza Borrego Desert, particularly within the State Park.

Productivity. Overall nest success and productivity for vireo populations monitored between 1986 and 2000 within Anza Borrego Desert has ranged from a low of 38 percent and 1.2 fledglings per pair in 1989 (Griffith and Griffith) to a high of 89 percent and 3.1 fledglings per pair in 1991 (Pluff), with average nest success rate and productivity over all four years at 57 percent and 1.9 fledglings per pair, respectively (Table 8).

Table 8. Overall nest success and productivity of least Bell's vireo populations in Anza Borrego Desert between 1986 and 2000.

Year and No. sites monitored	No. monitored pairs	No. monitored nests	Percent and (N) successful nests	Total No. eggs observed	Percent and (N) eggs hatched	Percent and (N) nestlings fledged	Percent and (N) of nests parasitized	Percent and (N) of parasitized nests that fledged vireo young	Percent and (N) nests predated / abandoned	Avg. clutch size ± std dev. N=unparasitized	Fledglings per / monitored pair
1986 5[a]	20	30	53% (16)	62	58% (38)	100% (38)	57% (17)	35% (6)	20% (6)	3.7 ± 0.8 (12)	1.9
1989 6[b]	22	26	38% (10)	?	-	-	19% (5)	40% (2)	42% (11)	-	1.2
1990 3[c]	10	12	50% (6)	35	51% (18)	89% (16)	8% (1)	0% (0)	42% (5)	3.4 + ? (10)	1.6
1991 4[d]	21	28	89% (25)	87	76% (66)	98% (65)	11% (3)	33% (1)	4% (1)	-	3.1
2000 4[e]	28	34	53% (18)	78	65% (51)	100% (51)	32% (11)	27% (3)	24% (8)	3.3 ± 0.6 (18)	1.9

[a] Lower Willows, Indian Canyon, Hellhole Canyon, Borrego Palm Canyon, Sentenac Canyon
[b] Lower Willows, Hellhole Canyon, Borrego Palm Canyon, Sentenac Canyon, Campbell Grade, Vallecito Valley
[c] Lower Willows, Hellhole Canyon, Borrego Palm Canyon
[d] Lower Willows, Borrego Palm Canyon, Sentenac Canyon, Vallecito Valley
[e] Lower Willows, Sentenac Canyon, San Felipe Valley, Vallecito Valley
Sources: Wier and Jones 1986; Griffith and Griffith 1989; Jones 1990; Pluff 1991; Wells and Kus 2000.

For comparison, nest success rates and productivity of vireos at the western San Luis Rey River in coastal San Diego County between 1989 and 1999 have ranged between 50 and 88 percent and 1.7 to 3.3 fledglings per pair, respectively (Kus 1989, 1990, 1991, 1992, 1993;

Griffith 1994, 1995, 1996; Wells and Turnbull 1997, 1998a, 1999). Long-term averages for these parameters in other populations include the Sweetwater River with 61 percent and 2.5 fledglings per pair (1989-93), Tijuana River Valley with 73 percent and 2.8 fledglings per pair (1990-94), and the Santa Margarita River with 66 percent and 2.7 fledglings per pair (1980-94) (U.S. Fish and Wildlife Service 1998). Thus, while nest success rates within Anza Borrego Desert have been comparable to those documented for other vireo populations under long-term study, seasonal productivity, expressed as fledglings per pair, has been lower.

Extending these comparisons to include factors influencing productivity, it appears that the comparatively low productivity observed within the Anza Borrego Desert vireo population is primarily the result of low hatch rates, since fledging rates are higher (average = 97 percent) than those at other sites (U.S. Fish and Wildlife Service 1998). In Anza Borrego Desert, the overall hatch rates of monitored vireo populations have ranged between 51 and 76 percent, with an average of 62.5 percent, considerably lower than at other populations such as the western San Luis Rey River (average = 75 percent), Sweetwater River (70 percent), and the Santa Margarita River (83 percent) (U.S. Fish and Wildlife Service 1998). The primary reasons for the low hatch rates at Anza Borrego Desert are brood parasitism and nest predation during the incubation stage. While overall parasitism rates and hatch rates within the combined Anza Borrego vireo populations have fluctuated from year to year, individual populations that have been subject to consistent cowbird control on a long-term basis, such as Lower Willows and Sentenac Canyon, have exhibited a decrease in parasitism rate and an increase in hatch rate (Table 9).

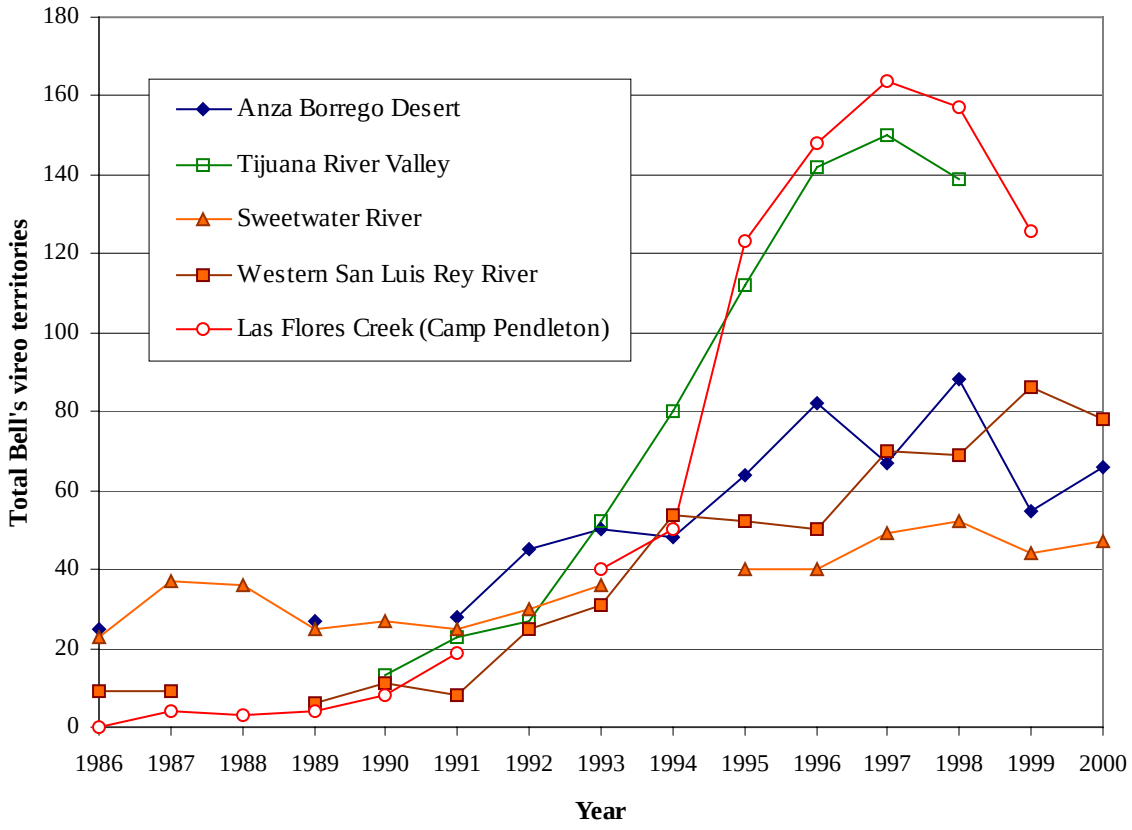
Table 9. Nest success and productivity of least Bell's vireos at three sites between 1986 and 2000, Anza Borrego Desert.

Year	Cowbird trapping	No. monitored pairs	No. monitored nests	Percent and (N) successful nests	Total No. eggs	Percent and (N) eggs hatched	Percent and (N) nestlings fledged	Percent and (N) nests parasitized	Percent and (N) nests predated / abandoned	Ave. clutch size ± std dev. N=unparasitized	Fledglings per monitored nest	Fledglings per / monitored pair
		San Felipe Creek (Sentenac Canyon)										
1986	N	4	4	75% (3)	12	58% (7)	100% (7)	50% (2)	25% (1)	3.0 ±0.0 (3)	1.8	1.8
1991	Y	2	3	66% (2)	8	75% (6)	100% (6)	33% (1)	0	-	2.0	3.0
1992	Y	5	6	33% (2)	-	-	(6)	17% (1)	66% (4)	-	1.0	1.2
1993	Y	4	4	100% (4)	-	-	(12)	0	0	-	3.0	3.0
2000	Y	3	3	100% (3)	8	100% (8)	100% (8)	0	0	2.7± 0.6 (3)	2.7	2.7
		Coyote Creek (Lower Willows)										
1986	Y	8	15	47% (7)	29	55% (16)	100% (16)	80% (12)	20% (3)	3.4 ± 0.9 (5)	1.6	2.0
1989	Y	?	11	27% (3)	21	38% (8)	100% (8)	0	73% (8)	-	0.7	-
1990	Y	6	8	50% (4)	23	43% (10)	80% (8)	0	50% (4)	-	1.1	1.3
1991	Y	12	17	94% (16)	57	75% (43)	98% (42)	0	6% (1)	-	2.5	3.5
2000[a]	Y	9	11	55% (6)	29	66% (19)	100% (19)	18% (2)	36% (4)	3.4 ± 0.5 (9)	2.1	2.1
		Vallecito Creek (Vallecito Valley)										
1991	Y	3	3	100% (3)	11	100% (11)	100% (11)	0	0	-	3.0	3.7
2000	N	11	13	38% (5)	23	52% (12)	100% (12)	54% (7)	7% (2)	3.0 ± 0.0 (4)	1.1	1.1

[a] Cowbird traps operated within 4.0km (2.5 miles) of site.

Recruitment. Recruitment within the Anza Borrego Desert vireo populations most likely occurs from within the immediate region, with larger populations such as Coyote Creek and Vallecito Creek contributing the most to colonization of other sites within the region. Least Bell's vireos elsewhere in their range exhibit a settlement pattern whereby population growth and expansion begins with large core populations expanding within the immediate area first, followed by more distant locations (Kus, unpubl. data, U.S. Fish and Wildlife Service 1998). Although no color-banding studies of dispersal have been conducted within the Park, it is likely that Park vireo populations are sustained primarily through internal recruitment rather than by immigration from populations outside of the desert. This is supported by the results of extensive color-banding efforts throughout the vireo's range, which have failed to document any movement of banded birds into the Anza Borrego Desert (Kus,unpubl. data; U.S. Fish and Wildlife Service 1998).

Other factors. In addition to habitat availability, productivity and recruitment, population trends within Anza Borrego Desert may be subject to limitations originating outside of the breeding range from factors not yet identified. Recent vireo population trends within San Diego County indicate an overall stabilization or possibly even a slight decline in vireo numbers rangewide (Figure 18).



Sources: Kus 1996, Wells and Turnbull 1998b (Tijuana River Valley); Sweetwater Authority 2000 (Sweetwater Reservoir); Griffith and Griffith 1999 (Las Flores Creek); Kus 1993, Wells and Turnbull 2000 (San Luis Rey River).

Figure 18. Least Bell's vireo population trends at five locations within San Diego County, CA, from 1986 to 2000.

CONCLUSIONS AND RECOMMENDATIONS

Based upon the results of this study as well as historical information from previous survey and monitoring studies, the least Bell's vireo population within Anza Borrego Desert appears to be stable and capable of continued stability and even expansion within certain areas. While overall productivity is somewhat lower than in other vireo populations, it is not at a level producing a decline or threatening the continued stability of the population. While brood parasitism still persists within many areas of Anza Borrego Desert, the effects appear limited with regard to the population as a whole. Brood parasitism and nest predation appear to be equally important within the study area as factors influencing nest success. In years when brood parasitism was relatively low, nest predation was high, resulting in approximately the same nest success across years. Given the limited accessibility of many riparian areas and vireo locations, increased cowbird trapping is unlikely to eliminate parasitism entirely. The single exception to this is Vallecito Valley, where some level of trapping would likely reduce parasitism substantially. The value of trapping at Vallecito Valley would need to be balanced, however, against the considerable logistics and funding involved in operating a trap so far removed from current trapping locations.

Future management for the least Bell's vireo as well as other riparian obligate bird species within Anza Borrego Desert should focus on habitat preservation, primarily through the continued acquisition of riparian habitat existing on private property. Twenty-nine of 91 (32 percent) vireo locations documented during this study occurred on private property, and 26 of these locations were within mesquite woodland habitat. While mesquite habitat has been recognized as an important habitat type for many wildlife species, it is not afforded the same protection as riparian or wetland habitats. The recent addition of the San Felipe Creek property to the Park exemplifies the importance of this management direction and is invaluable in the protection and preservation of large areas of habitat, as well as sensitive species.

Future vireo survey and monitoring efforts within Anza Borrego Desert should be tailored to specific goals, which can vary depending on resource management needs. To obtain information on the abundance and distribution of vireos in the Park for general trend assessments, we recommend continuation of volunteer-based survey efforts. While there are limitations in the nature and extent of data collection feasible through volunteer efforts, the surveys conducted between 1993 and 1999 were effective in documenting the general status of vireo populations within Anza Borrego Desert. Suggested modifications to current survey efforts that would provide additional information in a consistent manner include:

- Establish primary census areas that are surveyed in a consistent and comprehensive manner. Locations such as Lower Willows, Sentenac Canyon, San Felipe Valley, Campbell Grade, and Vallecito Valley should be surveyed first, followed by additional sites if time and personnel are available.

- Conduct two surveys within these primary areas to better document breeding status and nesting activity through, for example, observations of a pair within the territory, and evidence of nesting such as nest-construction activities, carrying food, or the presence of fledglings.

- Conduct surveys during late May and mid-June to increase information on fledging success and parasitism, as evidenced by adults tending vireo or cowbird young.

- Standardize surveys with regard to date, time of day, survey route, survey area, and survey intensity.

Nest monitoring is not a necessary accompaniment to surveys, particularly on an annual or even bi-annual basis. However, future monitoring would be useful in addressing specific questions regarding the Park's vireo population. For example, nest monitoring could be conducted to document the effectiveness of cowbird control by comparing productivity and population growth in trapped and untrapped areas. Similarly, it would be valuable in quantifying parasitism rates in areas where experimental trapping protocols are being tested. For example, it may be possible to reduce parasitism rates within Vallecito Valley to a negligible level with a single trap operated for just two weeks, rather than several traps over the entire breeding season. Nest monitoring combined with banding of vireo nestlings would provide information on recruitment and dispersal patterns within Anza Borrego Desert, and help identify the extent to which the desert is linked to other vireo populations through dispersal. We recommend that these and other objectives relating to the Park's information needs be prioritized and pursued in a systematic fashion to best enable effective resource stewardship.

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Appendix I. 2000 Anza Borrego Desert survey dates, times, and weather conditions.

Date	Location	Field Time Start	End	Hrs.	Weather Start	End	Wind Start	End	Temp. F Start	End
15-Apr	San Felipe Valley	0620	1145	5.42	clear - clear		1	1	50 - 74	
18-Apr	Lower Willows	0800	1415	6.25	cloudy-cloudy		1	3	55 - 60	
22-Apr	Palm Canyon	0600	1300	7.00	clear - clear		1	2	50 - 70	
24-Apr	Sentenac Cienega/Canyon	0700	1200	5.00	clear - clear		0	0	50 -	
25-Apr	Vallecito Valley	0630	1130	5.00	clear - clear		1	1	-	
29-Apr	Lower Willows	0645	1200	5.25	clear - clear		1	2	50 - 75	
30-Apr	San Felipe Valley	0600	1330	7.50	clear - clear		1	3	55 - 75	
3-May	Middle Willows	0730	1600	8.50	clear - clear		1	2	65 - 75	
4-May	Middle Willows	0645	1030	3.75	clear - clear		0	1	60 - 70	
7-May	Vallecito Valley	0700	1300	6.00	clear - clear		0	1	-	
10-May	Upper Willows	0730	1200	4.50	clear - clear		3	5	65 - 70	
11-May	Upper / Middle Willows	0600	1100	5.00	clear - clear		4	4	60 - 65	
13-May	Sentenac Cienega/Canyon	0645	1100	4.25	clear - clear		2	3	65 - 70	
13-May	Tamarisk Grove & Yaqui Well	1130	1400	2.50	clear - clear		2	3	70 - 75	
15-May	San Felipe Valley	0700	1200	5.00	clear - clear		2	3	65 - 75	
16-May	Lower Willows	0600	1300	7.00	clear - clear		3	4	60 -	
20-May	Vallecito Valley	0700	1100	4.00	clear - clear		1	1	65 - 85	
21-May	San Felipe Valley	0730	1200	4.50	clear - clear		0	1	65 -	
22-May	Vallecito Valley	0600	1030	4.50	clear - clear		0	1	65 - 80	
24-May	Vallecito Valley	0530	1230	7.00	clear - clear		0	2	70 - 90	
31-May	Campbell Grade	0530	1100	5.50	clear - clear		2	4	70 - 100	
2-Jun	Agua Caliente	0600	1000	4.00	clear - clear		1	1	70 - 85	
3-Jun	Sentenac Cienega/Canyon	0600	1200	6.00	clear - clear		0	2	70 -	
3-Jun	Angelina Spring	1300	1330	0.50	clear - clear		-	-	-	
5-Jun	San Felipe Valley	0520	1140	6.33	clear - clear		2	3	65 - 90	
8-Jun	Lower Willows	0615	1415	8.00	clear - clear		3	2	70 - 85	
9-Jun	Vallecito Valley	0530	1100	5.50	clear - clear		0	1	70 - 95	
10-Jun	Lower Willows	0645	1200	5.25	clear - clear		2	1	70 - 85	
16-Jun	Vallecito Valley	0530	1100	5.50	clear - clear		0	2	85 - 105	
16-Jun	Sentenac Canyon	1200	1400	2.00	clear - clear		2	2	95 - 95	
22-Jun	San Felipe Valley	0545	1330	7.75	clear - clear		0	1	70 - 95	
24-Jun	Lower Willows	0600	1300	7.00	clear - clear		1	-	-	
1-Jul	Campbell Grade	0530	0730	2.00	clear - clear		-	-	-	
1-Jul	Vallecito Valley	0800	1200	4.00	clear - clear		0	1	75 - 100	
7-Jul	Lower Willows	0600	1130	5.50	clear - clear		0	1	70 - 90	
8-Jul	San Felipe Valley/Sentenac Cyn.	0615	1230	6.25	clear - clear		1	2	70 - 90	
12-Jul	Campbell Grade	0545	0645	1.00	clear - clear		0	0	70 -	
12-Jul	Vallecito Valley	0715	1040	3.42	clear - clear		0	-	75 - 100	
13-Jul	San Felipe Valley	0600	1100	5.00	clear - clear		0	1	70 - 90	
Total field days - 34		Total field hrs. 198.5								

Appendix II. Brown-headed cowbird observations, year 2000 vireo surveys, Anza Borrego Desert.

Date	Location	Number observed	Comments
15-Apr	San Felipe Valley	5-6	female cowbird following vireo pr.
18-Apr	Lower Willows	0	
22-Apr	Borrego Palm Canyon	0	
24-Apr	Sentenac Cienega/Canyon	2 males	
25-Apr	Vallecito Valley	5 (2m, 3f)	
29-Apr	Lower Willows	2 (1m, 1f)	
30-Apr	San Felipe Valley	4(2m,2f)	
3-May	Middle Willows	3 (2m,1f)	
4-May	Middle Willows	1 female	
7-May	Vallecito Valley	8	foraging with cattle
10-May	Upper Willows	4 (3m,1f)	
11-May	Middle Willows	1 male	
13-May	Sentenac Cienega/Canyon	2 males	
13-May	Tamarisk Grove	1 male	
15-May	San Felipe Valley	2 (1m,1f)	
16-May	Lower Willows	1 male	
20-May	Vallecito Valley	3 (1m,2f)	1-female banded with metal FWS
21-May	San Felipe Valley	0	
22-May	Vallecito Valley	5 (3m,2f)	male cowbird following vireo pr.
24-May	Vallecito Valley	13 (5m,8f)	1-male banded with red FWS
31-May	Campbell Grade	0	
2-Jun	Agua Caliente	0	
3-Jun	Sentenac Cienega/Canyon	0	
3-Jun	Angelina Spring	0	
5-Jun	San Felipe Valley	2 males	
8-Jun	Lower Willows	0	
9-Jun	Vallecito Valley	5	
10-Jun	Lower Willows	0	
16-Jun	Vallecito Valley	3	
16-Jun	Sentenac Cienega/Canyon	0	
22-Jun	San Felipe Valley	1	
24-Jun	Lower Willows	0	
1-Jul	Campbell Grade	0	
7-Jul	Lower Willows	0	
12-Jul	Vallecito Valley	0	
13-Jul	San Felipe Valley	0	