Brown-headed Cowbird and Avian Population Monitoring in Anza-Borrego Desert State Park

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EXECUTIVE SUMMARY

Brown-headed Cowbird (*Molothrus ater*) parasitism has long been recognized as a primary factor in the decline of several federally listed songbirds, including the Least Bell's Vireo (*Vireo bellii pusillus*). As a result, cowbird control has been implemented throughout the range of the vireo. Evidently, this has been a successful strategy given that vireo numbers have greatly increased over the past thirty years. Cowbird trapping in Anza-Borrego Desert State Park (ABDSP) began in 1986, and this continued effort coincides with increases in the vireo population from 35 territories in 1986 to 220 in 2016. Given these past efforts, trapping program costs, and trapping risks to non-target native breeding birds, park environmental scientists are interested in evaluating cowbird and native bird populations known to be at risk of cowbird parasitism, in order to assess and inform the park's cowbird trapping program.

To begin the cowbird assessment process, ABDSP ceased cowbird trapping in 2017 and contracted the Southern Sierra Research Station (SSRS) to conduct point count surveys in six riparian sites (Campbell Grade, Lower Willows in Coyote Canyon, San Felipe North, San Felipe South, Sentenac Cienaga, and Vallecito Cienaga) within five geographic areas in 2017 (San Felipe North and San Felipe South are two adjacent geographic portions of the larger San Felipe area). Relatively few cowbirds were detected in all five areas with the average number detected per survey ranging from one to six. Similarly, female cowbirds were found in very low numbers, averaging between zero and two females per survey. Between 2017 and 2020, average cowbird detections (both male and female) across all sites increased from 1.5 to 3.06 cowbirds and the number of female cowbirds detected per survey increased from an average of 0.33 to 0.89 per site.

Similar to the Brown-headed Cowbird detection trend, between 2017 to 2020, the average number of birds detected at survey points also increased, from 12.6 to 13.7. During this time, the Least Bell's Vireo remained one of the most detected species on our point-count surveys, although the average number detected at survey sites declined slightly from 32 to 29.5 from 2017 to 2020.

Species with the greatest estimated densities were Bewick's Wren, Least-Bell's Vireo, Verdin, and House Finch. On average, across the three survey years, the Least Bell's Vireo was the second highest counted species during our surveys and had the second

highest estimated density. They were detected at all six sites and were most abundant at Vallecito Cienaga, Campbell Grade, and Lower Willows survey sites. Sentenac Cienaga, both for 2020 and for the 3-year average, had the lowest bird counts and density estimates, but had the highest species richness. We attribute this to a high degree of habitat diversity (cattail wetland, cottonwood riparian, mesquite bosque, open grassland, and rocky desert upland) and topography that appeared to funnel migrating songbirds through the site.

We recommend that ABDSP continue to suspend its cowbird trapping program and continue to monitor cowbird and other bird populations. In addition, the park should be ready to initiate small scale targeted cowbird control measures (e.g., target mist netting or setting up a trap for a short time period) in case an increased number of female cowbirds (e.g., average of 1 female per point count station) are detected in one of the study sites. Lastly, strongly consider monitoring a subset of Least Bell's Vireo nests for several years to assess the impact of higher cowbird numbers and to also provide data for building a model to predict parasitism rates based on female cowbird numbers.

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INTRODUCTION

Brown-headed Cowbirds (*Molothrus ater*, hereafter "BHCO" or "cowbird") are obligate brood parasites. They do not build their own nests, instead they lay their eggs in other bird species' nests, often removing or damaging a host's egg as well (Payne 1977, Sealy 1992, Sealy 1994, Peer and Sealy 1999). Cowbirds, while native to the United States, are not native to most of California, and expanded into the state in the late 1800s after suitable habitat was created through the clearing of land for agriculture (Laymon 1987, Rothstein 1994).

Cowbird parasitism has been attributed as one of the primary factors in the decline of several federally listed songbird species, such as Kirtland's Warbler (*Setophaga kirtlandii*), Black-capped Vireo (*Vireo atricapilla*), and Least Bell's Vireo (*Vireo bellii pusillus*, hereafter "LBVI" or "vireo") (Rothstein and Cook 2000). Thus, cowbird control has become a common tool to help increase populations of threatened or endangered birds that are susceptible to cowbird parasitism. These efforts have been largely successful at reducing parasitism and increasing productivity, though the results have been mixed on increasing population sizes (Kus and Whitfield 2005, Rothstein and Cook 2000, Hall and Rothstein 1999).

The LBVI has benefitted from cowbird trapping (Kus 1999). Across its range, LBVI abundance has increased from an estimate of 291 pairs when it was listed in 1985 to 2968 territories in 2005 (USFWS 2006). Cowbird trapping has been used as a management tool for LBVIs in Anza-Borrego Desert State Park (ABDSP) since 1986 and has very likely helped increase the vireo population from 35 territories in 1986 to 220 territories in 2016 (McDonald et al. 2011 Clark and Hyland 2017).

However, there has been very little analysis to examine cowbird populations and assess the impact and continued need for cowbird control. It has been long recognized that cowbird trapping has costs, in terms of monetary expense, and its impact to non-target species that are inadvertently captured in the traps (Hall and Rothstein 1999, Rothstein and Cook 2000, Rothstein et al. 2003, Ortega et al. 2005). Clark and Hyland (2017) recommended that the cowbird program at ABDSP be re-evaluated and to monitor cowbirds to determine where cowbird traps should be placed. These recommendations, as well as the low numbers of cowbirds trapped in recent years in the park, led to the cessation of cowbird trapping in 2017, and form the basis by which to assess the park's baseline conditions with regards to cowbirds, nesting birds, and cowbird control absent the potential confounding effects of cowbird trapping.

The purpose of this study was to estimate the number of cowbirds in several riparian areas that contain LBVI, as well as obtain estimates of other bird species at these sites. We will use these data to assess the need for cowbird control in these riparian patches and to make management recommendations for future cowbird control.

METHODS

Study Area. Study sites were located in Anza-Borrego Desert State Park, located in San Diego County, in southern California. ABDSP is the largest State Park in California, encompassing approximately 240,000 hectares. We surveyed six sites (Lower Willows in Coyote Canyon, San Felipe Creek North, San Felipe Creek South, Sentenac Cienega, Campbell Grade and Vallecito Cienega) within five geographic areas (Figure 1).

Point count surveys. In 2017, we set up six point-transects (sites) within the five survey areas, with the large San Felipe Creek area containing two separate point-transects: San Felipe North and San Felipe South. The number of point count stations within a transect varied due to differences in the size of the study site: San Felipe North (10), San Felipe South (10), Sentanac Cienega (12), Campbell Grade (6), Vallecito (10), Lower Willows (Coyote Canyon, 9). These 57 point count stations were surveyed three times each in 2017, 2019, and 2020.

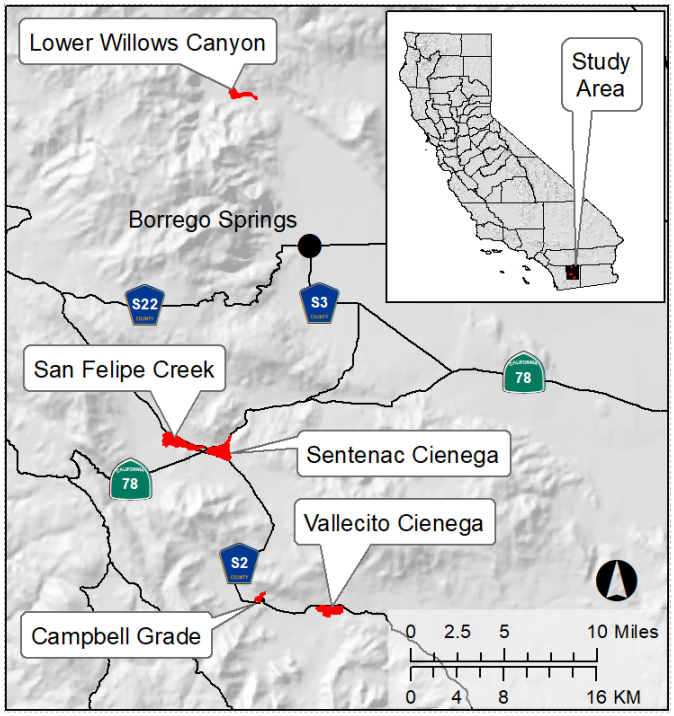

Figure 1. Location of five point count areas in Anza-Borrego Desert State Park, CA.

We spent five minutes at each point count station recording all birds detected within 125m. We recorded how each bird was detected (aural and/or visual), age (adult, local nestling, juvenile, adult or unknown), sex (if known), the estimated distance to the bird (using a rangefinder), and the surveyor who collected the data. Point counts were generally conducted 15 minutes before sunrise to 0900. However, there were a few instances (mostly during the first round in 2017) when counting was extended to 1000 in order to finish a transect.

Data analysis. Bird observations were summed and averaged to calculate total and average observed species abundances per point count station and by survey site (tables 1-3, Appendix 1). We calculated species richness per point count station and survey area by summing the total number of observed species.

We estimated species-specific detection probabilities to calculated species densities using the statistical software R with the Distance package (R Core Team 2020, Miller et al. 2019). The ability to detect a species is often greatly affected by a bird's distance from the observer, but can also be affected by species specific characteristics (e.g. size, color, movement, call frequency, and call volume), the surrounding environment (e.g. vegetation height and density), and observer ability (Buckland et. al 2001). The minimum number of independent detections recommended to model the detection function is relatively large, 75-100 for point-count data, and for some species greater sample sizes may be required to make robust estimates (Buckland et al. 2001). Detection probability and subsequent density estimates achieve increased precision with increased observations and are potentially biased or inaccurate with decreasing sample sizes (Buckland et al. 2015). We analyzed species data separately due to the variable detectability among species. For each species for with at least 75 independent detections, from the combined 2017, 2019, and 2020 datasets, we calculated species specific detection probabilities to estimate respective species densities. Estimates of precision for the density estimates were also calculated and include standard error (SE), coefficient of variation (CV - the standard error of the density estimate divided by the density estimate), and upper and lower confidence limit (UCL, LCL) estimates.

Birds flying over but not using the habitat were excluded from analyses. We truncated distant observations to eliminate outliers. These few distant observations offer relatively little information to the detection modeling process (proximal distance locations, especially those closer to zero, are much more important) and can result in spurious model-overfitting results if not removed (Buckland et al. 2001). Because numerous point count stations were near habitat edges, we truncated the data at 65 meters to minimize potential biases associated with edge effects in density modeling (Buckland et al. 2015).

A good detection function model contains a detection probability equal to one (100%), or close to one, at the survey point and smoothly declines with distance away from the point (Buckland et al. 2001). To model this behavior in the species distance dataset the R Distance package provides three flexible models for the detection function (called 'key functions' - uniform, half-normal and hazard-rate), and adjustment terms (e.g. cosine, simple polynomial) to adjust the model scale and create a top model fit to the data. We

fit a candidate set of detection function models to each species' point-count data, and used Akaike's Information Criterion to select the best detection model for each species (Burnham and Anderson 2002). Each candidate model for the detection function represented a unique combination of key function and adjustment terms.

RESULTS

In the years surveyed, cowbirds were detected at all sites at low numbers (2017, 2019, 2020 mean detections: 1.5, 2.7 and 3.1 BHCO per survey, Table 1). More importantly, female cowbirds detected on surveys were sparse (2017, 2019, 2020 mean female detections were 0.3, 1.2 and 0.9 female BHCO per survey, Table 1). The mean number of females observed per point count station ranged from 0.04 to 0.14 between 2017, 2019, and 2020; or stated another way, on average we saw between one female per 7 to 25 point-count stations in the years surveyed (Table 1). Female cowbird observations were lowest in 2017, peaked in 2019 and then declined slightly in 2020 (Table 1).

In 2017, 2019, and 2020, surveyors completed three visits per year to 57 point-count stations from late-April to mid-June (2017: 4/29-5/1, 5/21-22, and 6/13-14; 2019: 4/24-25, 5/22-23, and 6/10-11; 2020: 4/16-17, 5/16-17, and 6/10-11). Surveyors recorded a total of 95 bird species, including one Federally Threatened species (LBVI), potentially another Federally listed species (Southwestern Willow Flycatcher; we detected many WIFLs, some may have been the endangered subspecies) and four Partners in Flight (PIF) priority species (California Thrasher [CATH], Wrentit [WREN], Lawrence's Goldfinch [LAGO], and Oak Titmouse [OATI]). The birds with the greatest number of survey detections (averaged across the 3 survey years) include White-Winged Dove (206), Bewick's Wren (194), Least-Bell's Vireo (189), House Finch (116), and Verdin (89), (Table 2, Appendix 1, Whitfield and Stanek 2017, Whitfield and Stanek 2019).

The average point-count station bird abundance was similar across all survey sites (three-year average 13.4 birds observed per point-count station survey visit, range 11.2 to 16.1) (Table 3). Average (and annual) species richness was lower at the xeric mesquite bosque sites, Vallecito Cienaga (38 species), and Campbell Grade (36 species), compared to the more mesic sites with riparian cottonwood corridors and mesquite uplands, Lower Willows Canyon (45 species), San Felipe South (48 species), and San Felipe North (48 species) (Table 3). The greatest observed species richness was observed at Sentenac Cienaga (55 species) due to its inclusive habitat diversity (dry cottonwood wash, mesic cottonwood stringer, mesquite bosque, arid grassland, rocky desert upland, moist cattail wetland, and narrow riparian canyon).

Table 1. Total number and average Brown-headed Cowbirds detected at six riparian sites in Anza-Borrego Desert State Park late April to mid-June 2017, 2019, and 2020

Brown-headed Cowbirds	Campbell Grade			Lower Willows			San Felipe North			San Felipe South			Sentenac Cienega			Vallecito Cienaga			Site Average		
	2017	**2019**	**2020**	**2017**	**2019**	**2020**	**2017**	**2019**	**2020**	**2017**	**2019**	**2020**	**2017**	**2019**	**2020**	**2017**	**2019**	**2020**	**2017**	**2019**	**2020**
Total detected on three surveys	9	11	15	3	3	6	2	13	17	8	8	5	2	5	5	3	8	7	4.50	8.00	9.17
Average detected per survey visit	3.00	3.67	5.00	1.00	1.00	2.00	0.67	4.33	5.67	2.67	2.67	1.67	0.67	1.67	1.67	1.00	2.67	2.33	1.50	2.67	3.06
Total females detected on three surveys	2	6	6	1	2	2	1	6	2	2	3	3	0	2	1	0	2	2	1.00	3.50	2.67
Avg. females detected per survey visit	0.67	2.00	2.00	0.33	0.67	0.67	0.33	2.00	0.67	0.67	1.00	1.00	0.00	0.67	0.33	0.00	0.67	0.67	0.33	1.17	0.89
Avg female detected per point station	0.11	0.33	0.33	0.04	0.07	0.07	0.03	0.20	0.07	0.07	0.10	0.10	0.00	0.06	0.03	0.00	0.07	0.07	0.04	0.14	0.11

Table 2. The ten most detected bird species at point count stations, within 100m, in six riparian sites in Anza-Borrego Desert State Park in April to June 2017, 2019, and 2020. Species rank order changed between 2017, 2019, and 2020.

Species	Campbell Grade			Lower Willows			San Felipe North			San Felipe South			Sentenac Cienega			Vallecito Cienaga			Annual Total		
	2017	2019	2020	2017	2019	2020	2017	2019	2020	2017	2019	2020	2017	2019	2020	2017	2019	2020	2017	2019	2020
White-winged Dove	29	38	23	27	25	22	24	39	22	19	41	21	37	45	35	61	53	57	197	241	179
Least Bell's Vireo	32	36	25	44	37	51	31	32	27	17	15	5	12	8	7	56	71	62	192	199	177
Bewick's Wren	12	21	19	54	17	29	18	41	36	43	46	54	19	32	37	36	29	39	182	186	213
Verdin	19	16	15	9	18	11	11	5	6	19	9	4	5	8	2	53	32	25	116	88	63
House Finch	14	19	14	42	39	44	25	16	20	14	13	26	11	10	13	6	17	4	112	114	121
California Quail	1	13	6	6	1	12	12	5	8	51	38	53	9	14	18	2	0	4	81	71	101
California Towhee	8	10	7	17	13	7	8	15	12	29	44	20	8	9	8	5	3	13	75	94	67
Mourning Dove	7	15	11	13	17	1	17	20	7	8	13	17	12	20	6	16	43	17	73	128	59
Phainopepla	2	10	13	9	5	13	10	6	6	18	8	15	8	10	6	14	32	9	61	71	62
Ash-throated Flycatcher	5	4	5	8	0	6	7	17	26	24	28	24	15	25	27	1	0	2	60	74	90
Lesser Goldfinch	3	17	12	20	17	16	10	17	10	8	6	16	14	3	9	3	7	12	58	67	75
California Thrasher	10	5	5	8	1	11	6	13	17	7	13	23	10	14	12	17	5	23	58	51	91

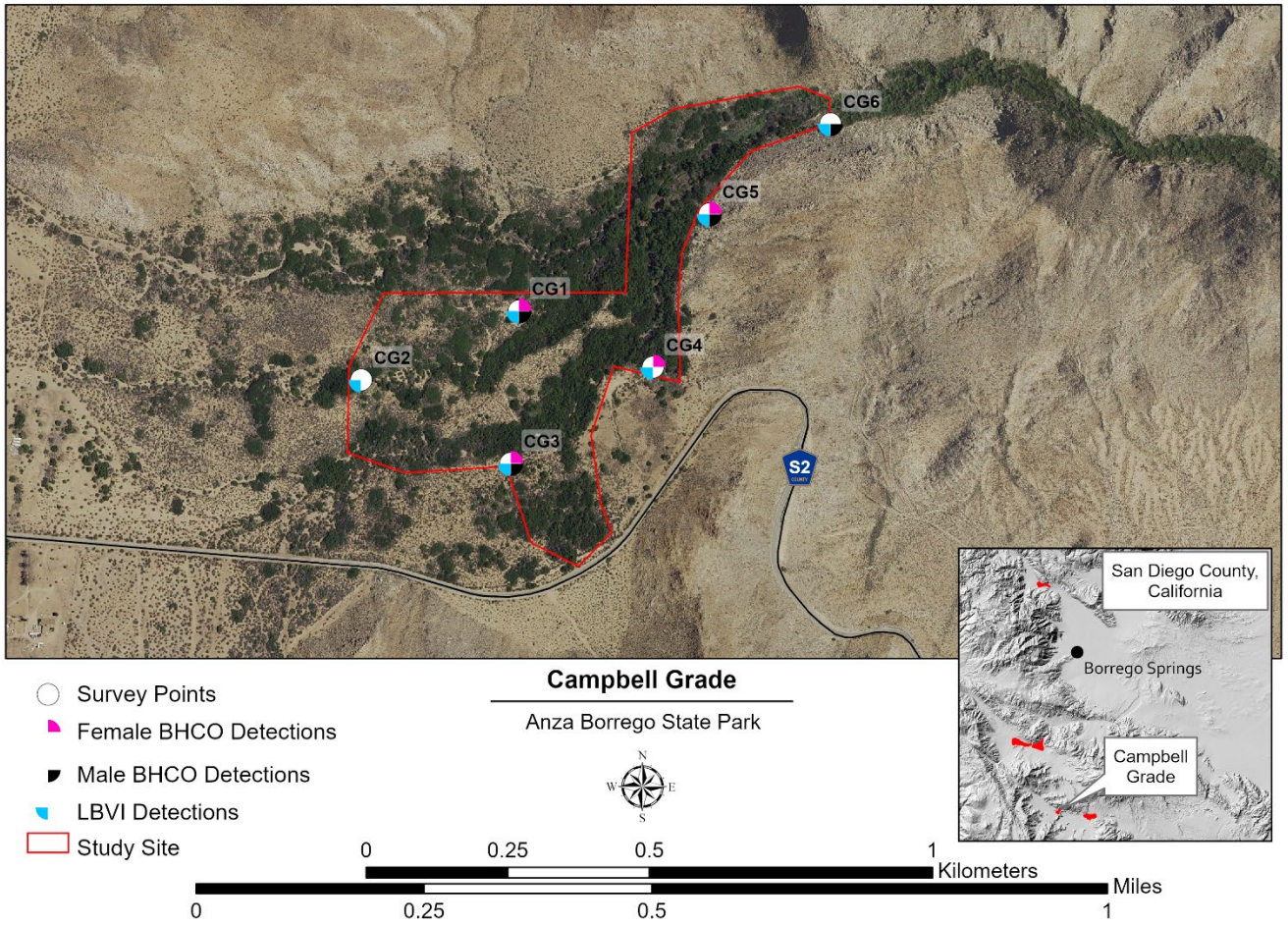

Figure 2. Campbell Grade point count station locations and points where we detected Least Bell's Vireos (LBVI) and Brown-headed Cowbirds (BHCO) in Anza-Borrego Desert Park in 2020.

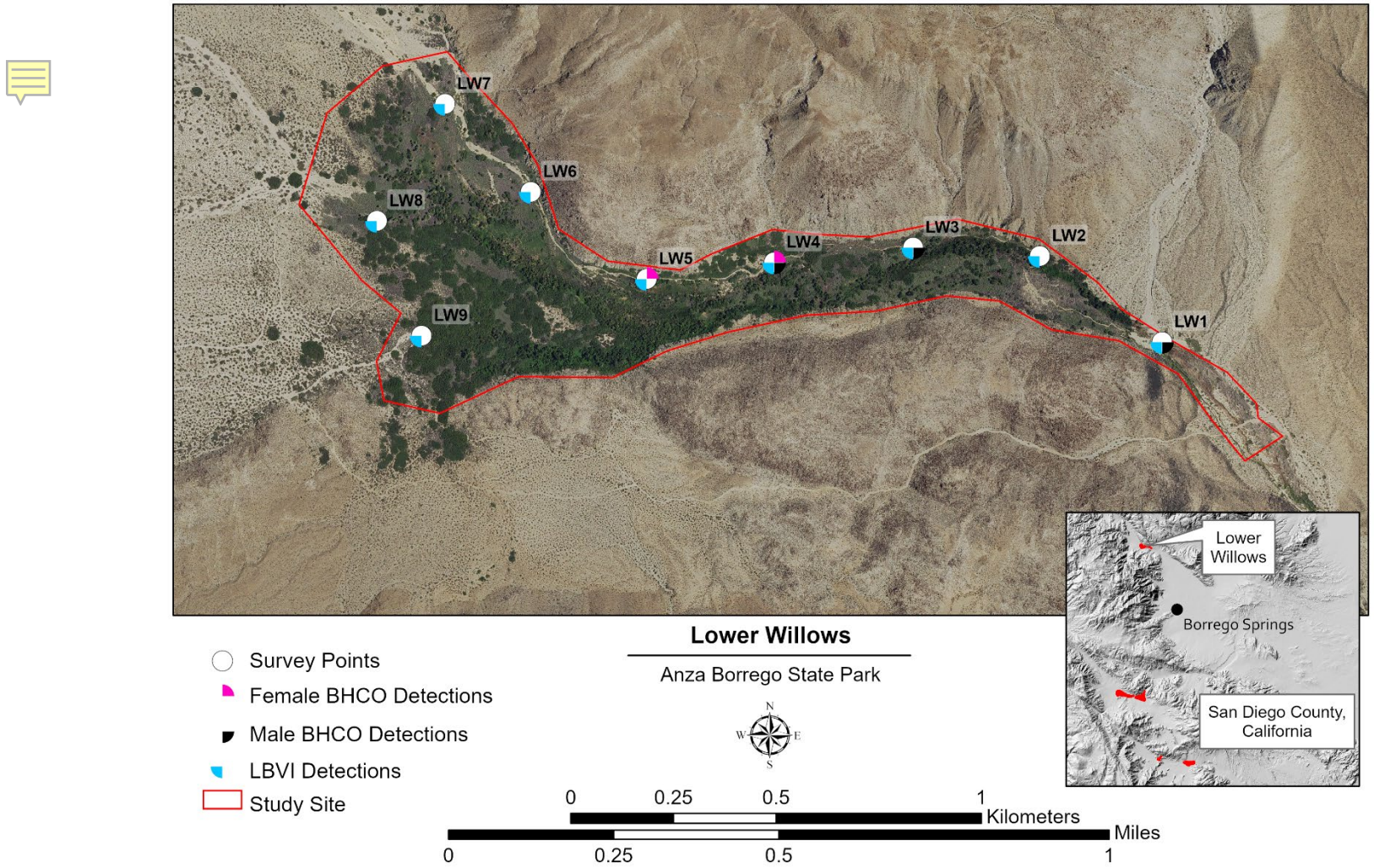

Figure 3. Lower Willows Canyon point count station locations and points where we detected Least Bell's Vireos (LBVI) and Brown-headed Cowbirds (BHCO) in Anza-Borrego Desert Park in 2020.

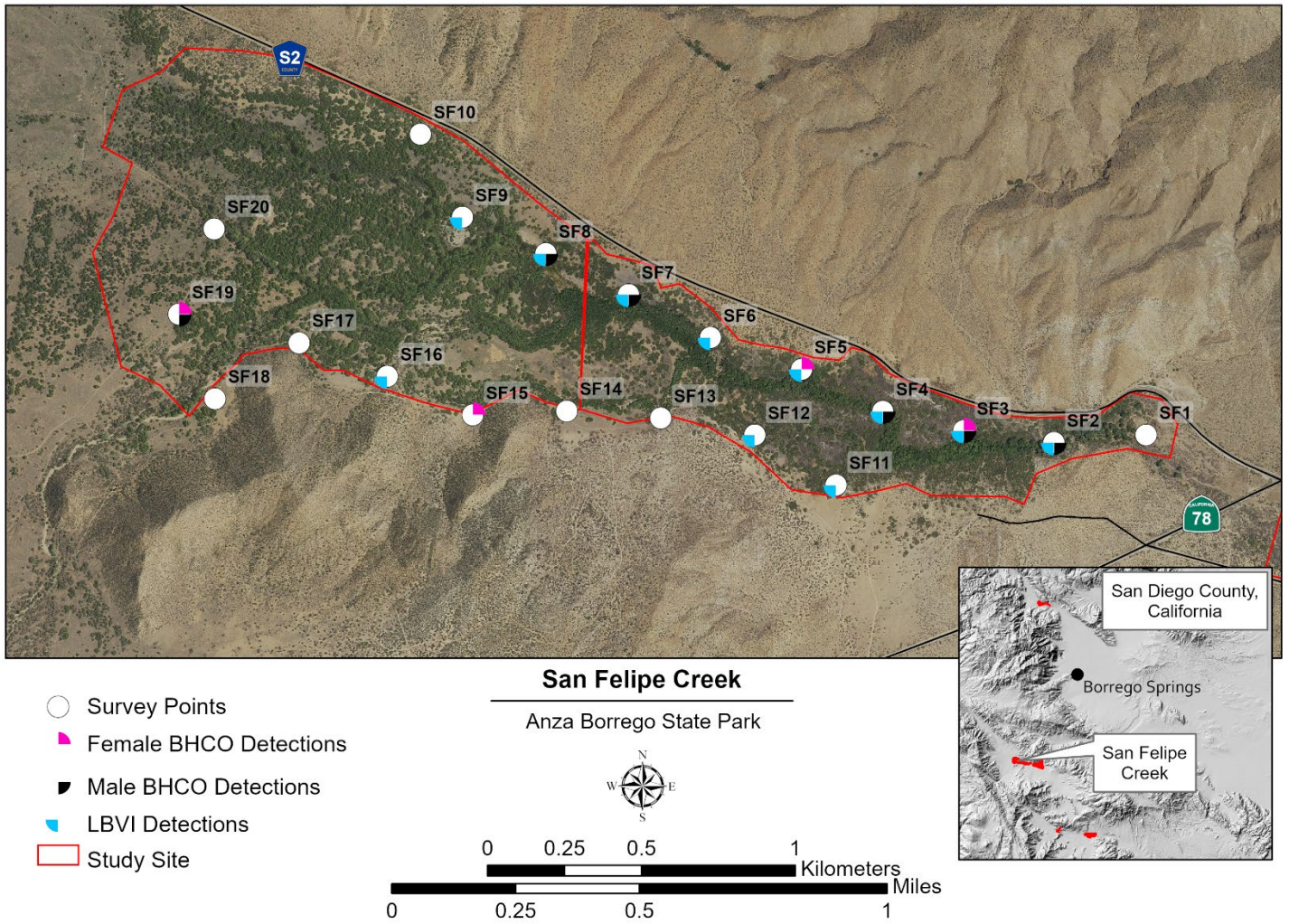

Figure 4. San Felipe Creek (North and South transects) point count station locations and points where we detected Least Bell's Vireos (LBVI) and Brown-headed Cowbirds (BHCO) in Anza-Borrego Desert Park in 2020.

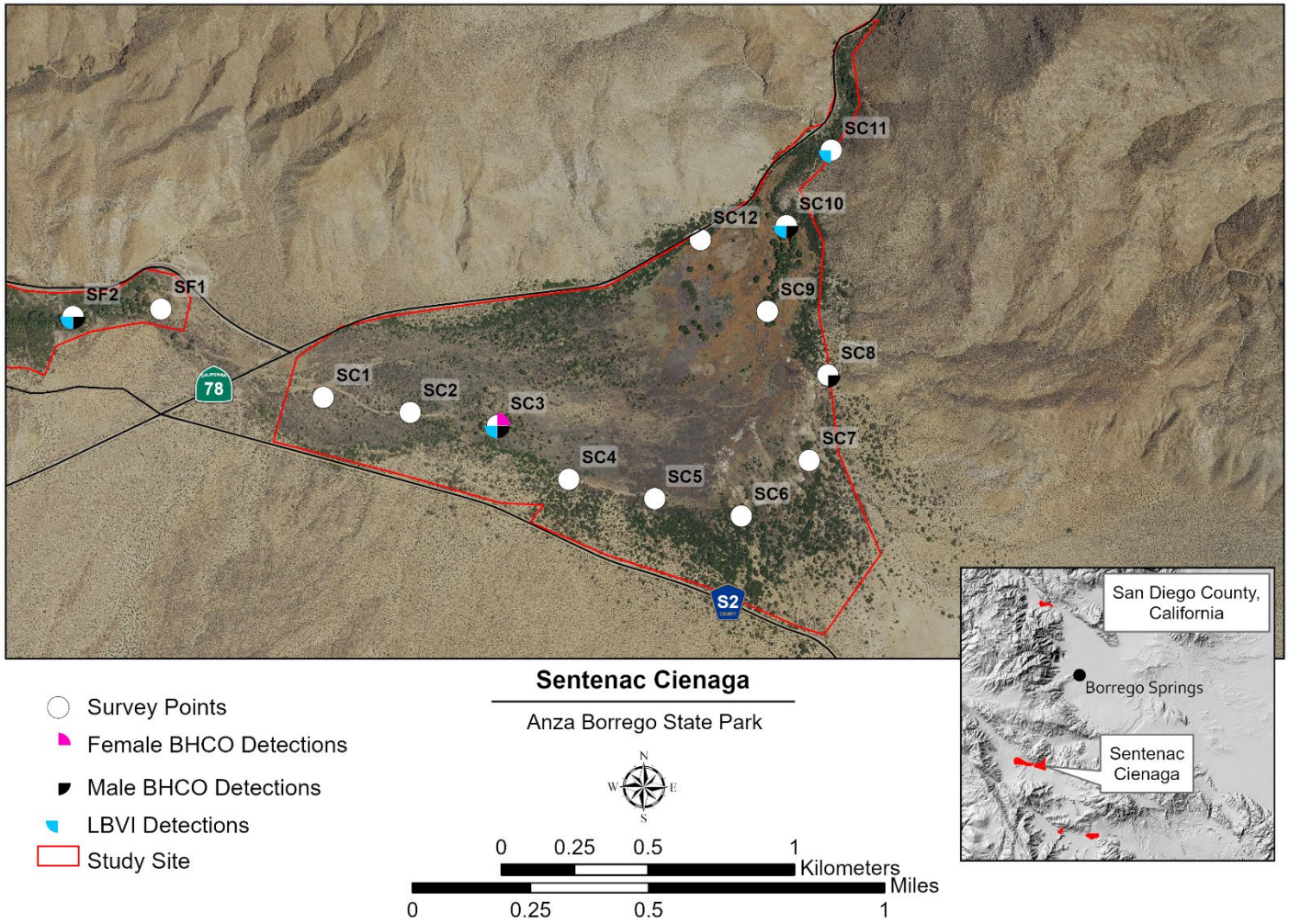

Figure 5. Sentenac Cienaga point count station locations and points where we detected Least Bell's Vireos (LBVI) and Brown-headed Cowbirds (BHCO) in Anza-Borrego Desert Park in 2020.

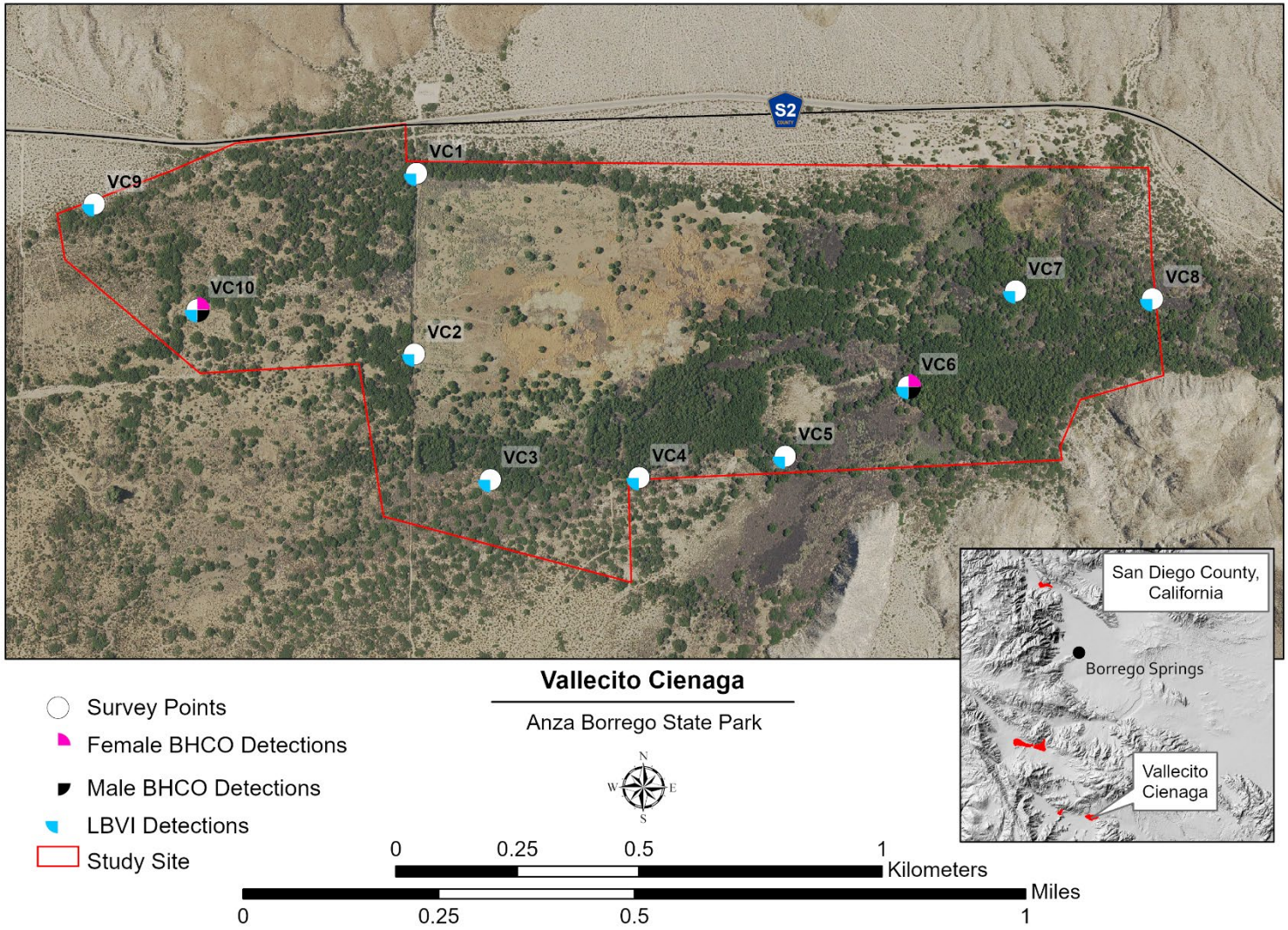

Figure 6. Vallecito Cienaga point count station locations and points where we detected Least Bell's Vireos (LBVI) and Brown-headed Cowbirds (BHCO) in Anza-Borrego Desert Park in 2020.

Table 3. Average abundance and species richness at six riparian sites in Anza-Borrego State Desert Park for 2017, 2019 and 2020.

	Year	Campbell	Lower Willows Canyon	San Felipe North	San Felipe South	Sentenac Cienega	Vallecito Cienaga	All Sites
Total number of individual birds detected	2017	210	372	396	396	394	347	2115
	2019	290	349	433	404	428	430	2334
	2020	250	342	428	469	442	408	2339
	Average	250	354	419	423	421	395	2263
Average Point-count Survey Abundance	2017	71.7	125	134	133.3	134.3	116.7	715
	2019	96.7	116.3	144.3	134.7	142.7	143.3	778
	2020	83.3	114.0	142.7	156.3	147.3	136.0	779.7
	Average	83.9	118.4	140.3	141.4	141.4	132.0	757.6
Average Point-count Station Abundance	2017	11.9	13.9	13.4	13.3	11.2	11.7	12.6
	2019	16.1	12.9	14.4	13.5	11.9	14.3	13.9
	2020	13.9	12.7	14.3	15.6	12.3	13.6	13.7
	Average	14.0	13.2	14.0	14.1	11.8	13.2	13.4
Species Richness	2017	35	43	52	49	57	32	77
	2019	36	47	44	45	54	39	74
	2020	38	46	49	51	55	43	79
	Average	36	45	48	48	55	38	77

We estimated detection probabilities and subsequent densities for eighteen species (Appendix 4), one of which is a federally protected species, the LBVI, and the CATH, a PIF Watchlist Species. Species with the highest densities were Bewick's Wren, Verdin, Least Bell's Vireo and House Finch. Brown-headed Cowbird estimated density was greatest at Campbell Grade (Figure 7, Appendix 4). Vallecito Cienega, Campbell Grade and Lower Willows had the highest Least Bell's Vireo estimated densities (Figure 8, Appendix 4).

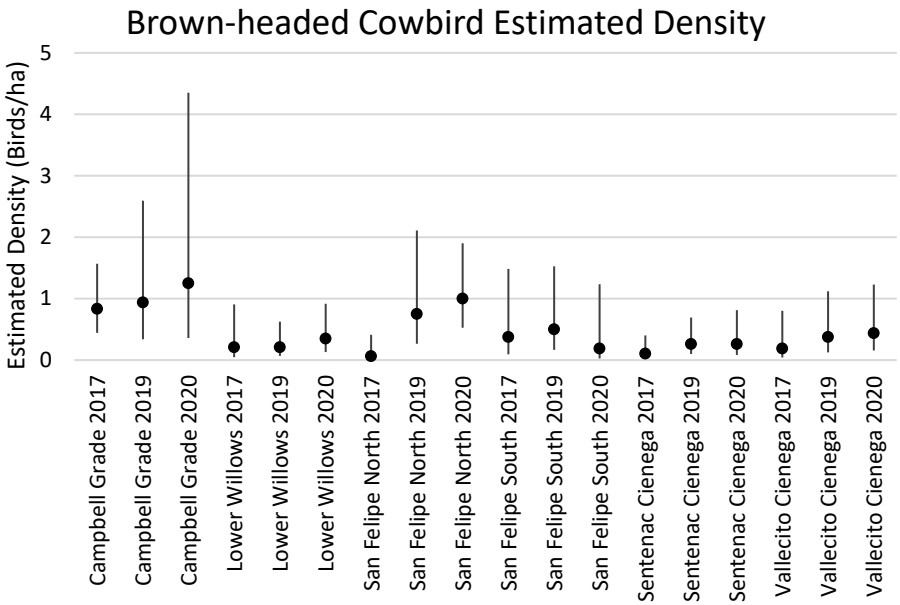

Figure 7. Brown-headed cowbird estimated densities with 95% confidence intervals for surveyed sites for 2017, 2019, and 2020. These estimated densities can also be found in Appendix 4.

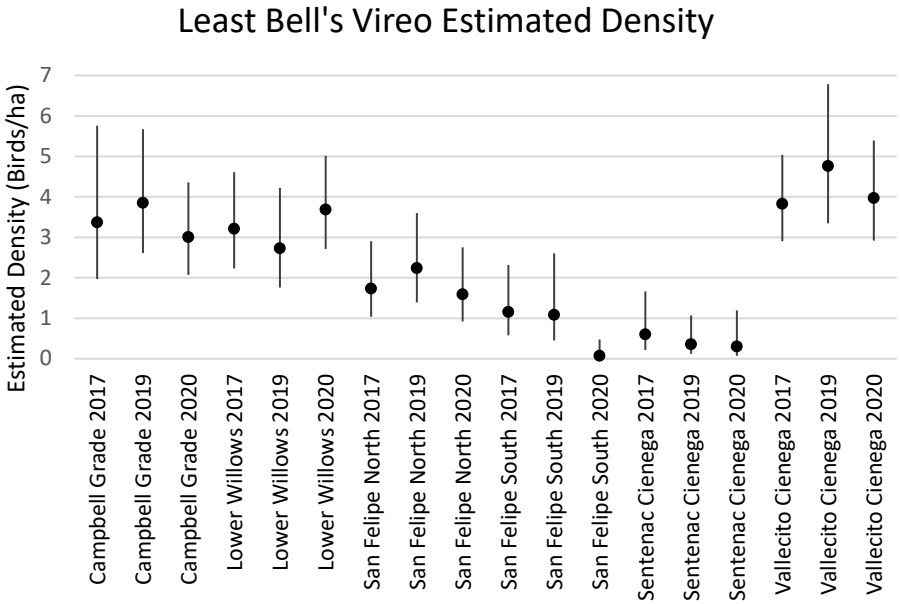

Figure 8. Least Bell's Vireo estimated densities with 95% confidence intervals for surveyed sites for 2017, 2019, and 2020. These estimated densities can also be found in Appendix 4.

DISCUSSION

We detected cowbirds during point-count surveys in all five riparian areas in 2019 and 2020; however, females were found only in three of these areas in 2017. Female counts averaged between 0.03 and 0.33 females per point count station in 2020 (Table 1). The number of cowbirds detected was slightly lower in 2020 compared to 2019, but was much higher relative to those counted 2017.

Least Bell's Vireo estimated densities ranged from 0.7 (San Felipe South 2020) to 4.8 (Vallecito 2019) birds per hectare (Figure 8). Overall, vireo numbers were similar at most sites between 2017 and 2019, but then decreased in 2020 (average of 7 fewer birds per survey round, Table 2). Most of these decreases occurred at Campbell Grade and San Felipe South.

The Verdin stands out as a species with a troubling trend; the number of detections significantly decreased, from 116 detections in 2017 to 63 in 2020 (average of ~18 fewer birds per survey round)(Table 2, Appendix 4). Similarly, site density estimate comparisons between 2017 and 2020 reveal Verdin declines between 22.2% and 79.0%, with exception to Lower Willows where estimated densities increased by 11.2% (Appendix 4). The greatest declines occurred at San Felipe Creek (north and south), Sentenac Cienega and Vallecito Cienega. We did not notice any obvious changes in habitat in these areas. This decline is steeper than the overall decline in the U.S. For example, the Breeding Bird Survey (BBS) reported a declining annual trend of 1.9% between 1968 and 2015 (~60% decline for the entire time period; USGS 2020). Verdin also declined in the Phoenix area (2007 to 2013)(Warren et al. 2019), but was stable in Tucson from (2001 to 2018)(Jennie McFarland, Tucson Bird Count). The Anza Borrego population decrease may be part of the reported climate change induced decline of birds in the nearby Mojave Desert (Iknayan and Beissinger 2018). The Yellow-breasted Chat also exhibited noticeable declines from 2017 to 2020 and warrants future monitoring and potential management action (Appendices 2, 3).

The average bird abundance per station was about the same for 2019 and 2020, but was much higher compared to 2017.(i.e. average bird abundance per station was 13.7, up from 12.6 in 2017). Bewick's Wren, Least Bell's Vireo, Verdin, and House Finch had the highest estimated densities among the six riparian sites we sampled in ABDSP. Although Sentenac Cienaga had the lowest counts and estimated bird densities compared to the other four areas, it had the highest species richness, likely due to its

diversity of different habitats. Lower Willows was the only area that showed a decrease in bird abundance (116 birds detected per survey down from 125 birds/survey in 2017). This is probably due to flood events that scoured out some of the habitat between July 2017 and April 2019.

An examination of past cowbird trapping data (2010-2016) showed that cowbird captures dramatically decreased in 2014-2016 (Whitfield and Stanek 2017). We concluded that most of the cowbirds trapped in past years were likely non-breeding birds (i.e. wintering or migrating) and the number of cowbirds trapped likely did not accurately reflect breeding population numbers. The abundance of LBVI and small number of cowbird captures were some of the factors that led to the cessation of trapping in 2017. After four years of no trapping, the female cowbird numbers are still low (average of 0.11 females per point count station). At most sites, estimated cowbird densities remained below 0.5 birds per ha and showed minimal annual variation between years. Cowbird density was greatest at Campbell Grade, exhibiting an increasing trend from 0.84 to 1.25 estimated cowbirds per hectare. This was likely due to the horses housed at the nearby RV park as cowbirds are commonly attracted to livestock.

The lack of significant increases in cowbird numbers after removing traps is similar to other experimental cowbird trap removals on the Santa Clara River in California (Parker et al. in prep) and in Michigan (Cooper et al. 2019). Cooper and others (2019) reduced cowbird traps from 2015-2017 and then removed them entirely (2018) in their study site in Michigan. Only 20 cowbirds were detected on point counts and only 1% of the Kirtland's Warbler nests were parasitized during the four years. Likewise, on the Santa Clara River, traps were reduced by 50% (from an average of ~2250 [2010 to 2015] to ~1100 trap days in 2016) and by 70% in 2017 and 2018. In addition, the time that the traps were run was reduced from three months to two months. Cowbird numbers were low (averaged less than 3 per survey) and no parasitized LBVI nests were found in 2016, however there were some parasitized nests in 2017 and 2018 (~16%). This area still requires some trapping, but substantially less than had been conducted in the past. Conversely, cowbird numbers increased after experimental trap removals on the San Diego River (Lynn and Kus 2014). Trapping was conducted in different areas for one to three years, they found that parasitism rates of Least Bell's Vireos went back to previous levels (~60%) once trapping was removed; even after three years of trapping prior to removal. These studies show that it is hard to generalize from one study area to another

and that it's important to take local factors into consideration when planning cowbird control measures.

LBVIs were detected at all five sites; they had the highest number of detections and the highest estimated densities at Campbell Grade, Lower Willows, and Vallecito. From 2017 to 2020, it is likely that the impact of cowbird parasitism was low for the vireo population, given the high densities of vireos and other bird species and low number of female cowbirds. However, it would be prudent to monitor vireo nests over the next few years to measure the impact of cowbird parasitism on this important vireo population in the absence of cowbird control.

MANAGEMENT RECOMMENDATIONS

1. Cowbird trapping is not needed for another year or two; given the low number of female cowbirds detected the past few years, it is unlikely that there will be a large increase in cowbirds in the next couple of years (but see number 3).
2. Continue point counts in the six sites to keep track of cowbird numbers and other bird populations. Particularly Least Bell's Vireo and Verdin populations.
3. If point counts indicate that female cowbird numbers are high in a particular area (e.g. Campbell Grade), be ready to institute small scale cowbird control, such as target mist-netting or placing a trap nearby (e.g. nearby horse corrals at Campbell Grade) for a short time period (i.e. 1 to 3 weeks).
4. If funding permits, start a LBVI nest monitoring program for a few years to correlate female cowbird numbers to parasitism rates. This is especially important now because the cowbird numbers have gone up since 2017, and it is prudent to measure the impact that the higher cowbird population is having on LBVI breeding. The monitoring will also make it possible to build a model using female cowbird numbers and host numbers to predict parasitism rates. This could be a valuable tool for deciding whether areas need to be trapped or not.
5. Consider conducting late season surveys for additional federally threatened or endangered species that have been detected in ABDSP in recent years, in particular, the Southwestern Willow Flycatcher and Yellow-billed Cuckoo (detected at San Felipe Creek in 2016, 2017).

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Appendix 1. Total and Average number of each species detected during point counts, across three visits in 2020 (see Appendix 2 for bander's code names).

Species (Bander's codes)	Campbell	Lower Willows Canyon	San Felipe North	San Felipe South	Sentenac Cienega	Vallecito Cienaga	Total	Average
AMKE			3	1	1		5	0.8
AMRO					1		1	0.2
ANHU		3	2			2	7	1.2
ATFL	5	6	26	24	27	2	90	15.0
BANO		2					2	0.3
BCFL		3	4		5	1	13	2.2
BCHU					1		1	0.2
BEWR	18	29	36	54	37	39	213	35.5
BGGN	2		5	6	3	6	22	3.7
BHCO	15	6	17	5	5	7	55	9.2
BHGR	1	3	3	3	2	1	13	2.2
BLGR		1	3	2	4	1	11	1.8
BLPH				1			1	0.2
BRBL					40		40	6.7
BRSP	1						1	0.2
BTGN	4	1		5		4	14	2.3
BTSP	1	2		1	1	18	23	3.8
BUOR	2	2	16	13	40	2	75	12.5
BUSH	4	2	1	2	5	2	16	2.7
CACW	3		1	2	1	1	8	1.3
CALT	7	7	12	20	8	13	67	11.2
CAQU	6	12	8	53	18	4	101	16.8
CASJ		1	6	9	12		28	4.7
CATH	5	11	17	23	12	23	91	15.2
COHA			1				1	0.2
COHU	6	12	6	9	3	8	44	7.3
CORA			5	3	1	4	13	2.2
COYE		10	7	1	9	5	32	5.3
EUCD		1	2		1		4	0.7
EUST			2		8	1	11	1.8
GAQU	1		1	2	1		5	0.8
GRFL				2			2	0.3
GRRO		1				5	6	1.0
HAWO		1			1		2	0.3
HOFI	14	44	20	26	13	4	121	20.2
HOOR	3	6	1		1	4	15	2.5

Appendix 1. continued

Species (Bander's codes)	Campbell	Lower Willows Canyon	San Felipe North	San Felipe South	Sentenac Cienega	Vallecito Cienaga	Total	Average
HOWR	1		21	3	2		27	4.5
LAGO	11	11	5	10	2	5	44	7.3
LAZB	2		4	2	3	4	15	2.5
LBVI	25	51	27	5	7	62	177	29.5
LBWO		6			8		14	2.3
LEGO	12	16	10	16	9	12	75	12.5
LENI		3	1				4	0.7
LISP		1	2				3	0.5
LOSH	1			2	4		7	1.2
LUWA				1			1	0.2
MODO	11	1	7	17	6	17	59	9.8
MOUQ		1					1	0.2
NAWA						1	1	0.2
NOFL			3	3	2		8	1.3
NOMO				4	5	1	10	1.7
NUWO			17	16	13		46	7.7
OATI			5	4			9	1.5
OCWA	1	1					2	0.3
PHAI	13	13	6	15	6	9	62	10.3
PSFL				1		5	6	1.0
RCKI		2				1	3	0.5
RTHA			1	3	2		6	1.0
SCOR		1		6	7		14	2.3
SOSP	2	3	23	2	11		41	6.8
SPTO	1	2	19	18	9		49	8.2
SUTA					1		1	0.2
TUVU			1				1	0.2
UNBI	4		1	1	5	10	21	3.5
UNHU	5	3		3	1	6	18	3.0
UNQU	11	1		13	3	1	29	4.8
UNSP	1	2					3	0.5
UNWA	1			3			4	0.7
UNWO				1	1		2	0.3
UNWR					1		1	0.2
VEFL		1					1	0.2
VERD	15	11	6	4	2	25	63	10.5

Appendix 1. Continued

Species (Bander's codes)	Campbell	Lower Willows Canyon	San Felipe North	San Felipe South	Sentenac Cienega	Vallecito Cienaga	Total	Average
WAVI	1				2	2	5	0.8
WCSP	5			1	6	4	16	2.7
WEFL	1			1		4	6	1.0
WEKI					9		9	1.5
WEME					1		1	0.2
WETA		4		1		5	10	1.7
WEWP			1	2	1		4	0.7
WIFL					9		9	1.5
WIWA	1	1	3	1		6	12	2.0
WREN	1	1	4	4			10	1.7
WWDO	22	22	22	21	35	57	179	29.8
YBCH	3	11	3			7	24	4.0
YEWA	1	5	29	9	7	3	54	9.0
YRWA		2	2	9	1	4	18	3.0

Appendix 2. Bander's Codes, Common names and Scientific names of birds detected at six riparian areas in Anza-Borrego Desert Park in 2017, 2019, and 2020.

Species	Common Name	Scientific Name
AMCR	American Crow	*Corvus brachyrhynchos*
AMKE	American Kestrel	*Falco sparverius*
AMRO	American Robin	*Turdus migratorius*
ANHU	Anna's Hummingbird	*Calypte anna*
ATFL	Ash-throated Flycatcher	*Myiarchus cinerascens*
BCFL	Brown-crested Flycatcher	*Myiarchus tyrannulus*
BCHU	Black-chinned Hummingbird	*Archilochus alexandri*
BCSP	Black-chinned Sparrow	*Spizella atrogularis*
BEWR	Bewick's Wren	*Thryomanes bewickii*
BGGN	Blue-gray Gnatcatcher	*Polioptila caerulea*
BHCO	Brown-headed Cowbird	*Molothrus ater*
BHGR	Black-headed Grosbeak	*Pheucticus melanocephalus*
BLGR	Blue Grosbeak	*Passerina caerulea*
BLPH	Black Phoebe	*Sayornis nigricans*
BNOW	Barn Owl	*Tyto alba*
BRBL	Brewer's Blackbird	*Euphagus cyanocephalus*
BRSP	Brewer's Sparrow	*Spizella breweri*
BTGN	Black-tailed Gnatcatcher	*Polioptila melanura*
BTSP	Black-throated Sparrow	*Amphispiza bilineata*
BUOR	Bullock's Oriole	*Icterus bullockii*
BUSH	Bushtit	*Psaltriparus minimus*
CACW	Cactus Wren	*Campylorhynchus brunneicapillus*
CALT	California Towhee	*Melozone crissalis*
CAQU	California Quail	*Callipepla californica*
CASJ	California Scrub Jay	*Aphelcoma californica*
CATH	California Thrasher	*Toxostoma redivivum*
CAVI	Cassin's Vireo	*Vireo cassinii*
CHSP	Chipping Sparrow	*Spizella passerina*
COHA	Cooper's Hawk	*Accipiter cooperii*
COHU	Costa's Hummingbird	*Calypte costae*
CORA	Common Raven	*Corvus corax*
COYE	Common Yellowthroat	*Geothlypis trichas*
DOWO	Downy Woodpecker	*Picoides pubescens*
DUFL	Dusky Flycatcher	*Empidonax oberholseri*
EUST	European Starling	*Sturnus vulgaris*
GAQU	Gambel's Quail	*Callipepla gambelii*
GRFL	Gray Flycatcher	*Empidonax wrightii*
GRRO	Greater Roadrunner	*Geococcyx californianus*

Species	Common Name	Scientific Name
GTTO	Green-tailed Towhee	*Pipilo chlorurus*
HAWO	Hairy Woodpecker	*Picoides villosus*
HETH	Hermit Thrush	*Catharus guttatus*
HOFI	House Finch	*Haemorhous mexicanus*
HOOR	Hooded Oriole	*Icterus cucullatus*
HOWR	House Wren	*Troglodytes aedon*
LAGO	Lawrence's Goldfinch	*Spinus lawrencei*
LASP	Lark Sparrow	*Chondestes grammacus*
LAZB	Lazuli Bunting	*Passerina amoena*
LBVI	Least Bell's Vireo	*Vireo bellii pusillus*
LBWO	Ladder-backed Woodpecker	*Picoides scalaris*
LEGO	Lesser Goldfinch	*Spinus psaltria*
LENI	Lesser Nighthawk	*Chordeiles acutipennis*
LISP	Lincoln's Sparrow	*Melospiza lincolnii*
LOSH	Loggerhead Shrike	*Lanius ludovicianus*
LUWA	Lucy's Warbler	*Oreothlypis luciae*
MODO	Mourning Dove	*Zenaida macroura*
MOUQ	Mountain Quail	*Oreortyx pictus*
NAWA	Nashville Warbler	*Oreothlypis ruficapilla*
NOFL	Northern Flicker	*Colaptes auratus*
NOMO	Northern Mockingbird	*Mimus polyglottos*
NUWO	Nuttall's Woodpecker	*Picoides nuttallii*
OATI	Oak Titmouse	*Baeolophus inornatus*
OCWA	Orange-crowned Warbler	*Oreothlypis celata*
PHAI	Phainopepla	*Phainopepla nitens*
PSFL	Pacific-slope Flycatcher	*Empidonax difficilis*
PYNU	Pygmy Nuthatch	*Sitta pygmaea*
RCKI	Ruby-crowned Kinglet	*Regulus calendula*
ROWR	Rock Wren	*Salpinctes obsoletus*
RSHA	Red-shouldered Hawk	*Buteo lineatus*
RTHA	Red-tailed Hawk	*Buteo jamaicensis*
RWBL	Red-winged Blackbird	*Agelaius phoeniceus*
SAPH	Say's Phoebe	*Sayornis saya*
SCOR	Scott's Oriole	*Icterus parisorum*
SOSP	Song Sparrow	*Melospiza melodia*
SPTO	Spotted Towhee	*Pipilo maculatus*
SUTA	Summer Tanager	*Piranga rubra*
SWTH	Swainson's Thrush	*Catharus ustulatus*
TOWA	Townsend's Warbler	*Setophaga townsendi*
TUVU	Turkey Vulture	*Cathartes aura*

Species	Common Name	Scientific Name
VEFL	Vermilion Flycatcher	*Pyrocephalus rubinus*
VERD	Verdin	*Auriparus flaviceps*
WAVI	Warbling Vireo	*Vireo gilvus*
WCSP	White-crowned Sparrow	*Zonotrichia leucophrys*
WEBL	Western Bluebird	*Sialia mexicana*
WEFL	Western Flycatcher	*Empidonax difficilis or occidentalis*
WEKI	Western Kingbird	*Tyrannus verticalis*
WEME	Western Meadowlark	*Sturnella neglecta*
WETA	Western Tanager	*Piranga ludoviciana*
WEWP	Western Wood-Pewee	*Contopus sordidulus*
WIFL	Willow Flycatcher	*Empidonax traillii*
WIWA	Wilson's Warbler	*Cardellina pusilla*
WREN	Wrentit	*Chamaea fasciata*
WWDO	White-winged Dove	*Zenaida asiatica*
YBCH	Yellow-breasted Chat	*Icteria virens*
YEWA	Yellow Warbler	*Setophaga petechia*
YRWA	Yellow-rumped Warbler	*Setophaga coronata*

Appendix 3. Annual species total counts and average count from three surveys conducted in 2017, 2019, and 2020. Blank cells indicate the species was not detected. See Appendix 2 for species' code names.

Species	2017	2019	2020	Average
AMCR		7		2.3
AMKE	1	3	5	3.0
AMRO		1	1	0.7
ANHU	11	24	7	14.0
ATFL	60	74	90	74.7
BCFL	19	6	13	12.7
BCHU			1	0.3
BCSP	2			0.7
BEWR	182	186	213	193.7
BGGN	11	6	22	13.0
BHCO	26	48	55	43.0
BHGR	5	6	13	8.0
BLGR	13	14	11	12.7
BLPH		4	1	1.7
BNOW			2	0.7
BRBL	3		40	14.3
BRSP			1	0.3
BTGN	25	25	14	21.3
BTSP	7	11	23	13.7
BUOR	50	63	75	62.7
BUSH	26	12	16	18.0
CACW	3	10	8	7.0
CALT	75	94	67	78.7
CAQU	81	71	101	84.3
CASJ	18	24	28	23.3
CATH	58	51	91	66.7
CAVI	4	5		3.0
CHSP	1			0.3
COHA			1	0.3
COHU	30	65	44	46.3
CORA	22	14	13	16.3
COYE	6	15	32	17.7
DOWO	2			0.7
DUFL	1	2		1.0
EUCD	16	1	4	7.0
EUST	17	17	11	15.0
GAQU	3	2	5	3.3

Appendix 3. continued

Species	2017	2019	2020	Average
GRFL			2	0.7
GRRO	5	2	6	4.3
GTTO		2		0.7
HAWO			2	0.7
HETH	3	1		1.3
HOFI	112	114	121	115.7
HOOR	13	4	15	10.7
HOWR	12	28	27	22.3
LAGO	9	55	44	36.0
LASP	1			0.3
LAZB	1	36	15	17.3
LBVI	192	199	177	189.3
LBWO	26	7	14	15.7
LEGO	58	67	75	66.7
LENI	6	5	4	5.0
LISP			3	1.0
LOSH	12	16	7	11.7
LUWA	1		1	0.7
MODO	73	128	59	86.7
MOUQ			1	0.3
NAWA			1	0.3
NOFL	2	12	8	7.3
NOMO	11	13	10	11.3
NUWO	34	32	46	37.3
OATI	1	3	9	4.3
OCWA	4		2	2.0
PHAI	61	71	62	64.7
PSFL	4	38	6	16.0
PYNU		3		1.0
RCKI			3	1.0
ROWR	2	1		1.0
RSHA		3		1.0
RTHA	10	2	6	6.0
RWBL	1	1		0.7
SAPH	1	1		0.7
SCOR	7	12	14	11.0
SOSP	17	34	41	30.7
SPTO	46	30	49	41.7
SUTA	3	6	1	3.3
SWTH	1	7		2.7

Appendix 3. continued

Species	2017	2019	2020	Average
TOWA		1		0.3
TUVU	1		1	0.7
VEFL			1	0.3
VERD	116	88	63	89.0
WAVI	3	7	5	5.0
WCSP	3		16	6.3
WEBL		1		0.3
WEFL			6	2.0
WEKI	7	2	9	6.0
WEME			1	0.3
WETA	5	5	10	6.7
WEWP	3	11	4	6.0
WIFL		14	9	7.7
WIWA	31	32	12	25.0
WREN	20	12	10	14.0
WWDO	197	241	179	205.7
YBCH	44	28	24	32.0
YEWA	58	46	54	52.7
YRWA	2	2	18	7.3

Appendix 4. Species density estimates for all six sites for years 2017, 2019, and 2020 with sample size and measures of precision. Density estimates are presented for species with a minimum recommended sample size (n > 75 individuals from all detections made in 2017, 2019 and 2020) and robust detection probability model results. See Appendix 2 for species 's code names.

Species	Site	Year	n[1]	Density Estimate[2]	D SE[3]	D CV[4]	LCL[5]	UCL[6]
ATFL	Campbell Grade	2017	3	0.219	0.158	72%	0.046	1.055
		2019	4	0.292	0.161	55%	0.088	0.976
		2020	3	0.219	0.158	72%	0.046	1.055
	Lower Willows	2017	8	0.39	0.145	37%	0.184	0.825
		2019	0	0	0	0%	0	0
		2020	5	0.244	0.12	49%	0.089	0.667
	San Felipe North	2017	3	0.132	0.073	56%	0.043	0.405
		2019	17	0.745	0.276	37%	0.355	1.565
		2020	21	0.921	0.268	29%	0.52	1.632
	San Felipe South	2017	24	1.052	0.298	28%	0.604	1.833
		2019	24	1.052	0.338	32%	0.557	1.989
		2020	16	0.702	0.247	35%	0.348	1.414
	Sentenac Cienega	2017	9	0.329	0.122	37%	0.158	0.684
		2019	24	0.877	0.28	32%	0.468	1.642
		2020	14	0.512	0.167	33%	0.269	0.972
	Vallecito Cienega	2017	1	0.044	0.045	103%	0.007	0.29
		2019	0	0	0	0%	0	0
		2020	1	0.044	0.045	103%	0.007	0.29

[1] n – the number of individuals used in the density analysis; the total number of birds detected within 65m of the survey point

[2] Density Estimate – estimated number of birds per ha

[3] D SE – the standard error of the density estimate

[4] D CV – the density estimate coefficient of variation (D SE/D Estimate)

[5] LCL – the lower 95% confidence limit of the density estimate

[6] UCL – the upper 95% confidence limit of the density estimate

Appendix 4. continued

Species	Site	Year	n[1]	Density Estimate[2]	D SE[3]	D CV[4]	LCL[5]	UCL[6]
BEWR	Campbell Grade	2017	12	1.891	0.559	30%	0.917	3.901
		2019	19	2.994	0.847	28%	1.498	5.982
		2020	15	2.364	0.433	18%	1.529	3.654
	Lower Willows	2017	54	5.673	4.285	76%	1.21	26.604
		2019	17	1.786	0.416	23%	1.065	2.995
		2020	26	2.731	0.604	22%	1.673	4.458
	San Felipe North	2017	15	1.418	0.231	16%	1	2.012
		2019	37	3.498	0.389	11%	2.776	4.408
		2020	31	2.931	0.405	14%	2.185	3.931
	San Felipe South	2017	34	3.214	0.516	16%	2.277	4.538
		2019	43	4.065	0.519	13%	3.107	5.32
		2020	45	4.254	0.647	15%	3.072	5.892
	Sentenac Cienega	2017	15	1.182	0.396	34%	0.58	2.406
		2019	25	1.97	0.3	15%	1.429	2.715
		2020	35	2.757	0.531	19%	1.831	4.152
	Vallecito Cienega	2017	35	3.309	0.684	21%	2.11	5.189
		2019	27	2.553	0.476	19%	1.703	3.826
		2020	37	3.498	0.52	15%	2.545	4.808
BHCO	Campbell Grade	2017	8	0.835	0.221	27%	0.445	1.569
		2019	9	0.94	0.396	42%	0.341	2.593
		2020	12	1.253	0.656	52%	0.361	4.352
	Lower Willows	2017	3	0.209	0.149	71%	0.048	0.908
		2019	3	0.209	0.106	51%	0.07	0.623
		2020	5	0.348	0.155	44%	0.132	0.915
	San Felipe North	2017	1	0.063	0.063	100%	0.01	0.412
		2019	12	0.752	0.365	49%	0.268	2.109
		2020	16	1.003	0.296	30%	0.529	1.899
	San Felipe South	2017	6	0.376	0.253	67%	0.095	1.486
		2019	8	0.501	0.264	53%	0.165	1.524
		2020	3	0.188	0.189	100%	0.029	1.237
	Sentenac Cienega	2017	2	0.104	0.071	68%	0.027	0.403
		2019	5	0.261	0.123	47%	0.098	0.694
		2020	5	0.261	0.145	56%	0.084	0.813
	Vallecito Cienega	2017	3	0.188	0.135	72%	0.044	0.801
		2019	6	0.376	0.194	52%	0.126	1.119
		2020	7	0.439	0.213	49%	0.156	1.232

Appendix 4. continued

Species	Site	Year	n[1]	Density Estimate[2]	D SE[3]	D CV[4]	LCL[5]	UCL[6]
CALT	Campbell Grade	2017	6	0.789	0.412	52%	0.227	2.743
		2019	10	1.316	0.609	46%	0.432	4.005
		2020	7	0.921	0.384	42%	0.336	2.521
	Lower Willows	2017	15	1.316	0.339	26%	0.747	2.318
		2019	13	1.14	0.282	25%	0.663	1.962
		2020	6	0.526	0.232	44%	0.202	1.374
	San Felipe North	2017	6	0.474	0.179	38%	0.21	1.069
		2019	15	1.184	0.587	50%	0.413	3.392
		2020	12	0.947	0.411	43%	0.374	2.402
	San Felipe South	2017	24	1.894	0.35	19%	1.277	2.809
		2019	42	3.315	0.438	13%	2.524	4.354
		2020	20	1.579	0.336	21%	0.999	2.495
	Sentenac Cienega	2017	7	0.46	0.268	58%	0.141	1.503
		2019	8	0.526	0.207	39%	0.231	1.201
		2020	8	0.526	0.284	54%	0.174	1.59
	Vallecito Cienega	2017	5	0.395	0.179	45%	0.149	1.042
		2019	3	0.237	0.122	52%	0.08	0.704
		2020	13	1.026	0.382	37%	0.459	2.292
CAQU	Campbell Grade	2017	0	0	0	0%	0	0
		2019	11	1.192	0.343	29%	0.652	2.178
		2020	5	0.542	0.367	68%	0.119	2.459
	Lower Willows	2017	3	0.217	0.158	73%	0.049	0.949
		2019	1	0.072	0.073	102%	0.011	0.493
		2020	12	0.867	0.606	70%	0.21	3.585
	San Felipe North	2017	8	0.52	0.253	49%	0.191	1.414
		2019	4	0.26	0.204	79%	0.056	1.217
		2020	2	0.13	0.132	102%	0.02	0.859
	San Felipe South	2017	49	3.185	2.09	66%	0.849	11.952
		2019	30	1.95	0.55	28%	1.106	3.438
		2020	43	2.795	1.311	47%	1.064	7.345
	Sentenac Cienega	2017	7	0.379	0.28	74%	0.091	1.585
		2019	7	0.379	0.28	74%	0.091	1.585
		2020	11	0.596	0.387	65%	0.166	2.145
	Vallecito Cienega	2017	2	0.13	0.09	69%	0.033	0.52
		2019	0	0	0	0%	0	0
		2020	2	0.13	0.132	102%	0.02	0.859

Appendix 4. continued

Species	Site	Year	n[1]	Density Estimate[2]	D SE[3]	D CV[4]	LCL[5]	UCL[6]
CATH	Campbell Grade	2017	9	1.628	0.568	35%	0.811	3.267
		2019	4	0.723	0.298	41%	0.31	1.69
		2020	5	0.904	0.57	63%	0.233	3.507
	Lower Willows	2017	7	0.844	0.416	49%	0.313	2.275
		2019	1	0.121	0.125	103%	0.018	0.826
		2020	10	1.206	0.463	38%	0.564	2.578
	San Felipe North	2017	5	0.543	0.282	52%	0.193	1.527
		2019	13	1.411	0.546	39%	0.658	3.022
		2020	16	1.736	0.71	41%	0.773	3.897
	San Felipe South	2017	7	0.76	0.415	55%	0.256	2.256
		2019	12	1.302	0.407	31%	0.709	2.391
		2020	17	1.845	0.689	37%	0.885	3.845
	Sentenac Cienega	2017	7	0.633	0.328	52%	0.229	1.751
		2019	11	0.995	0.45	45%	0.409	2.418
		2020	11	0.995	0.386	39%	0.466	2.124
	Vallecito Cienega	2017	15	1.628	0.545	34%	0.847	3.127
		2019	5	0.543	0.282	52%	0.193	1.527
		2020	18	1.953	0.647	33%	1.024	3.726
HOFI	Campbell Grade	2017	12	1.625	0.383	24%	0.923	2.859
		2019	18	2.437	1.201	49%	0.748	7.946
		2020	13	1.76	0.78	44%	0.604	5.13
	Lower Willows	2017	41	3.701	0.734	20%	2.401	5.704
		2019	37	3.34	1.203	36%	1.511	7.384
		2020	35	3.159	0.761	24%	1.86	5.368
	San Felipe North	2017	20	1.625	0.706	44%	0.639	4.13
		2019	16	1.3	0.705	54%	0.415	4.071
		2020	16	1.3	0.639	49%	0.457	3.697
	San Felipe South	2017	14	1.137	0.314	28%	0.625	2.07
		2019	11	0.894	0.397	45%	0.345	2.316
		2020	22	1.787	0.686	38%	0.781	4.093
	Sentenac Cienega	2017	10	0.677	0.348	51%	0.235	1.953
		2019	10	0.677	0.247	37%	0.314	1.462
		2020	12	0.812	0.366	45%	0.318	2.078
	Vallecito Cienega	2017	6	0.487	0.183	38%	0.216	1.099
		2019	16	1.3	0.512	39%	0.556	3.039
		2020	3	0.244	0.125	52%	0.082	0.725

Appendix 4. continued

Species	Site	Year	n[1]	Density Estimate[2]	D SE[3]	D CV[4]	LCL[5]	UCL[6]
HOFI	Campbell Grade	2017	12	1.076	0.269	25%	0.608	1.903
		2019	18	2.372	1.423	60%	0.586	9.594
		2020	13	1.113	0.498	45%	0.385	3.219
	Lower Willows	2017	41	4.142	0.902	22%	2.643	6.489
		2019	37	3.31	1.282	39%	1.43	7.659
		2020	35	2.036	0.489	24%	1.209	3.426
	San Felipe North	2017	20	0.976	0.471	48%	0.368	2.584
		2019	16	1.036	0.573	55%	0.328	3.275
		2020	16	0.835	0.411	49%	0.294	2.37
	San Felipe South	2017	14	1.201	0.4	33%	0.593	2.435
		2019	11	1.044	0.477	46%	0.4	2.729
		2020	22	1.137	0.431	38%	0.504	2.564
	Sentenac Cienega	2017	10	0.443	0.259	59%	0.141	1.389
		2019	10	0.729	0.287	39%	0.322	1.649
		2020	12	0.529	0.234	44%	0.211	1.325
	Vallecito Cienega	2017	6	0.622	0.286	46%	0.237	1.63
		2019	16	1.355	0.725	54%	0.479	3.831
		2020	3	0.164	0.085	52%	0.055	0.488
LBVI	Campbell Grade	2017	28	3.369	0.757	23%	1.97	5.761
		2019	32	3.85	0.647	17%	2.615	5.669
		2020	25	3.008	0.489	16%	2.074	4.363
	Lower Willows	2017	40	3.209	0.539	17%	2.233	4.61
		2019	34	2.727	0.547	20%	1.76	4.226
		2020	46	3.69	0.534	15%	2.714	5.017
	San Felipe North	2017	24	1.733	0.412	24%	1.035	2.902
		2019	31	2.238	0.492	22%	1.391	3.6
		2020	22	1.588	0.403	25%	0.915	2.756
	San Felipe South	2017	16	1.155	0.37	32%	0.576	2.318
		2019	15	1.083	0.441	41%	0.45	2.605
		2020	1	0.072	0.072	100%	0.011	0.475
	Sentenac Cienega	2017	10	0.602	0.296	49%	0.217	1.666
		2019	6	0.361	0.19	53%	0.122	1.069
		2020	5	0.301	0.209	69%	0.076	1.192
	Vallecito Cienega	2017	53	3.826	0.506	13%	2.905	5.039
		2019	66	4.765	0.792	17%	3.345	6.787
		2020	55	3.971	0.578	15%	2.923	5.393

Appendix 4. continued

Species	Site	Year	n[1]	Density Estimate[2]	D SE[3]	D CV[4]	LCL[5]	UCL[6]
MODO	Campbell Grade	2017	6	0.491	0.225	46%	0.165	1.463
		2019	13	1.064	0.337	32%	0.5	2.262
		2020	7	0.573	0.241	42%	0.209	1.566
	Lower Willows	2017	13	0.709	0.197	28%	0.387	1.299
		2019	11	0.6	0.188	31%	0.303	1.189
		2020	1	0.055	0.055	101%	0.008	0.372
	San Felipe North	2017	11	0.54	0.193	36%	0.251	1.164
		2019	15	0.736	0.245	33%	0.36	1.505
		2020	4	0.196	0.11	56%	0.061	0.635
	San Felipe South	2017	5	0.245	0.112	46%	0.093	0.65
		2019	10	0.491	0.135	28%	0.272	0.887
		2020	9	0.442	0.142	32%	0.221	0.884
	Sentenac Cienega	2017	6	0.245	0.144	59%	0.075	0.804
		2019	20	0.818	0.257	31%	0.423	1.582
		2020	4	0.164	0.072	44%	0.066	0.406
	Vallecito Cienega	2017	15	0.736	0.209	28%	0.4	1.356
		2019	42	2.062	0.352	17%	1.446	2.939
		2020	14	0.687	0.232	34%	0.333	1.418
NUWO	Campbell Grade	2017	1	0.067	0.068	101%	0.008	0.566
		2019	0	0	0	0%	0	0
		2020	0	0	0	0%	0	0
	Lower Willows	2017	1	0.045	0.045	101%	0.007	0.306
		2019	0	0	0	0%	0	0
		2020	0	0	0	0%	0	0
	San Felipe North	2017	11	0.444	0.144	33%	0.226	0.873
		2019	12	0.485	0.174	36%	0.229	1.025
		2020	16	0.646	0.208	32%	0.331	1.262
	San Felipe South	2017	8	0.323	0.095	29%	0.176	0.593
		2019	8	0.323	0.112	35%	0.156	0.668
		2020	15	0.606	0.143	24%	0.375	0.978
	Sentenac Cienega	2017	6	0.202	0.121	60%	0.061	0.669
		2019	4	0.135	0.061	45%	0.053	0.34
		2020	10	0.337	0.14	42%	0.144	0.789
	Vallecito Cienega	2017	3	0.121	0.088	73%	0.028	0.52
		2019	0	0	0	0%	0	0
		2020	0	0	0	0%	0	0

Appendix 4. continued

Species	Site	Year	n[1]	Density Estimate[2]	D SE[3]	D CV[4]	LCL[5]	UCL[6]
PHAI	Campbell Grade	2017	1	0.1	0.1	100%	0.012	0.844
		2019	9	0.897	0.345	39%	0.355	2.27
		2020	10	0.997	0.344	35%	0.433	2.293
	Lower Willows	2017	5	0.332	0.148	44%	0.126	0.873
		2019	5	0.332	0.148	44%	0.126	0.873
		2020	12	0.797	0.322	40%	0.329	1.93
	San Felipe North	2017	6	0.359	0.136	38%	0.159	0.811
		2019	5	0.299	0.103	34%	0.142	0.629
		2020	5	0.299	0.136	46%	0.113	0.79
	San Felipe South	2017	15	0.897	0.356	40%	0.382	2.108
		2019	4	0.239	0.134	56%	0.074	0.772
		2020	11	0.658	0.25	38%	0.29	1.49
	Sentenac Cienega	2017	4	0.199	0.114	57%	0.062	0.637
		2019	5	0.249	0.139	56%	0.08	0.776
		2020	4	0.199	0.114	57%	0.062	0.637
	Vallecito Cienega	2017	10	0.598	0.206	34%	0.284	1.258
		2019	28	1.675	0.273	16%	1.19	2.357
		2020	9	0.538	0.172	32%	0.27	1.073
SOSP	Campbell Grade	2017	0	0	0	0%	0	0
		2019	1	0.165	0.168	102%	0.02	1.38
		2020	1	0.165	0.168	102%	0.02	1.38
	Lower Willows	2017	1	0.11	0.112	102%	0.016	0.753
		2019	0	0	0	0%	0	0
		2020	3	0.33	0.178	54%	0.109	1.006
	San Felipe North	2017	13	1.289	0.693	54%	0.43	3.867
		2019	18	1.785	0.635	36%	0.865	3.684
		2020	18	1.785	0.635	36%	0.865	3.684
	San Felipe South	2017	0	0	0	0%	0	0
		2019	4	0.397	0.313	79%	0.085	1.859
		2020	1	0.099	0.101	102%	0.015	0.655
	Sentenac Cienega	2017	2	0.165	0.168	102%	0.026	1.042
		2019	8	0.661	0.413	63%	0.192	2.276
		2020	10	0.826	0.398	48%	0.314	2.176
	Vallecito Cienega	2017	0	0	0	0%	0	0
		2019	2	0.198	0.138	70%	0.049	0.794
		2020	0	0	0	0%	0	0

Appendix 4. continued

Species	Site	Year	n[1]	Density Estimate[2]	D SE[3]	D CV[4]	LCL[5]	UCL[6]
SPTO	Campbell Grade	2017	1	0.114	0.115	101%	0.014	0.966
		2019	2	0.229	0.23	101%	0.027	1.932
		2020	1	0.114	0.115	101%	0.014	0.966
	Lower Willows	2017	5	0.381	0.207	54%	0.12	1.206
		2019	1	0.076	0.077	101%	0.011	0.52
		2020	2	0.153	0.102	67%	0.038	0.614
	San Felipe North	2017	18	1.235	0.432	35%	0.587	2.599
		2019	12	0.824	0.318	39%	0.362	1.875
		2020	16	1.098	0.38	35%	0.526	2.293
	San Felipe South	2017	12	0.824	0.265	32%	0.416	1.631
		2019	8	0.549	0.233	43%	0.223	1.352
		2020	17	1.167	0.286	25%	0.697	1.954
	Sentenac Cienega	2017	8	0.458	0.163	36%	0.218	0.962
		2019	4	0.229	0.132	58%	0.071	0.735
		2020	8	0.458	0.163	36%	0.218	0.962
	Vallecito Cienega	2017	0	0	0	0%	0	0
		2019	0	0	0	0%	0	0
		2020	0	0	0	0%	0	0
VERD	Campbell Grade	2017	18	3.229	0.425	13%	2.467	4.226
		2019	16	2.87	0.867	30%	1.404	5.865
		2020	14	2.511	0.588	23%	1.464	4.308
	Lower Willows	2017	9	1.076	0.415	39%	0.465	2.493
		2019	17	2.033	0.614	30%	1.053	3.924
		2020	10	1.196	0.305	26%	0.689	2.075
	San Felipe North	2017	11	1.184	0.393	33%	0.581	2.413
		2019	4	0.43	0.181	42%	0.175	1.056
		2020	6	0.646	0.187	29%	0.347	1.202
	San Felipe South	2017	19	2.045	0.623	30%	1.064	3.93
		2019	9	0.969	0.269	28%	0.534	1.756
		2020	4	0.43	0.242	56%	0.133	1.392
	Sentenac Cienega	2017	4	0.359	0.278	78%	0.08	1.614
		2019	8	0.717	0.389	54%	0.237	2.174
		2020	2	0.179	0.122	68%	0.046	0.694
	Vallecito Cienega	2017	52	5.596	0.847	15%	4.111	7.619
		2019	32	3.444	0.855	25%	2.029	5.845
		2020	23	2.475	0.565	23%	1.525	4.018

Appendix 4. continued

Species	Site	Year	n[1]	Density Estimate[2]	D SE[3]	D CV[4]	LCL[5]	UCL[6]
WWDO	Campbell Grade	2017	19	1.092	0.292	27%	0.581	2.052
		2019	23	1.322	0.242	18%	0.878	1.99
		2020	16	0.92	0.262	28%	0.469	1.804
	Lower Willows	2017	21	0.805	0.197	25%	0.473	1.369
		2019	16	0.613	0.15	24%	0.361	1.042
		2020	11	0.422	0.119	28%	0.228	0.779
	San Felipe North	2017	9	0.31	0.124	40%	0.132	0.729
		2019	31	1.069	0.148	14%	0.807	1.417
		2020	11	0.379	0.135	36%	0.176	0.817
	San Felipe South	2017	14	0.483	0.154	32%	0.243	0.96
		2019	24	0.828	0.255	31%	0.427	1.605
		2020	10	0.345	0.095	28%	0.191	0.623
	Sentenac Cienega	2017	18	0.517	0.174	34%	0.255	1.05
		2019	34	0.977	0.29	30%	0.524	1.824
		2020	24	0.69	0.182	26%	0.396	1.201
	Vallecito Cienega	2017	56	1.932	0.417	22%	1.221	3.056
		2019	40	1.38	0.327	24%	0.832	2.289
		2020	28	0.966	0.178	18%	0.656	1.421
YBCH	Campbell Grade	2017	1	0.104	0.104	101%	0.012	0.878
		2019	3	0.312	0.143	46%	0.105	0.928
		2020	1	0.104	0.104	101%	0.012	0.878
	Lower Willows	2017	12	0.831	0.411	50%	0.287	2.407
		2019	6	0.415	0.185	45%	0.159	1.088
		2020	10	0.692	0.327	47%	0.25	1.917
	San Felipe North	2017	9	0.561	0.225	40%	0.238	1.319
		2019	3	0.187	0.134	72%	0.044	0.798
		2020	3	0.187	0.097	52%	0.063	0.558
	San Felipe South	2017	1	0.062	0.063	101%	0.009	0.41
		2019	1	0.062	0.063	101%	0.009	0.41
		2020	0	0	0	0%	0	0
	Sentenac Cienega	2017	0	0	0	0%	0	0
		2019	1	0.052	0.052	101%	0.008	0.325
		2020	0	0	0	0%	0	0
	Vallecito Cienega	2017	13	0.81	0.414	51%	0.276	2.377
		2019	9	0.561	0.26	46%	0.21	1.5
		2020	4	0.249	0.14	56%	0.077	0.806

Appendix 4. continued

Species	Site	Year	n[1]	Density Estimate[2]	D SE[3]	D CV[4]	LCL[5]	UCL[6]
YEWA	Campbell Grade	2017	0	0	0	0%	0	0
		2019	0	0	0	0%	0	0
		2020	1	0.11	0.11	100%	0.013	0.93
	Lower Willows	2017	6	0.439	0.221	51%	0.147	1.306
		2019	5	0.365	0.161	44%	0.139	0.959
		2020	5	0.365	0.249	68%	0.088	1.511
	San Felipe North	2017	28	1.842	0.432	24%	1.105	3.071
		2019	15	0.987	0.254	26%	0.563	1.731
		2020	24	1.579	0.409	26%	0.897	2.778
	San Felipe South	2017	5	0.329	0.112	34%	0.157	0.689
		2019	5	0.329	0.226	69%	0.081	1.336
		2020	3	0.197	0.101	51%	0.066	0.586
	Sentenac Cienega	2017	16	0.877	0.435	50%	0.314	2.451
		2019	11	0.603	0.252	42%	0.25	1.452
		2020	5	0.274	0.19	69%	0.069	1.085
	Vallecito Cienega	2017	1	0.066	0.066	100%	0.01	0.433
		2019	4	0.263	0.109	41%	0.108	0.642
		2020	3	0.197	0.141	72%	0.046	0.841