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SANTA CLARA VALLEY HABITAT PLAN 2021 BURROWING OWL BREEDING SEASON SURVEY REPORT

December 2021

SANTA CLARA VALLEY
HABITAT AGENCY

City of Gilroy

City of Morgan Hill

City of San José

County of Santa Clara

Santa Clara Valley Water District

Santa Clara Valley
Transportation Authority

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EXECUTIVE SUMMARY

The western burrowing owl *(Athene cunicularia hypugaea)* is a species covered under the Santa Clara Valley Habitat Plan (Habitat Plan), and annual population monitoring during the breeding season is a required activity, as described in the Western Burrowing Owl Conservation Strategy (Appendix M of the Habitat Plan, ICF International 2012). This report presents the results of Year 8 of these breeding season surveys. Also included in the report is pertinent background information, discussion of the results, and recommendations.

In collaboration with resource agencies, cities, and other local jurisdictions who are annually surveying for breeding burrowing owls, the South Bay Burrowing Owl Survey Network (Survey Network) was formed and has jointly contributed population data for the region since 2014. Data include regional distribution, adult population size, nest success, and productivity. These data enable the Habitat Agency to monitor changes in the population over time and evaluate progress toward the primary goal for burrowing owls within the Habitat Plan study area:

To establish a burrowing owl population in the study area and the expanded study area that is first stable, then increasing over time, while accounting for normal fluctuations in population levels.

During the 2021 breeding season surveys, surveyors observed a total of 36 adult (17 pairs) and 36 juvenile burrowing owls. Average productivity was 2.1 juvenile per pair. In comparison, in 2020 the number of adults observed was 38 and 66 juvenile burrowing owls, resulting in an average productivity of 3.67 juveniles per pair. In 2019 the number of adults was 33, the number of juveniles was 46, resulting in a productivity rate of 3.29 juveniles per pair. Currently, the goal of establishing a stable, then increasing owl population is not being met and the Habitat Agency will be working with the regulatory agencies and the Burrowing Owl Expert Team to explore and implement additional conservation measures in 2022.

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INTRODUCTION

The Santa Clara Valley Habitat Plan (Habitat Plan), approved in 2013, includes the western burrowing owl (*Athene cunicularia hypugaea)* as a covered species. The Habitat Plan's primary goal for this species is to establish a population in the study area and the expanded study area (Figure 1) that is first stable, then increasing over time, while accounting for normal fluctuations in population levels. The Santa Clara Valley Habitat Agency (Habitat Agency) is required to monitor the progress towards this goal and has coordinated annual breeding burrowing owl surveys in the Plan area.

In collaboration with resource agencies, cities, and other local jurisdictions who are annually surveying for breeding burrowing owls, the South Bay Burrowing Owl Survey Network (Survey Network) was formed and has jointly contributed population data since 2014. The Survey Network meets twice a year; once in February before the breeding season begins (spring meeting), and again in October after the breeding season concludes (fall meeting). During the spring meetings, survey coverage is discussed, and survey protocols are reaffirmed. During the fall meetings, survey results are shared, and adaptive management strategies discussed.

The Survey Network enables extensive survey area coverage and provides the Habitat Agency with confident estimates of the number of breeding burrowing owls and their reproductive rates in the region. Estimates include the number of pairs and single adults observed during the breeding season, as well as the number of juveniles produced per pair. This report presents the results of the 2021 breeding season surveys, evaluates progress towards the primary goal for this species, and informs conservation strategy implementation conducted by the Habitat Agency in coordination with the South Bay Burrowing Owl Survey Network and the Burrowing Owl Experts Team.

BACKGROUND

The number of breeding burrowing owls in the greater San Francisco Bay area—and the South Bay area in particular—is in decline (DeSante et al. 2007, Townsend and Lenihan 2007, California Natural Diversity Database [https://www.wildlife.ca.gov/data/cnddb]). During a statewide survey for burrowing owls during 1991–1993, researchers estimated 150–170 pairs breeding in the San Francisco Bay area (DeSante and Ruhlen 1995; DeSante et al. 1997) and estimated a 53% decline from the previous census period of 1986–1990 (DeSante et al. 1997). Findings of the 1991–1993 statewide census showed that 75% of the burrowing owl population in the San Francisco Bay area occurred in Santa Clara County and that nearly all owls were located around the southern edge of the San Francisco Bay (DeSante et al. 1997). About a third (43– 47 pairs) of these breeding pairs occurred inside what is now the Habitat Plan study area (City of San José 2000). Results of the 2006−2007 statewide census, (Wilkerson and Siegel 2010) showed similar findings in distribution of burrowing owls around the southern edge of the Bay. For the "San Francisco Bay Area Interior" survey area, which included seven counties from Sonoma in the north to Santa Clara in the south, and inland stretching from Napa to Alameda counties, the "best estimate" for the number of burrowing owl pairs in the region was 119, which represented a nearly 28% reduction from the 165 pairs estimated from the 1991−1993 survey (Wilkerson and Siegel 2010).

The Habitat Agency is implementing measures aimed at reversing the declining trend of the burrowing owl population in Santa Clara County. As described in the Conservation Strategy (Appendix M of the Habitat Plan, ICF International 2012), conservation actions are grouped into three "tiers" of priority, and during the first years of Plan implementation, the focus had been on Tier 1 conservation actions which were designed to stabilize the existing population by protecting and/or managing occupied burrowing owl nesting habitat in areas within 0.5 mile of established breeding sites. For the last four years, Tier 2 and Tier 3 conservation actions have also been implemented. Tier 2 actions include facilitating "growth and expansion of existing colonies, the number of colonies, and the range of the species in the permit area by protecting and managing potential burrowing owl nesting habitat in all portions of the permit area." Tier 3 conservation actions consist of "more experimental and active methodologies such as population augmentation and owl relocation within the permit area to increase owl numbers and expand distribution" (Appendix M of the Habitat Plan, ICF International 2012).

Surveys have also been conducted in areas currently not occupied, but containing suitable burrowing owl habitat. Collectively, these data inform adaptive management of this species and help prioritize use of funds for burrowing owl conservation under the Plan.

STUDY AREA

The Habitat Plan study area (519,506 acres) is located in Santa Clara County in the central California Coast Range (Figure 1). The primary valley in the study area is the Santa Clara Valley, extending from the south end of the San Francisco Bay to San Benito County. The Santa Clara Valley is bounded by the Diablo Range to the east, the Santa Cruz Mountains to the west, and the San Francisco Bay shoreline to the north. The study area excludes tidally influenced portions of the Baylands (Figure 1). For a description of the political, ecologic, and hydrologic factors used to define the study area, see Chapter 1 of the Habitat Plan (ICF International 2012).

During the development of the Habitat Plan, it was determined that opportunities for increasing the local population of burrowing owls were very limited within the study area. After extensive discussions with the California Department of Fish and Wildlife (CDFW), U.S. Fish and Wildlife Service (USFWS), and species experts, it was decided that one way to increase the local population was to include conservation areas outside the study area. An expanded study area for burrowing owl conservation (expanded study area) was identified at the northern edge of Santa Clara County in portions of the cities of San José, Santa Clara, Mountain View, Milpitas, and Sunnyvale, as well as in Fremont in Alameda County, and in a small portion of San Mateo County (Figure 1). The expanded study area for burrowing owl conservation added 48,464 acres where burrowing owl surveys and conservation actions can occur.

The North San José/Baylands region contains the largest remaining populations of breeding burrowing owls in the South Bay area. As in previous years, surveys in 2021 were primarily conducted in this region, specifically at Shoreline at Mountain View, San José-Santa Clara Regional Wastewater Facility (RWF), Don Edwards San Francisco Bay National Wildlife Refuge – Warm Springs Unit, NASA Ames Research Center at Moffett Field, San José International Airport, Sunnyvale Baylands Park, and Sunnyvale Landfill (Figure 2).

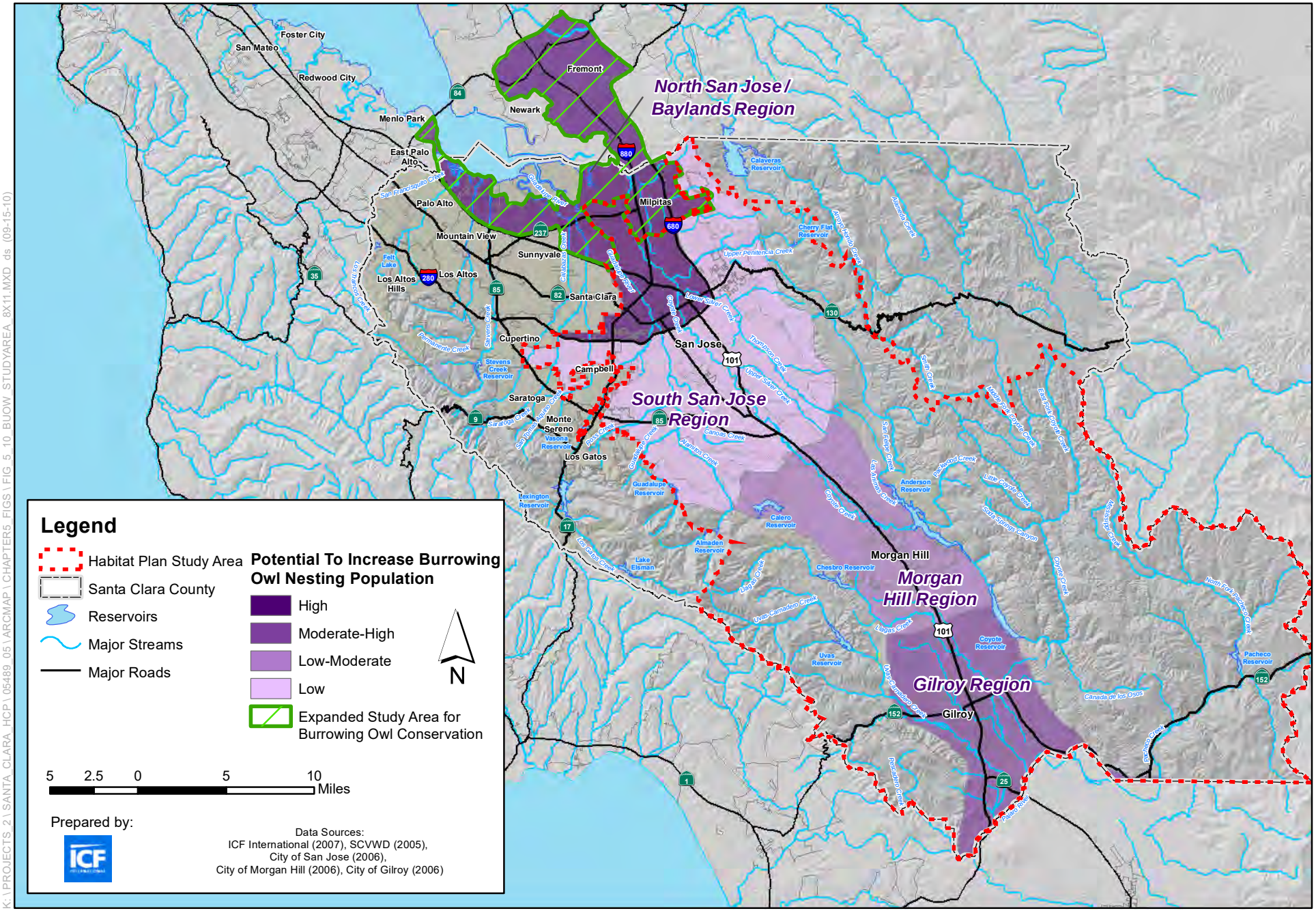
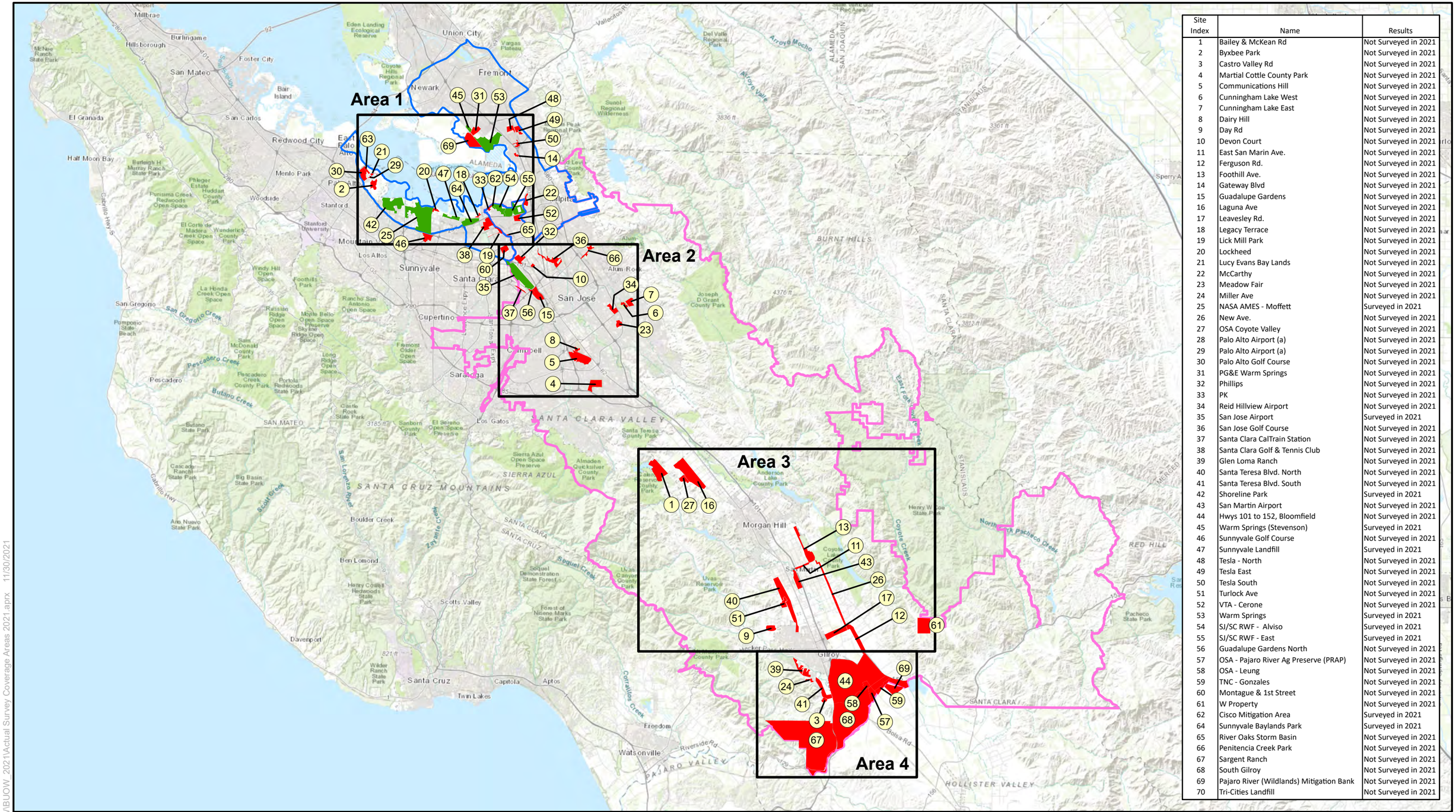


Figure 1. Santa Clara Valley Habitat Plan Study Area and Expanded Study Area for burrowing owl conservation.



Site Index	Name	Results
1	Bailey & McKean Rd	Not Surveyed in 2021
2	Byxbee Park	Not Surveyed in 2021
3	Castro Valley Rd	Not Surveyed in 2021
4	Martial Cottle County Park	Not Surveyed in 2021
5	Communications Hill	Not Surveyed in 2021
6	Cunningham Lake West	Not Surveyed in 2021
7	Cunningham Lake East	Not Surveyed in 2021
8	Dairy Hill	Not Surveyed in 2021
9	Day Rd	Not Surveyed in 2021
10	Devon Court	Not Surveyed in 2021
11	East San Marin Ave.	Not Surveyed in 2021
12	Ferguson Rd.	Not Surveyed in 2021
13	Foothill Ave.	Not Surveyed in 2021
14	Gateway Blvd	Not Surveyed in 2021
15	Guadalupe Gardens	Not Surveyed in 2021
16	Laguna Ave	Not Surveyed in 2021
17	Leavesley Rd.	Not Surveyed in 2021
18	Legacy Terrace	Not Surveyed in 2021
19	Lick Mill Park	Not Surveyed in 2021
20	Lockheed	Not Surveyed in 2021
21	Lucy Evans Bay Lands	Not Surveyed in 2021
22	McCarthy	Not Surveyed in 2021
23	Meadow Fair	Not Surveyed in 2021
24	Miller Ave	Not Surveyed in 2021
25	NASA AMES - Moffett	Surveyed in 2021
26	New Ave.	Not Surveyed in 2021
27	OSA Coyote Valley	Not Surveyed in 2021
28	Palo Alto Airport (a)	Not Surveyed in 2021
29	Palo Alto Airport (a)	Not Surveyed in 2021
30	Palo Alto Golf Course	Not Surveyed in 2021
31	PG&E Warm Springs	Not Surveyed in 2021
32	Phillips	Not Surveyed in 2021
33	PK	Not Surveyed in 2021
34	Reid Hillview Airport	Not Surveyed in 2021
35	San Jose Airport	Surveyed in 2021
36	San Jose Golf Course	Not Surveyed in 2021
37	Santa Clara CalTrain Station	Not Surveyed in 2021
38	Santa Clara Golf & Tennis Club	Not Surveyed in 2021
39	Glen Loma Ranch	Not Surveyed in 2021
40	Santa Teresa Blvd. North	Not Surveyed in 2021
41	Santa Teresa Blvd. South	Not Surveyed in 2021
42	Shoreline Park	Surveyed in 2021
43	San Martin Airport	Not Surveyed in 2021
44	Hwys 101 to 152, Bloomfield	Not Surveyed in 2021
45	Warm Springs (Stevenson)	Surveyed in 2021
46	Sunnyvale Golf Course	Not Surveyed in 2021
47	Sunnyvale Landfill	Surveyed in 2021
48	Tesla - North	Not Surveyed in 2021
49	Tesla East	Not Surveyed in 2021
50	Tesla South	Not Surveyed in 2021
51	Turlock Ave	Not Surveyed in 2021
52	VTA - Cerone	Not Surveyed in 2021
53	Warm Springs	Surveyed in 2021
54	SJ/SC RWF - Alviso	Surveyed in 2021
55	SJ/SC RWF - East	Surveyed in 2021
56	Guadalupe Gardens North	Not Surveyed in 2021
57	OSA - Pajaro River Ag Preserve (PRAP)	Not Surveyed in 2021
58	OSA - Leung	Not Surveyed in 2021
59	TNC - Gonzales	Not Surveyed in 2021
60	Montague & 1st Street	Not Surveyed in 2021
61	W Property	Not Surveyed in 2021
62	Cisco Mitigation Area	Surveyed in 2021
64	Sunnyvale Baylands Park	Surveyed in 2021
65	River Oaks Storm Basin	Not Surveyed in 2021
66	Penitencia Creek Park	Not Surveyed in 2021
67	Sargent Ranch	Not Surveyed in 2021
68	South Gilroy	Not Surveyed in 2021
69	Pajaro River (Wildlands) Mitigation Bank	Not Surveyed in 2021
70	Tri-Cities Landfill	Not Surveyed in 2021

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Figure 2. 2021 Overview of burrowing owl survey coverage in the Santa Clara Valley Habitat Plan Study Area and Expanded Study Area for burrowing owl conservation.

Habitat Plan Expanded Study Area
Habitat Plan Permit Area
Surveyed in 2021 (4,190.9 acres)
Not Surveyed in 2021 (24,030.5 acres)

D:\HCP_PROJECTS\BUOW\BUOW_2021\Actual Survey Coverage Areas 2021.aprx 11/30/2021

METHODS

The survey protocol was adapted from the *Burrowing Owl Survey Protocol and Mitigation Guidelines* (The California Burrowing Owl Consortium 1993), as well as the *Staff Report on Burrowing Owl Mitigation* (California Department of Fish and Game 2012) and modified to meet the biological goals and objectives of the Habitat Plan's Burrowing Owl Conservation Strategy (Habitat Plan Appendix M, ICF International 2012). The Habitat Agency, in coordination with USFWS and CDFW, uses the survey results to allocate burrowing owl conservation funds and to assess compliance with the conservation program outlined in the Western Burrowing Owl Conservation Strategy.

BREEDING SEASON SURVEYS

All sites were surveyed multiple times during the height of the breeding season (March 15−July 15). Site visits were generally conducted between morning civil twilight to 10:00 a.m., or two hours before sunset until evening civil twilight. Pedestrian surveys were conducted during weather conducive to observing owls outside their burrows by avoiding surveying during heavy rain, high winds (>20 km per hour), or dense fog. All burrowing owl sightings, occupied burrows, and burrows with owl sign (e.g., whitewash, feathers, regurgitated pellets, prey remains) were recorded and mapped. Numbers of adult and juvenile burrowing owls and their behaviors such as courtship and foraging were also recorded. Unoccupied sites were classified as having low, moderate, or high potential for breeding burrowing owls based on site conditions observed during the surveys.

Surveyors scanned the ground, all perch structures inside the survey area, and perimeter fences (if present) with binoculars or spotting scopes from various observation points. They walked each site and inspected ground squirrel burrows for signs of burrowing owl occupancy, including whitewash, nest decoration materials, prey remains, and molted feathers. The surveyors recorded the date, time, weather conditions, and observations on the survey form. They took digital photographs of most survey areas.

RESULTS

The Habitat Agency, in coordination with USFWS and CDFW, uses the survey results to allocate burrowing owl conservation funds and to assess compliance with the conservation program outlined in the Western Burrowing Owl Conservation Strategy.

SURVEYS OF CURRENTLY OCCUPIED BREEDING SITES

As in previous years, burrowing owls were observed at four breeding sites in the South Bay area during the 2021 breeding season: Shoreline at Mountain View, San José-Santa Clara Regional Wastewater Facility, NASA Ames Research Center at Moffett Field, and the San José International Airport. No breeding pairs were observed at Don Edwards San Francisco Bay National Wildlife Refuge – Warm Springs Unit. In total, surveyors observed 36 adults, forming 17 pairs, 10 of which were successful (Table 1). Pairs produced a total of 36 young resulting in a reproductive rate of 2.1 young/pair. In comparison, in 2020 the number of adults observed was 38 and 66 juvenile burrowing owls, resulting in an average productivity of 3.67 juveniles per pair. In 2019 the number of adults was 33, the number of juveniles was 46, resulting in a productivity rate of 3.29 juveniles per pair.

This year, six (3 pairs) of the breeding owls, as well as three single males were released at RWF as part of the Juvenile Burrowing Owl Overwintering Project. These nine owls represented 25% of the total breeding population in the Plan Study Area. Additionally, four owls (2 females and 2 males) from the Overwintering Project were retained to initiate a Captive Breeding Program. More detailed information on these 13 individuals is included under the site descriptions below.

Table 1. 2021 Breeding burrowing owl survey results for the Santa Clara Valley Habitat Plan Study Area and Expanded Study Area for Burrowing Owl Conservation.

Site Name/Location	Number of adults	Number of juveniles	Number of pairs	Number of successful pairs
San José International Airport	4	10	2	2
San José-Santa Clara Regional Wastewater Facility	12**	9	6**	2
Study Area subtotal	*16*	*19*	*8*	*4*
Shoreline at Mountain View	11*	6	5*	2
Don Edwards SFB National Wildlife Refuge - Warm Springs Unit	0	0	0	0
NASA Ames Research Center at Moffett Field	6*	7	3*	2
Expanded Study Area subtotal	*17*	*13*	*8*	*4*
Captive Breeding Program	4***	4	2***	2
Totals	36	36	17	10

* One female travelled between Shoreline and Moffett; counted as part of a pair at each site, but only once in the totals.
** Nine of the 12 adults (3 pairs and 3 single males) were released on site as part of the Juvenile Burrowing Owl Overwintering Project.
*** Four owls were retained for the Captive Breeding Program from the Juvenile Burrowing Owl Overwintering Project.

Shoreline Regional Wildlife Area in Mountain View

This breeding site is located in the City of Mountain View between Highway 101 and south-San Francisco Bay, and includes the lands around Shoreline Amphitheater and Shoreline Golf Links. Data for this population have been collected consistently since 1998 (Figure 3). The number of adult owls observed during the breeding season has fluctuated over time with a low of two owls observed in 2019 to a high of 26 owls in 2003. This year, two of five pairs successfully reproduced and raised a total of six offspring. Nesting success was 40% with a productivity of 1.20 young/pair. Last year, productivity was 4.38 young/pair and average productivity (1998−2021) at this site is 1.9 young/pair.

Last year, five pairs were soft-released at Shoreline as part of the Juvenile Overwintering Project. All five pairs remained on site during the 2020 breeding season and successfully raised young. Of the five released pairs, three pairs and one single female were observed at Shoreline for the 2021 breeding season. The single female paired up with an unbanded male. In addition to the released owls, a fifth pair nested at Shoreline. This pair were siblings hatched at Moffett during 2019. They successfully produced offspring at Shoreline during 2020, but were not successful during 2021. The female from this sibling pair actually abandoned her nest burrow and moved to Moffett where she paired up with a different male, but did not produce any young. She then returned to Shoreline to pair up with her sibling again, with no success.

Since 2017, supplemental feeding has been implemented at this site as well as at Moffett Field, San José-Santa Clara RWF, and Warm Springs Unit (Higgins et al. 2017−2021). Twice per week, we placed dead mice in nest burrow entrances at each participating site. We fed 14 mice (~255gm) per week at each nest burrow during the period from estimated pair formation until fledging, following the protocol described by Wellicome et al. (2013). Supplemental feeding begins each year when pairs typically lay eggs (March/April) and continues until young are fledged. If no offspring are observed at a nest burrow by July 1, supplemental feeding at that particular burrow ceases.

Adult and young owls have been banded at this site from 1998 to 2004, and then continuously since 2012. Banding data show at least seven instances of inbreeding in 2004, 2006, 2015, 2016, 2017, and 2020. Inbreeding is a common occurrence for small populations and has been observed at other locations within the study area (Barclay and Menzel 2011).

Habitat loss and direct human disturbance have been the main observable factors for the population decline at this site. Between 2014 and 2018, a total of 56 ground squirrel burrows have been intentionally blocked at Shoreline, 16 of these were used by burrowing owls at some time. In 2017, at least two occupied burrow entrances were blocked on purpose. In recent years there has also been an increase in recreational drones that are flown above the owl habitat. Drones have been observed circling around occupied burrows, and owls responded by seeking cover underground.

Additionally, pedestrians have been observed off-trail near occupied burrows and dogs are frequently let off their leashes. With the installation of a 6-foot tall chain link fence around the NE Meadowlands in 2019, human disturbance at this location has been eliminated. During the 2021 breeding season, four of the five pairs nested inside the fenced area. The fifth pair nested outside the fenced area and in response to continual disturbance from photographers and birders, two temporary fences had to be installed around this nest burrow. The fences provided some protection; however, on multiple occasions the temporary fences were torn down, or people climbed over or under them.

Due to COVID-19 restrictions, public access to Shoreline was reduced during part of the year. Once access restrictions were eased, however, more people with dogs were observed on site, most likely because people had more flexible schedules working from home or being unemployed.

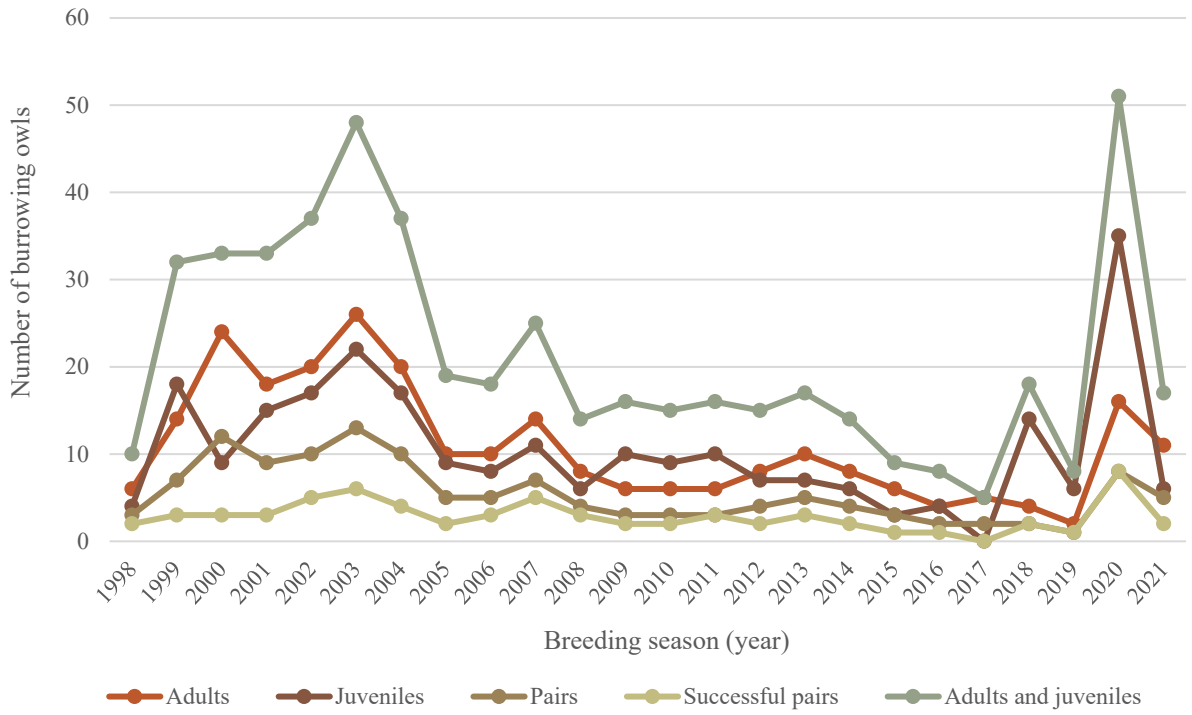


Figure 3. Shoreline at Mountain View Annual Burrowing Owl Survey Results, 1998−2021.

NASA Ames Research Center at Moffett Field

Moffett Field is located immediately east of Shoreline, north of the intersection of Highway 101 and 237. Data for this population has been collected consistently since 1998. The number of breeding adults has fluctuated between a high of 61 adults in 1999 and a low of four adults in 2020 (Figure 4). This year, two of three breeding pairs were successful and produced seven young. Productivity was 2.3 young/pair, which was higher than the average productivity of 1.9 young/pair (1998−2020) at this breeding site.

In 2020, one of two breeding pairs was successful and produced five young, and in 2019 only one of five breeding pairs was successful and produced eight young. In 2018, 15 adults (6 females and 9 males) were observed, but because of a shortage of females, only six pairs formed and produced a total of 30 young, more than twice as many young produced compared to the prior year.

This was the fifth year supplemental feeding was implemented (Higgins et al. 2017−2021, Wellicome et al. 2013) at this site. Each year, all pairs and their young were fed throughout the breeding season. Adult and juvenile owls were banded annually during the breeding season. Incestuous mating and polygyny were documented in 2010, 2012−2014, and 2019, likely limiting genetic diversity within the colony.

The owls at Moffett Field continue to be impacted by multiple stressors. Cumulative negative effects from construction projects over the years have destroyed, degraded, and fragmented historical nesting, wintering, and foraging habitat. Other strains on this population were a lapse in non-native predator abatement (especially red foxes) and USDA's need to balance airfield safety with wildlife management/habitat protection.

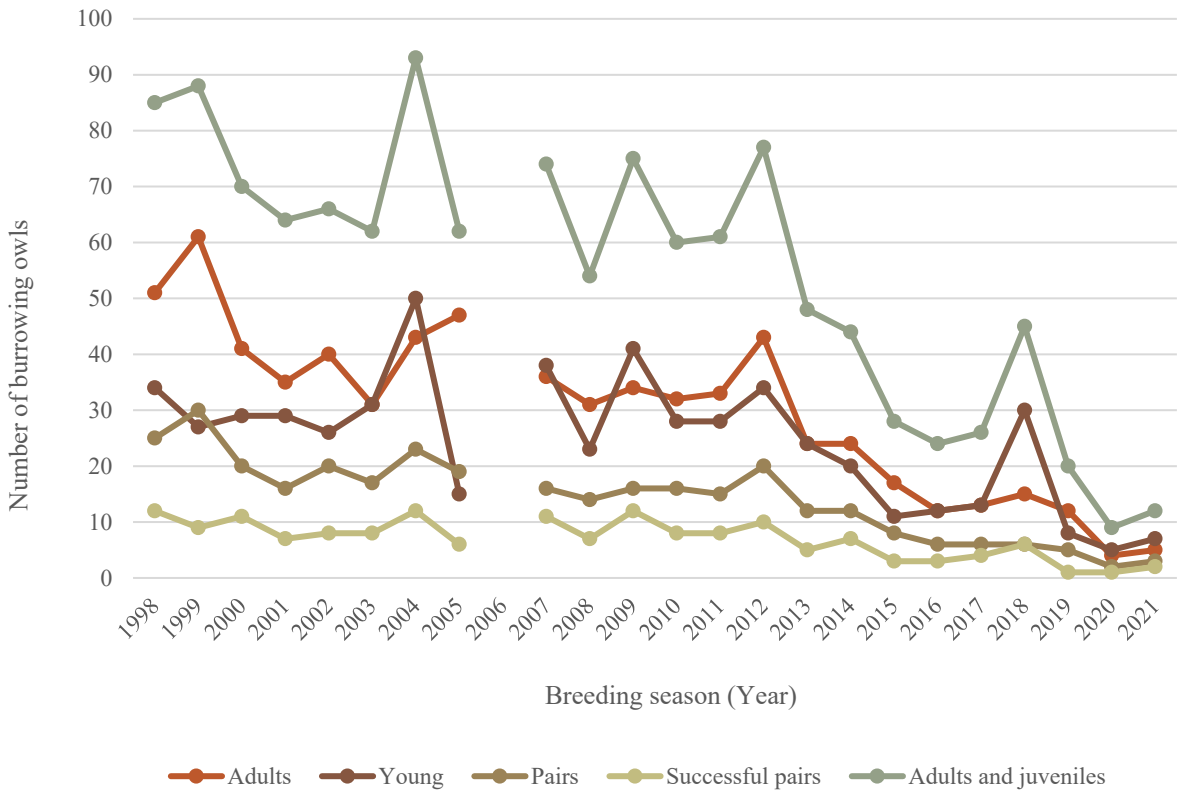


Figure 4. NASA Ames Research Center at Moffett Field Annual Burrowing Owl Survey Results, 1998−2021.

San José-Santa Clara Regional Wastewater Facility Bufferlands

The bufferlands are located in Alviso in north San José, north of Highway 237 between Coyote Creek and the Guadalupe River. Data for this population were collected opportunistically from 1996–2013 and then more consistently since 2014. The number of adult owls observed during the breeding season has fluctuated between a low of two adults in 2012 and a high of 35−37 adults in 2017 (Figure 5). This year, two of six pairs were successful and produced a total of nine young. Productivity was 1.5 young/pair which was lower than the average productivity of 3.1 young/pair (2015−2021) at this breeding site. Last year, two of three pairs were successful and produced a total of nine young. Productivity in 2020 was 3.0 young/pair.

This year, on 26 February, three single males were soft-released into a single hacking enclosure as part of the Juvenile Burrowing Owl Overwintering Project. These males were kept in the enclosure until 12 March. Upon removal of the enclosure, two males remained on site and paired up with females. One of these pairs successfully produced five young, while the other pair did not reproduce.

On 19 March, three pairs were soft-released into separate hacking enclosures as part of the Juvenile Overwintering Project. Two of the enclosures were removed on 16 April, after we observed six eggs in Enclosure 1 and four eggs in Enclosure 2. We did not observe eggs in Enclosure 3, even after delaying removal of the enclosure until 1 May. The female in this enclosure was a rehabilitated owl from the Silicon Valley Wildlife Rescue Center. As a rescue, her age was unknown; possibly she was past reproductive age. None of these three released pairs produced offspring, even though two of the females had laid eggs.

The only other pair that successfully reproduced at RWF during 2021 produced four young. This was the second year in a row that this pair successfully reproduced. The female was released as part of the Juvenile Overwintering Project in 2020, as described in the next paragraph, while the male hatched at RWF.

Last year, three female burrowing owls were released at RWF as part of the Juvenile Overwintering Project. They were released into one hacking enclosure on 21 February 2020. After the enclosure was removed on March 6, one of the females was never resighted post-release; the two others found mates and remained on site for the breeding season.

2021 and 2020, were the least productive years, with nine young each year, since consistent data collection began in 2014. In 2019, four of five pairs were successful and produced a total of 21 young. In 2018, nine pairs were observed, seven of which were successful, and produced a total of 22 young (Santa Clara Valley Audubon Society 2018−2020).

All pairs and their young were supplementally fed throughout the breeding season (Higgins et al. 2017−2021, Wellicome et al. 2013). This was the third year supplemental feeding was implemented at RWF. Adult and juvenile owls have been banded at this site since 2015. Analysis of banding data revealed that one pair was inbreeding in 2019; a female mated with her male offspring and produced five young (Chromczak 2015−2020).

Foraging habitat for this population has been reduced in recent years. During 2016 and 2017, grassland areas to the northeast along Disk Drive were fully developed. Increased use of anticoagulant rodenticides leading to secondary poisoning in these newly urbanized areas is of concern to burrowing owl survival. During the 2018 breeding season, two burrowing owl pairs closest to the new development failed to produce fledglings; the cause for this failure is unclear. In 2019, six nestlings were orphaned in the same area; the fate of their parents was unknown. Fortunately, we were able to capture all six orphans and transfer them to the Wildlife Care Center at the Peninsula Humane Society in Burlingame where they were cared for as part of the Juvenile Burrowing Owl Overwintering Project.

Vegetation management at this site has varied over the years, from minimal maintenance, to intensive sheep grazing, to regular mowing. Habitat enhancements at this site include the installation of artificial burrows, mounds and berms, vegetative islands, and brush piles. In 2017 and 2019, extended periods of flooding at the start of the breeding season reduced the availability of breeding and foraging habitat.

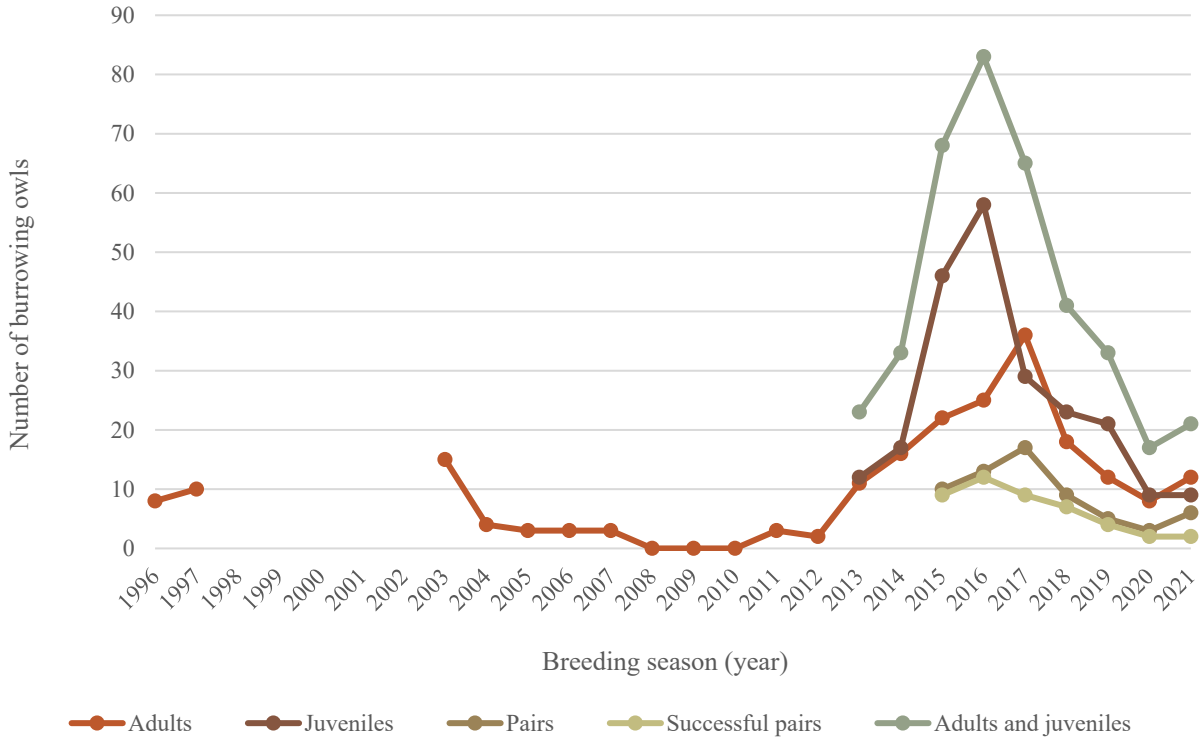


Figure 5. San José-Santa Clara Regional Wastewater Facility Annual Burrowing Owl Survey Results, 1996−2021.

Don Edwards San Francisco Bay National Wildlife Refuge – Warm Springs Unit

The Warm Springs Unit of the refuge is located along the southeastern side of San Francisco Bay, west of Highway 880. Of the five main owl populations in the South Bay, the Warm Springs Unit has the greatest amount of suitable, undisturbed habitat for burrowing owls. Data for this population have been collected somewhat consistently since 2001. Adult and juvenile owls have been banded at this site annually since 2015.

The number of adult owls observed during the breeding season has fluctuated between a high of 64 adults in 2008 and a low of two single adults in 2020 (Figure 6). In 2021, we observed no breeding adults at this site.

Vegetation management at this site included cattle grazing and targeted application of herbicide to control non-native weed species. Vegetation conditions were favorable throughout the year. Urban development has increased around the Warm Springs Unit. Construction of the Pacific Commons development, adjacent to the north, has been completed; development is planned along Auto Mall Parkway. Increased use of anticoagulant rodenticides leading to secondary poisoning in these newly urbanized areas is of concern to burrowing owl survival. The site is now mainly surrounded by habitat unsuitable for owls; salt ponds to the southwest and urban development everywhere else.

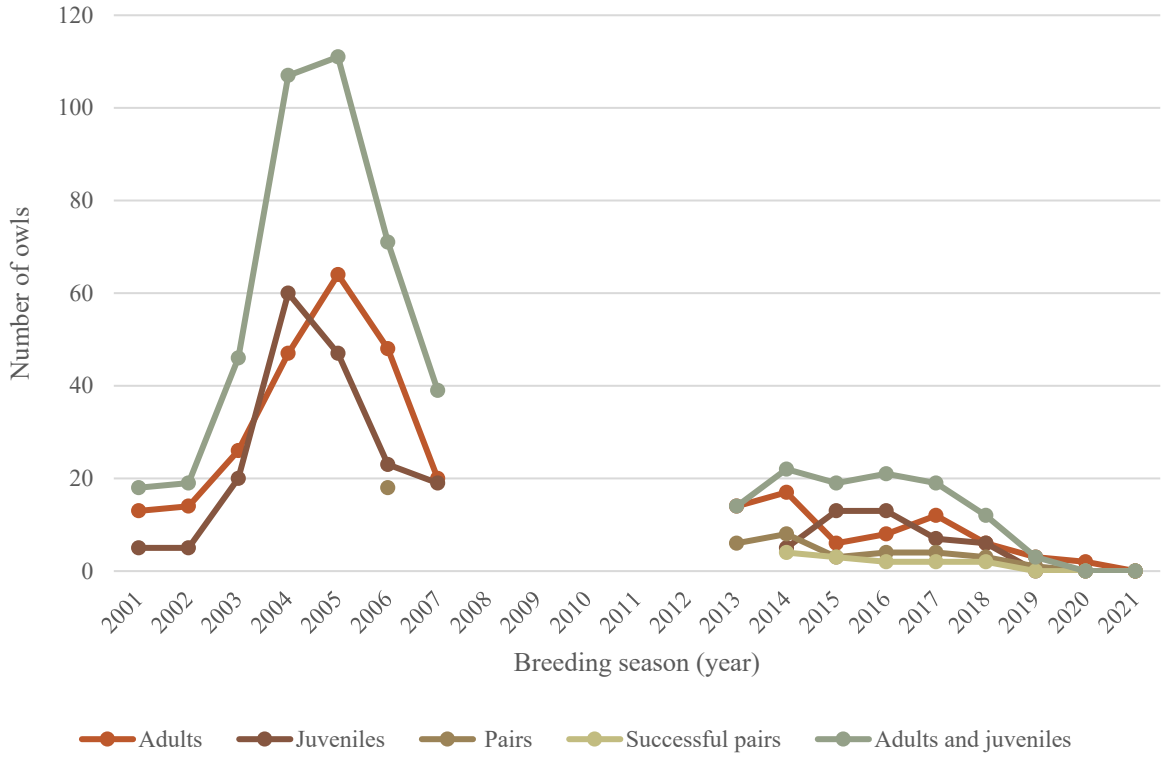


Figure 6. Don Edwards San Francisco Bay National Wildlife Refuge – Warm Springs Unit Annual Burrowing Owl Survey Results, 2001−2021.

San José International Airport

San José International Airport is currently the southernmost site for breeding burrowing owls within the Habitat Plan study area and is located just south of Highway 101 and west of Highway 880. Data for this population were collected consistently during 1990−2012 (Barclay et al. 2011), and somewhat consistently since then by U.S. Department of Agriculture. The number of adult owls observed during the breeding season at this site has fluctuated between a high of 82 adults in 2002 and a low of eight adults in 2017 (Figure 7). This year, two pairs produced a total of 10 young for a reproductive rate of five young/pair. Average productivity at this breeding site is 3.7 young/pair. Last year, five pairs produced a total of 17 young.

This population also faces a variety of stressors, including habitat loss, airfield traffic/strike hazard, and USDA's need to balance airfield safety with wildlife management and habitat protection. Between 1997 and 2012, the burrowing owl population was actively managed by installing and maintaining artificial burrows along taxiways and at the end of runways where the strike hazard of burrowing owls with aircraft is lowest (Barclay 2007, Barclay et al. 2011). Burrowing owls chose to occupy artificial burrows more frequently than natural burrows and breeding success was greater at artificial burrows than at natural burrows. However, annual surface maintenance and regular maintenance of the entire artificial burrow are essential for longer-term occupancy (Menzel 2018).

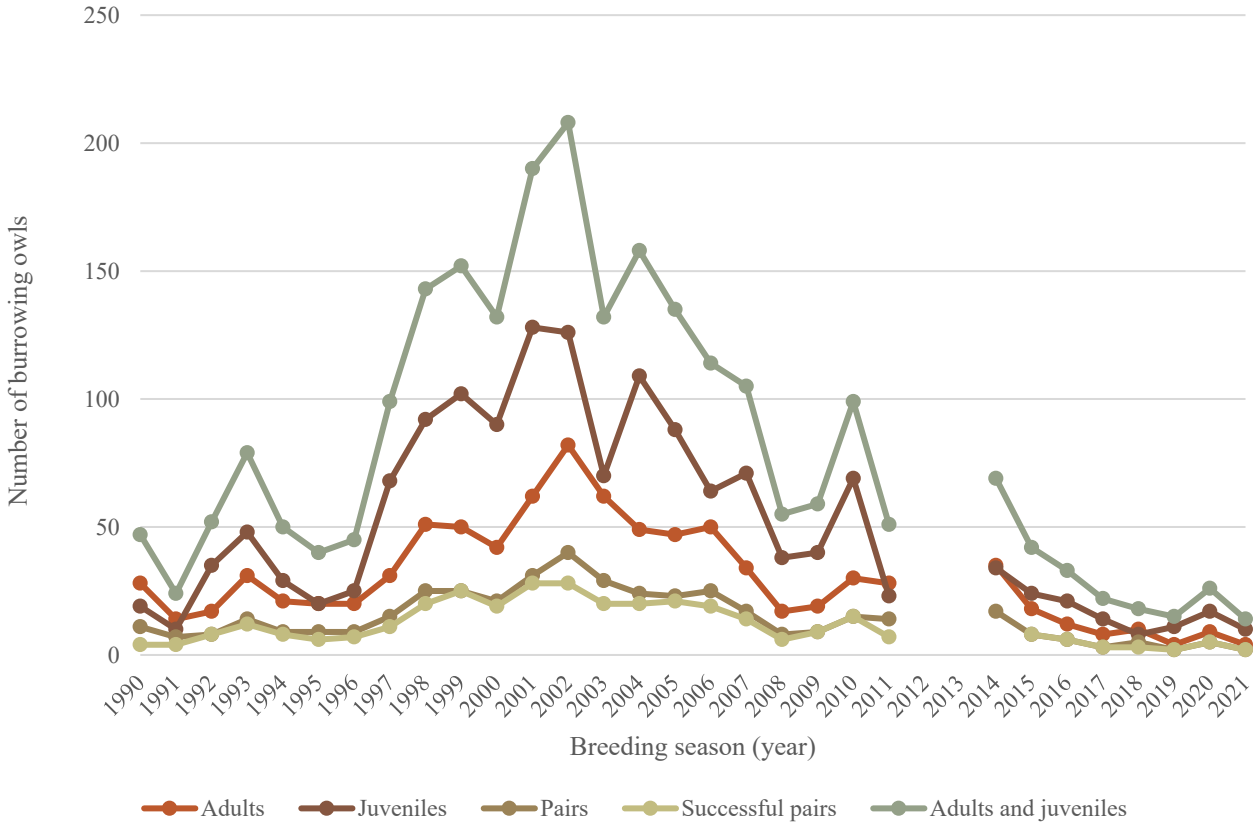


Figure 7. San José International Airport Annual Burrowing Owl Survey Results, 1990−2021.

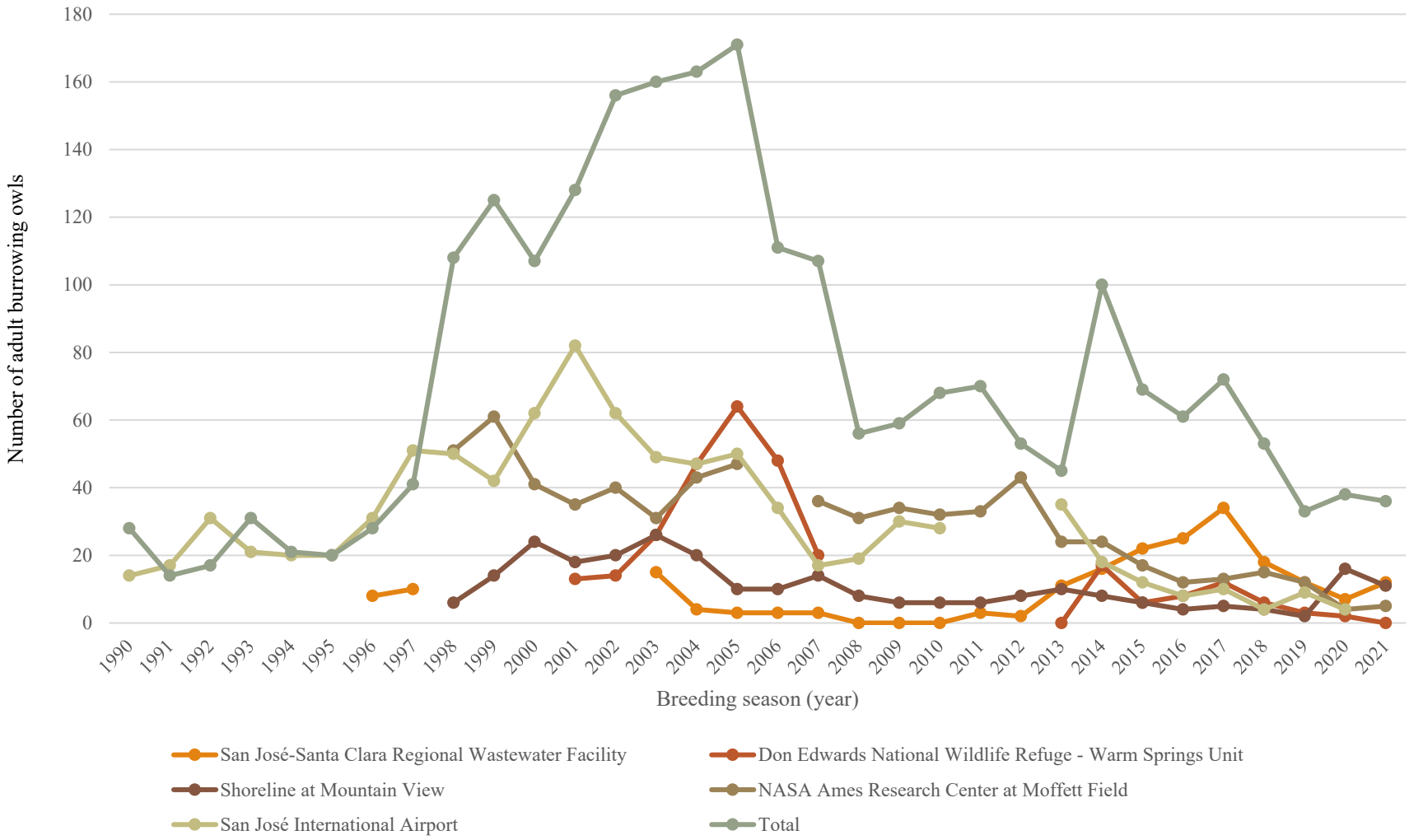


Figure 8. Number of adult owls observed at five breeding sites in the Santa Clara Valley Habitat Plan Study Area and Expanded Study Area for burrowing owl conservation, 1991−2021.

ADDITIONAL SURVEY AREAS

Besides the five breeding sites described above, two additional areas were surveyed during the breeding season (Table 2). No breeding owls were observed within either of these areas. Fresh sign of burrowing owl activity was observed at Sunnyvale Baylands Park in July 2018, but not since then. Wintering owls were observed at Sunnyvale Landfill in October/November 2021.

Table 2. Summary of burrowing owl and ground squirrel observations at two locations within the Habitat Plan Permit Area and Expanded Study Area in 2021.

Survey location (Location number)	Survey frequency	No. of burrowing owls observed	Abundance of ground squirrels	Vegetation height
Sunnyvale Baylands Park (64)	Quarterly surveys, April and July 2021	None	Low	short−medium
Sunnyvale Landfill (47)	Monthly surveys, April−August 2021	None	High	short−medium

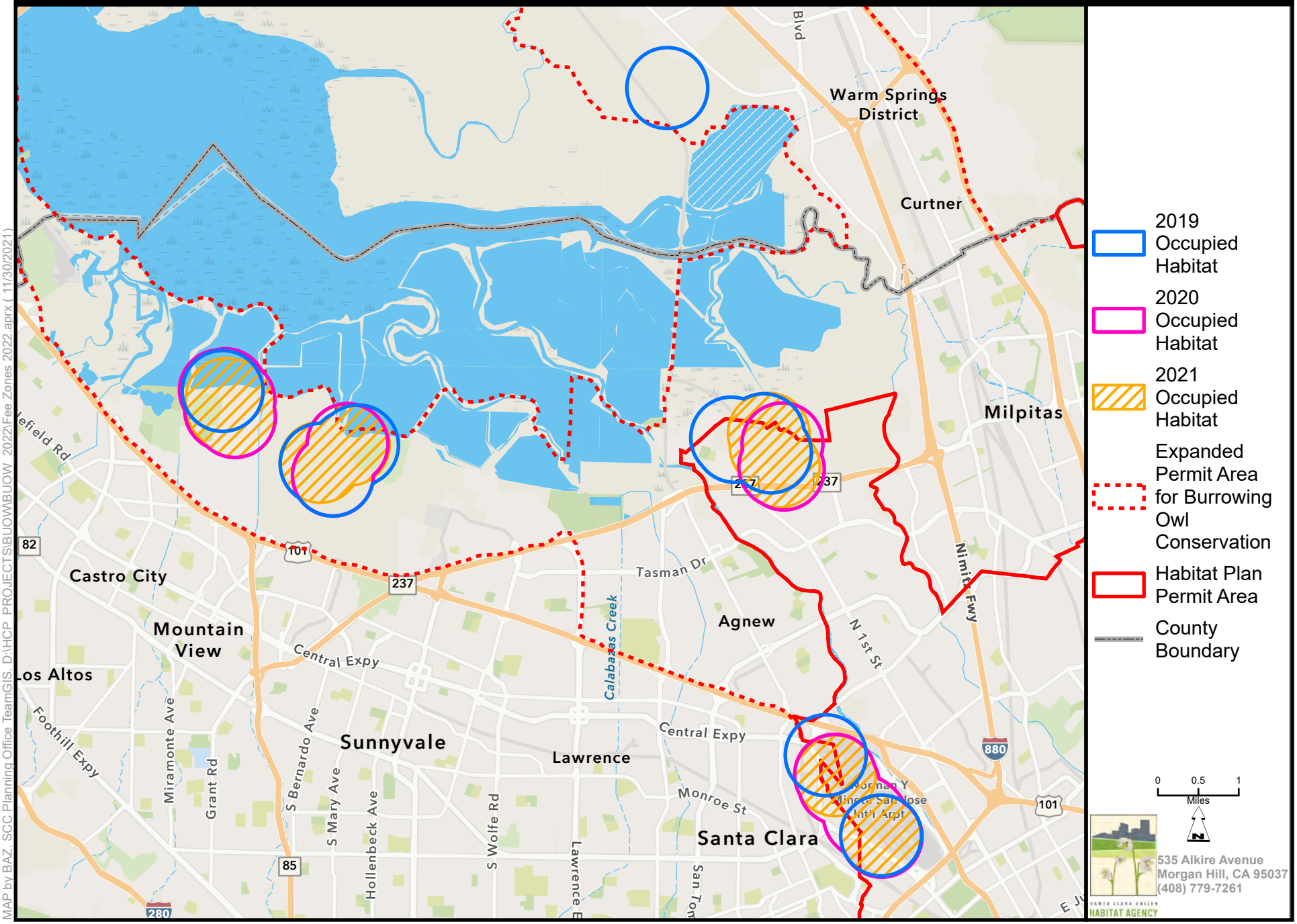
OCCUPIED BURROWING OWL HABITAT

The area of occupied burrowing owl habitat, which includes foraging habitat within a 0.5-mile radius around each nest location, has been calculated (Table 3) and delineated (Figure 9) annually to aid revision of the burrowing owl conservation fee map (Appendix 6). Based on the recent distribution of breeding burrowing owls in the study area and the propensity of burrowing owls to forage within 0.5 mile of nest locations during the breeding season (Haug and Oliphant 1990, Rosenberg and Haley 2004), the Habitat Plan area contained an estimated 3,244.6 acres of occupied nesting habitat in 2021. The acreage of occupied habitat in the Plan Area has decreased by 49.4% (6,568.4 acres) since 2018 (Table 3).

Table 3. Area of occupied burrowing owl habitat in the Santa Clara Valley Habitat Plan Study Area and Expanded Study Area for burrowing owl conservation, 2014−2021. Acreage includes a 0.5-mile buffer around each occupied nest burrow.

Year	Acres
2014	5,095.8
2015	5,533.6
2016	8,375.1
2017	8,607.5
2018	6,568.4
2019	3,830.3
2020	3,394.1
2021	3,244.6

Figure 9. Occupied Burrowing Owl Habitat in the Santa Clara Valley Habitat Plan Study Area and Expanded Study Area, 2019-2021



MAP by BAZ, SCC Planning Office TeamGIS, D:\HCP PROJECTS\BUOWMBUOW 2022\Fee Zones 2022.aprx (11/30/2021)

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DISCUSSION

Since 2014, the South Bay Burrowing Owl Survey Network has supported the Habitat Agency in meeting the Habitat Plan's survey goals. During this eighth annual breeding season survey, the number of owls has slightly decreased from a total of 38 adults in 2020 to 36 in adults in 2021 (Table 4). Small populations such as this are inherently more vulnerable to external environmental perturbations and chance fluctuations in local survival and fecundity (Keller and Waller 2002).

Table 4. Comparison of adult burrowing owls observed in the Santa Clara Valley Habitat Plan area during the breeding season, 2014−2021.

Location	2014	2015	2016	2017	2018	2019	2020	2021
San José International Airport	34	18	12	8	10	4	9	4
SJ/SC Regional Wastewater Facility	16	22−23	25−26	35−37	18	12	8 (3)*	12 (9) *
Shoreline at Mountain View	6	6	4	5	4	2	16 (10)*	11
Don Edwards-Warm Springs Unit	11	6	8	11−12	5–6	3	2**	0
Moffett Field	24	17	12	13	15	12	4	6***
Other Locations	16	5	0	2	0	0	0	0
Captive Breeding Program	—	—	—	—	—	—	—	4
Total	107	75	62	77	52−53	33	38	36

* In parenthesis is the number of owls released on site as part of the Juvenile Burrowing Owl Overwintering Project.
** One male travelled between SJ-SC RWF and Warm Springs; counted at each site, but only once in the totals.
*** One female travelled between Shoreline and Moffett; counted at each site, but only once in the totals.

Of the 36 adults, nine (25%) were released as part of the Juvenile Burrowing Owl Overwintering Project in 2021 (Figure 10). Without protection of these juveniles in captivity, 50−75% of them would likely have perished during fall and winter and the number of breeding adults in 2021 would likely have been lower. This year, we also initiated a Captive Breeding Program. Four owls from the Juvenile Overwintering Project were retained to form two breeding pairs. These two captive pairs produced a total of four offspring (Figure 10). The success of the Overwintering Project and the Captive Breeding Program are crucial for maintaining, and hopefully increasing, a source population in the Plan area.

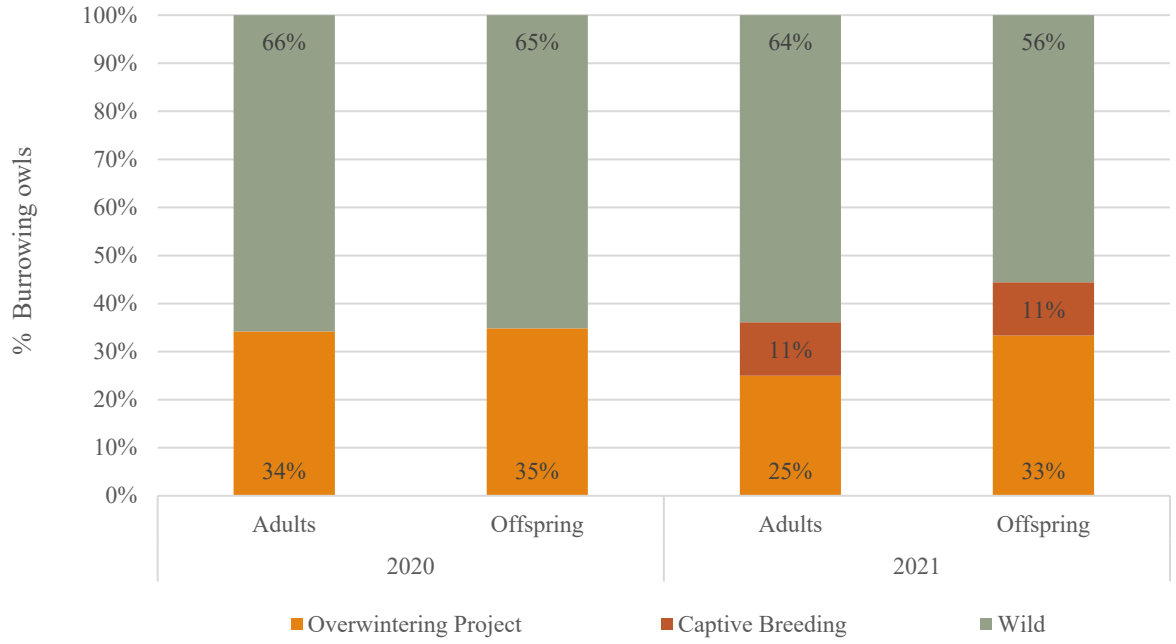

Figure 10. The total number of breeding burrowing owls and their offspring observed in the Santa Clara Valley Habitat Plan area represented in percentages based on source affiliation: owls breeding in the wild, released as part of the Juvenile Overwintering Project, or retained for the Captive Breeding Program.

A Population Viability Analysis (PVA) for burrowing owls completed during preparation of the Habitat Plan suggested that in order to change the population trend from negative to positive within a 10-year time period at the three sites included in the PVA (Moffett Field, San Jose International Airport, and Shoreline), there would have to be an increase of three adult owls per year for all three sites combined (Appendix M and N of the Habitat Plan, ICF International 2012). The baseline count was 51 adult owls in 2009. Currently, the combined count of adult owls at these three breeding sites is 20 adults, down from 29 adults in 2020.

Inbreeding has been observed at several sites over the last decade and likely contributes to the overall population decline through *inbreeding depression*. Inbreeding depression is the reduction in the average fitness of offspring born to parents that are closely related to each other, compared to the fitness of offspring born to unrelated parents. Inbreeding depression occurs because closely related parents share more genes, and thus their offspring are more likely to receive two copies (one from each parent) of alleles that cause deleterious traits or genetic diseases. Inbreeding data from bird and mammal populations suggest that inbreeding depression often significantly affects birth weight, survival, reproduction, resistance to disease, predation, and environmental stress (Keller and Waller 2002).

In addition to a low number of individuals, pairs of burrowing owls in the South Bay were limited to only four breeding sites. This regional contraction in range exposes the breeding population to stochasticity and therefore a high risk of local extirpation, especially because all these sites are facing increasing pressure from encroaching development. While burrow availability and foraging habitat have been reduced, the rate of disturbance and predation pressure has increased. Habitat protection and management at current breeding sites is imperative.

One additional pressure during the last two years were extreme drought conditions perhaps exacerbated by climate change. During drought years, prey availability for burrowing owls is limited and competition for these reduced resources is increased. Severe and changing weather events, including precipitation and temperature patterns, must be anticipated in the future, but will be challenging to predict/alleviate. During 2021, some grass species were dormant or had limited growth and we noticed an increased distribution of some invasive weedy species (mustard spp., stinkwort, and pepperweed) at most sites. In addition, we observed few if any grasshoppers during transect surveys. In prior years, grasshoppers were abundant during the summer. Grasshoppers are an essential prey item for burrowing owls during the breeding season while adults feed their young. Scarcity of grasshoppers (and likely other invertebrates) in 2021 could have contributed to the reduced breeding success and productivity of the owls.

RECOMMENDATIONS

We recommend that the Habitat Agency continue to organize the South Bay Burrowing Owl Survey Network's breeding season surveys in 2022. In-person meetings to discuss the approach and results of these surveys were usually held in spring (February/March) and fall (September/October). These meetings might need to continue to be held as video conference calls due to COVID-19 restrictions on in-person meetings.

Recommended activities in 2022 include the following:

1. Continue surveys in occupied habitat (Figure 9) in the Habitat Plan study area and expanded burrowing owl conservation area (locations with known occurrences in the last 3 years).
2. Implement additional measures as described in Tier 2 and Tier 3 conservation actions in the Habitat Plan to help achieve the goal of a stable, then increasing breeding burrowing owl population. Special emphasis should be placed on:

    - Preventing disturbance near occupied nest burrows with full support of stakeholders.
    - Reducing adult mortality rates by preventing the use of harmful rodenticides near occupied habitat and reducing the threat from non-native predators.
    - Continuing the Juvenile Burrowing Owl Overwintering Project, initiated in 2019, to reduce juvenile mortality rates
    - Increasing reproductive success through supplemental feeding.
    - Continuing the Burrowing Owl Captive Breeding Program, initiated in 2021.
    - Once extant colonies are stabilized, reintroductions to currently unoccupied sites should be considered, specifically in the southern part of Santa Clara County (Coyote Valley).
    - Increasing California ground squirrel distribution and abundance through habitat enhancements and reintroduction programs.
    - Implementing prey-base enhancement projects. This may include unmowed/ungrazed areas, islands with native plants, and rock and brush piles.

ACKNOWLEDGMENTS

The Santa Clara Valley Habitat Agency thanks the following individuals and entities of the South Bay Burrowing Owl Survey Network for their ongoing collaboration and their commitment to burrowing owls in Santa Clara County.

- Cathy Correia, Andrew Martin, and Catherine Borrowman at the San José-Santa Clara Regional Wastewater Facility
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- Philip Higgins and Ryan Phillips at the City of Mountain View/Shoreline at Mountain View
- Sandra Menzel at Albion Environmental, Inc.
- Ryan Phillips, Andrew Bradshaw, Philip Higgins, Sandra Menzel, and Grant Huber at Talon Ecological Research Group

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APPENDICES

Appendix 1. Burrowing owl survey form.

Site Info

Surveyor(s) and contact info:			Site Name/Desc:			
Map sheet #(s):			Survey method: □ On foot □ In car			
Distance covered:			Total time surveyed:			
Date	/ /	Time	Temp	Wind	Sky (% cover)	Weather last 24 hrs
Sun(rise/set):	Start:					
	End:					

Habitat Plan Region:
□ Within Habitat Plan Study Area
□ Within Expanded BUOW Study Area

□ Occupied Site (within last 3 years)
□ Occurrence older than 3 years
□ Suitable habitat but no recorded occurrences

Habitat Conditions/Assessment

Land cover (Check all that apply & add additional types if needed)

□ *Grasslands*	□ *Agricultural*	□ *Oak Woodland*
□ *Developed*	□ Orchard	□ *Aquatic feature*
□ Urban-Suburban	□ Vineyard	□ Marsh/Wetland
□ Rural-Residential	□ Grain, Row Crop, Hay and Pasture, Disked/Short-Term	□ Pond
□ Landfill		Other Land Cover Types :
□ Golf Course/Urban Park	□ Fallowed	
□ Barren	□ Agriculture Developed	

Approximate height of grasses and/or other plants within site:
□ <6" □ 6-12" □ >12"

Presence and abundance of ground squirrels:
□ None □ Low (1-4) □ Medium (5-10) □ High (>10)

Suitable foraging habitat adjacent to site (any barriers to movement):

Existing land use practices:

Dominant Surrounding Land Use:

Notes (potential measures to improve and expand available habitat):

Photo #(s):

Breeding Season Survey

Percentage of site covered during survey : □ 0-25% □ 26-50% □ 51-75% □ 76-100% □ Unknown		Access restrictions?
Burrows observed? □ Yes □ No #	Burrow condition:	Other suitable nesting substrate (culverts, rock piles, etc.):

Owls observed? □ Yes/ □ No		Behavior (check all observed):		
# of adults:	Band	□ Courtship	□ Feeding young	□ Peeking out of burrow
# of juveniles:	observed?	□ Copulation	□ Perching	□ Standing next to burrow
M/F (If known):	□ Yes □ No	□ Foraging	□ Preening	
# of pairs:		□ Flying	□ Calling	

Other owl sign observed (check all observed): □ Molted feathers □ Whitewash □ Cast pellets
□ Eggshell fragments □ Prey remains □ Other:

Location info and other notes (other species observed):

Photo #(s):

QA/QC _____
Date _____

Region - North San Jose/Baylands

Site Index	Name	Results
2	Byxbee Park	Not Surveyed in 2021
14	Gateway Blvd	Not Surveyed in 2021
18	Legacy Terrace	Not Surveyed in 2021
19	Lick Mill Park	Not Surveyed in 2021
20	Lockheed	Not Surveyed in 2021
21	Lucy Evans Bay Lands	Not Surveyed in 2021
22	McCarthy	Not Surveyed in 2021
25	NASA AMES - Moffett	Surveyed in 2021
28	Palo Alto Airport (a)	Not Surveyed in 2021
29	Palo Alto Airport (a)	Not Surveyed in 2021
30	Palo Alto Golf Course	Not Surveyed in 2021
31	PG&E Warm Springs	Not Surveyed in 2021
33	PK	Not Surveyed in 2021
38	Santa Clara Golf & Tennis Club	Not Surveyed in 2021
42	Shoreline Park	Surveyed in 2021
45	Warm Springs (Stevenson)	Surveyed in 2021
46	Sunnyvale Golf Course	Not Surveyed in 2021
47	Sunnyvale Landfill	Surveyed in 2021
48	Tesla - North	Not Surveyed in 2021
49	Tesla East	Not Surveyed in 2021
50	Tesla South	Not Surveyed in 2021
52	VTA - Cerone	Not Surveyed in 2021
53	Warm Springs	Surveyed in 2021
54	SJ/SC RWF - Alviso	Surveyed in 2021
55	SJ/SC RWF - East	Surveyed in 2021
62	Cisco Mitigation Area	Surveyed in 2021
64	Sunnyvale Baylands Park	Surveyed in 2021
65	River Oaks Storm Basin	Not Surveyed in 2021
70	Tri-Cities Landfill	Not Surveyed in 2021

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(408) 779-7261

0 0.5 1 Miles

Habitat Plan Expanded Study Area
Habitat Plan Permit Area
Surveyed in 2021
Not Surveyed in 2021

Appendix 2. 2021 Burrowing owl survey coverage — Area 1.

Area 1

D:\HCP PROJECTS\BUOW\BUOW 2021\Actual Survey Coverage Areas 2021.aprx 11/30/2021

Region: South San Jose

Site Index	Name	Results
4	Martial Cottle County Park	Not Surveyed in 2021
5	Communications Hill	Not Surveyed in 2021
6	Cunningham Lake West	Not Surveyed in 2021
7	Cunningham Lake East	Not Surveyed in 2021
8	Dairy Hill	Not Surveyed in 2021
10	Devon Court	Not Surveyed in 2021
15	Guadalupe Gardens	Not Surveyed in 2021
23	Meadow Fair	Not Surveyed in 2021
32	Phillips	Not Surveyed in 2021
34	Reid Hillview Airport	Not Surveyed in 2021
35	San Jose Airport	Surveyed in 2021
36	San Jose Golf Course	Not Surveyed in 2021
37	Santa Clara CalTrain Station	Not Surveyed in 2021
56	Guadalupe Gardens North	Not Surveyed in 2021
60	Montague & 1st Street	Not Surveyed in 2021
66	Penitencia Creek Park	Not Surveyed in 2021

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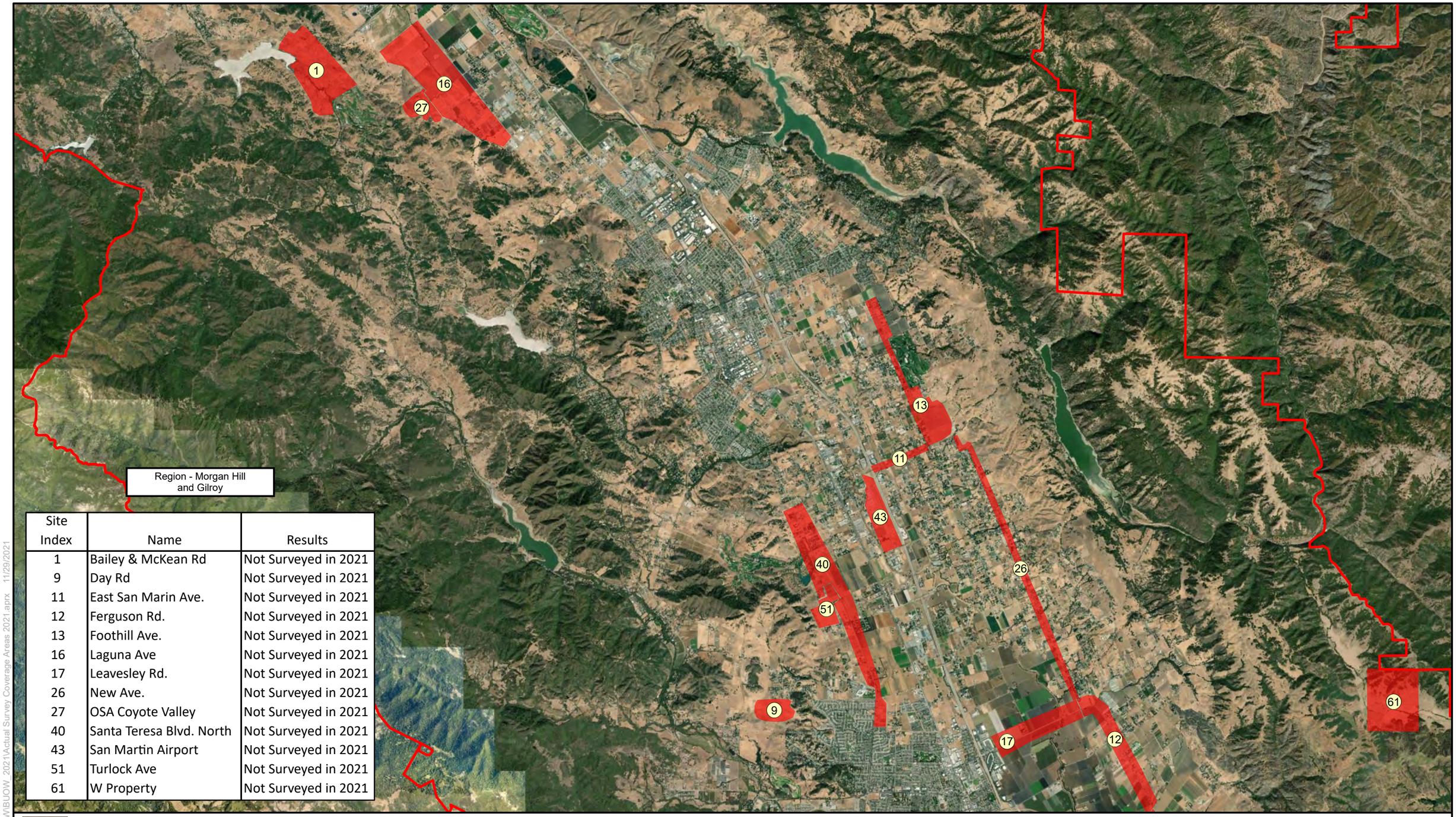
0 0.5 1 Miles

Appendix 3. 2021 Burrowing owl survey coverage — Area 2.

Habitat Plan Expanded Study Area
Habitat Plan Permit Area
Surveyed in 2021
Not Surveyed in 2021

Area 2

D:\HCP_PROJECTS\BUOWBUOW_2021\Actual Survey Coverage Areas 2021.aprx 11/29/2021



Region - Morgan Hill and Gilroy

Site Index	Name	Results
1	Bailey & McKean Rd	Not Surveyed in 2021
9	Day Rd	Not Surveyed in 2021
11	East San Marin Ave.	Not Surveyed in 2021
12	Ferguson Rd.	Not Surveyed in 2021
13	Foothill Ave.	Not Surveyed in 2021
16	Laguna Ave	Not Surveyed in 2021
17	Leavesley Rd.	Not Surveyed in 2021
26	New Ave.	Not Surveyed in 2021
27	OSA Coyote Valley	Not Surveyed in 2021
40	Santa Teresa Blvd. North	Not Surveyed in 2021
43	San Martin Airport	Not Surveyed in 2021
51	Turlock Ave	Not Surveyed in 2021
61	W Property	Not Surveyed in 2021

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0 0.5 1 Miles

Appendix 4. 2021 Burrowing owl survey coverage — Area 3.

Habitat Plan Expanded Study Area
Habitat Plan Permit Area
Surveyed in 2021
Not Surveyed in 2021

Area 3

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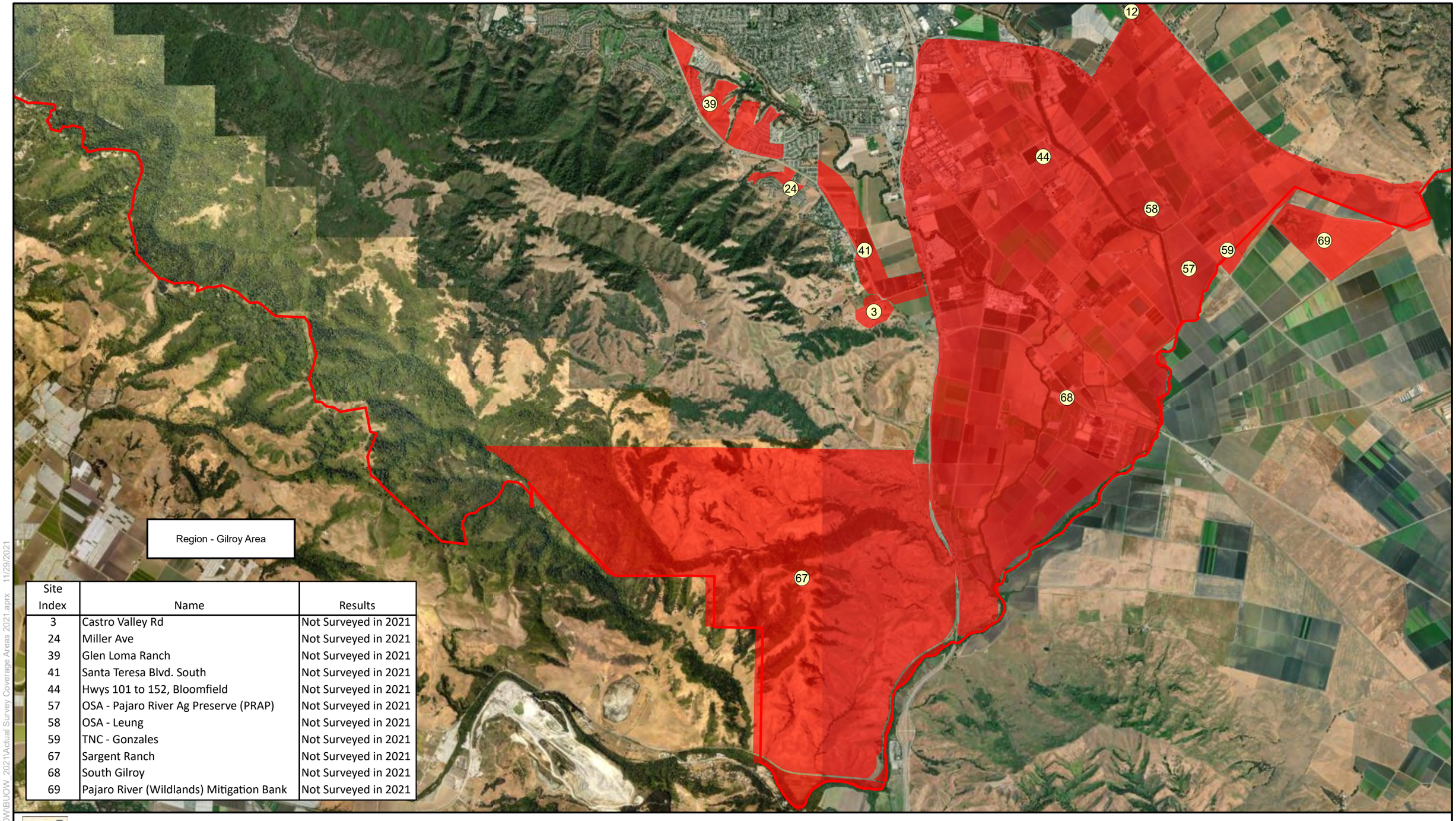

Region - Gilroy Area

Site Index	Name	Results
3	Castro Valley Rd	Not Surveyed in 2021
24	Miller Ave	Not Surveyed in 2021
39	Glen Loma Ranch	Not Surveyed in 2021
41	Santa Teresa Blvd. South	Not Surveyed in 2021
44	Hwys 101 to 152, Bloomfield	Not Surveyed in 2021
57	OSA - Pajaro River Ag Preserve (PRAP)	Not Surveyed in 2021
58	OSA - Leung	Not Surveyed in 2021
59	TNC - Gonzales	Not Surveyed in 2021
67	Sargent Ranch	Not Surveyed in 2021
68	South Gilroy	Not Surveyed in 2021
69	Pajaro River (Wildlands) Mitigation Bank	Not Surveyed in 2021

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0 0.5 1 Miles

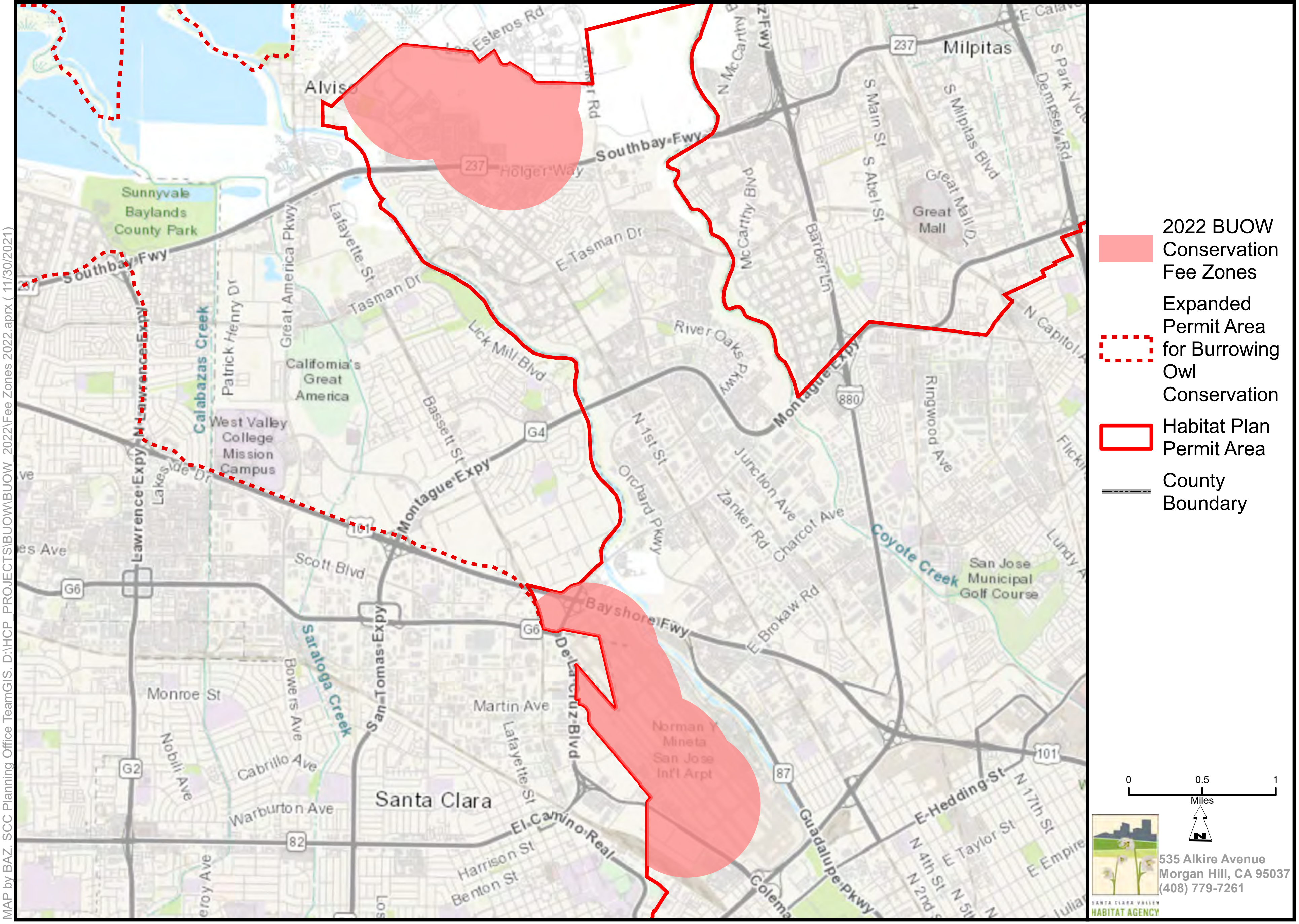
Appendix 5. 2021 Burrowing owl survey coverage — Area 4.

Habitat Plan Expanded Study Area
Habitat Plan Permit Area
Surveyed in 2021
Not Surveyed in 2021

Area 4

D:\HCP_PROJECTS\BUOW\BUOW_2021\Actual Survey Coverage Areas 2021.aprx 11/29/2021

Appendix 6. 2022 Burrowing Owl Conservation Fee Zones for the Santa Clara Valley Habitat Plan area.



MAP by BAZ. SCC Planning Office TeamGIS. D:\HCP_PROJECTS\BUOW\BUOW_2022\Fee Zones 2022.aprx (11/30/2021)