San Diego Association of Governments
BURROWING OWL CONSERVATION BREEDING AND RELEASE PREPARATION
Final Report
Project Period: 12/6/2018 –12/6/2020
SANDAG Contract Number: 5005517

Executive Summary

In San Diego County, western burrowing owls (*Athene cunicularia hypugaea*; BUOW) were once widespread and abundant but have experienced declining populations for decades (Lincer and Bloom 2007). By the 2010s, only one breeding population was known to remain in the county in Otay Mesa. Since 2013, the San Diego Zoo Wildlife Alliance (SDZWA), formerly San Diego Zoo Institute for Conservation Research (ICR), has monitored core areas of the Otay Mesa population as a component of research and adaptive management.

Conservation planning for the species, including the BUOW Conservation and Management Plan for San Diego County (BUOW Plan; SDZ ICR 2017), identified and prioritized conservation and management needs for BUOW in San Diego County to support a coordinated and evidence-based species recovery strategy. The BUOW Plan recommended the development of a short- to medium-term conservation breeding program, due to the insufficient numbers of birds available for building new breeding nodes solely through translocation from development projects. SDZWA conducted a data-driven evaluation of potential recovery sites in San Diego County. The San Diego BUOW Partners Group, which consists of many stakeholders in the county including wildlife and regulatory agencies, non-profits, and biological consultants, worked collaboratively to identify Rancho Jamul Ecological Reserve (RJER), which is owned and managed by the California Department of Fish and Wildlife (CDFW), as the first priority site for breeding node establishment. Initial establishment was accomplished with the active translocation of five wild BUOW pairs in early 2018. The immediate aim of this project was to ensure persistence of the new node at RJER through conservation breeding.

The primary goal of this project was to support the establishment of the first recovery node for BUOW in San Diego County to help lower the risk of extirpation. Our project focused on two main areas to achieve this goal: (1) extending conservation breeding; and (2) translocation of owls to RJER. The objective for the conservation breeding task was to conduct Years 2-3 of a short-term breeding program at the San Diego Zoo Safari Park (SDZSP) and Living Coast Discovery Center (LCDC) to provide a source of owls for supplemental translocations. Owl groups produced from this effort were soft released to RJER (and eventually additional priority sites as identified by the interagency BUOW Partners Group). Success will be measured through established quantitative metrics of owl settlement, survival, and reproductive success gathered through post-release monitoring.

In 2019 and 2020, 18 BUOW were released from the conservation breeding program including one wild pair that was brought to SDZSP in 2017 due to construction activities in Otay Mesa. In 2019, two BUOW were released; one settled and successfully bred on site, while the fate of the second individual was unknown (50% settlement/survival). In 2020, a total of 16 BUOW were released in two groups (six

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unpaired singles and five pairs). Short-term settlement and survival of translocated individuals was high, with 15 of 18 individuals (83%) confirmed as having settled and survived for at least 30-days post-release. All translocated individuals that settled attempted to breed at RJER. Nine of the 18 translocated individuals (50%) successfully bred (i.e. had one or more juveniles fledge [survive to 45 days of age]) with a total of 35 fledglings. One translocated individual had two successful clutches with the same female at the same breeding burrow. On average, each nest had 4.85 (SE 0.93) eggs, 4.50 (SE 0.50) chicks, and 3.89 (SE 0.61) fledglings. These results are comparable to a similar reintroduction study conducted in British Columbia (Mitchell et al. 2011).

Thirty-seven BUOW were fledged in the conservation breeding program during 2019 and 2020. BUOW hatched in 2020 will be translocated to the Ramona Grasslands Conservation Bank (owned and managed by San Diego Habitat Conservancy) in 2021.

We successfully accomplished our specified goals of expanding the conservation breeding program and translocating BUOW to RJER in support of breeding node establishment. The owls produced in the conservation breeding program enabled the establishment of a second breeding node (through supplemental translocations) and the initiation of a third breeding node. These translocations directly support the Management Strategic Plan (SDMMP 2013, SDMMP 2017) and BUOW Plan by creating sub-occurrences of five or more BUOW pairs within San Diego County. We would not have been able to accomplish this solely through translocation of BUOW impacted by development; the funding from SANDAG was instrumental in expanding the conservation breeding program and enhancing the BUOW population in the county. However, the work of ensuring the long-term persistence of BUOW in the county is by no means done and this project represents the beginning of a longer-term strategy.

We will continue to monitor the population at RJER in coordination with CDFW and may take action in the future if needed to ensure the sustainability of the new population. Continued vegetation management at RJER and the adjacent Hollenbeck Canyon Wildlife Management Area may result in an increase in suitable habitat which would allow for further expansion of the BUOW population through natural dispersal and/or translocation. Management actions may include supplemental feeding during years with low prey numbers or additional translocations to augment or expand the population.

We are also embarking on the establishment of another new breeding node in Ramona. BUOW produced in the conservation breeding program with the support of this grant will form the initial release cohort for 2021. We hope to replicate our successes at RJER, creating a third breeding node and further supporting persistence of the species in the county. Plans for future node establishment beyond 2021 will likely include owls from the conservation breeding program.

Contents

Project Background

Need for the Project

Once fairly common and widespread throughout the western United States and Canada, the western burrowing owl (*Athene cunicularia hypugaea*; BUOW) has experienced population declines and its breeding range has contracted (DeSante et al. 2004, DeSante et al. 2007a, DeSante et al. 2007b, Conway et al. 2010, Wilkerson and Siegel 2010, Wilkerson et al. 2011). In response, BUOW have been listed as a Species of Conservation Concern in the United States, federally endangered in Canada, state endangered in Minnesota and Iowa, and threatened in Mexico (Klute et al. 2003, USFWS 2008). In California, BUOW are designated as a Species of Special Concern (Gervais et al. 2008), and may be re-evaluated for listing under the California Endangered Species Act (Center for Biological Diversity 2015).

Southern California supports one of the last strongholds for BUOW. The largest remaining contiguous population of BUOW in North America occurs in Imperial Valley, which comprises 50 percent of the western North American population and an estimated 70 percent of the California population (DeSante et al. 1996, Bowen 2001, Klute et al. 2003, DeSante et al. 2004, Wilkerson and Siegel 2011). However, population declines and local extirpations have been documented across Southern California (Klute et al. 2003, Gervais et al. 2008), and BUOW population estimates from the Imperial Valley have declined over the last 20 years by nearly 40% (DeSante et al. 2007a, DeSante et al. 2007b, Wilkerson and Siegel 2010, Wilkerson et al. 2011).

In San Diego County, BUOW were once widespread and abundant but have experienced declining populations for decades (Lincer and Bloom 2007). The San Diego Bird Atlas provides a detailed account of declines in the county population since the 1920s, when the owl was common along an elevational gradient extending from coast to foothills (Unitt 2004). The number of occupied sites had declined by the 1970s, although breeding owls could still be found in coastal locations such as Mission Bay, the Palomar Airport area, and San Marcos, as well as several inland sites that are no longer occupied by BUOW. Nearly all coastal populations were extirpated by 1997 due to intensive urban development and habitat fragmentation. Extensive field surveys conducted in the years 1997-2002 for the San Diego Bird Atlas documented five locations of breeding pairs: Warner Valley, Borrego Valley, two locations in Otay Mesa, Imperial Beach Naval Outlying Landing Field, and Naval Air Station North Island (Unitt 2004). In the years since those surveys, the number of breeding pairs has dropped, and they are now primarily detected in scattered sites on Otay Mesa. On Naval Air Station North Island, successful nesting has not been observed since 2011. Imperial Beach Naval Outlying Landing Field supported nesting owls on an intermittent basis, but only wintering owls have been detected on either site in the past eight years (L. Beyer Wilson, personal communication). Borrego Valley was utilized by single pairs rather than a colony, and breeding pairs have not been detected there or at Warner Valley in recent years. By the 2010s, only one breeding population was known to remain in the county in Otay Mesa.

The San Diego Zoo Wildlife Alliance (SDZWA), formerly San Diego Zoo Institute for Conservation Research (ICR), has monitored core areas of the Otay Mesa population since 2013 as a component of research and adaptive management funded by the Otay Grassland Mitigation Fund at The San Diego Foundation, Metropolitan Airpark, LLC, and other sources. Owls in the Otay Mesa population occupy a

mix of natural and artificial burrows across several sites including Brown Field Municipal Airport, Lonestar Ridge, East Otay Mesa, and the United States-Mexico border buffer. Based on our level of monitoring effort and accessibility throughout Otay Mesa, reports of BUOW from other agencies, and potential remaining habitat for the species, we estimate the Otay Mesa breeding season population size at approximately 100 breeding pairs.

The available habitat in Otay Mesa is only moderately suitable, due to heavy clay soils, habitat fragmentation, limited squirrel presence, and heavy reliance on artificial burrows. Ongoing development pressure and land use changes in the area also threaten this breeding population. While a plan to establish a network of Conserved Lands with connectivity and appropriate habitat for BUOW is in process on Otay Mesa, the need for additional breeding populations in other locations has been recognized and included in conservation planning.

MSP Goals for BUOW

The 2013 Management Strategic Plan (MSP) and the updated Management and Monitoring Strategic Plan Roadmap (SDMMP 2013; SDMMP 2017) identified BUOW as an SL species. A category SL species is defined as a "species whose persistence in the MSPA is at high risk of loss without immediate management action above and beyond that of daily maintenance activities" (SDMMP 2017). The MSP set a regional goal to **"**Increase the abundance of nesting BUOW to ensure that there are multiple interbreeding sub-occurrences of appropriate size (≥ 5 pairs) and distribution (primarily utilizing natural burrow systems) on Conserved Lands that will provide for BUOW persistence in the MSPA over the long-term (> 100 years)."

One of the objectives set out in the MSP was the development and implementation of a BUOW Conservation and Management Plan for San Diego County (BUOW Plan; SDZ ICR 2017). In 2017, SDZWA completed this plan, which identified and prioritized conservation and management needs for BUOW in San Diego County to support a coordinated and evidence-based species recovery strategy. The BUOW Plan recommended the development of a short- to medium-term conservation breeding program, due to the insufficient numbers of birds available for building new breeding nodes solely through translocation from development projects. Wild individuals are not likely to establish new breeding areas through natural dispersal and settlement because existing population density is too low. A local conservation breeding program is the best option for meeting the species goals set out in the MSP Roadmap. SDZWA initiated a conservation breeding program at the San Diego Zoo Safari Park (SDZSP) in 2017, with approval from the wildlife agencies, using two pairs brought into managed care from a development site in Otay Mesa.

Also as part of the BUOW Plan (SDZ ICR 2017), SDZWA conducted a data-driven evaluation of potential recovery sites in San Diego County. This approach included landscape-scale habitat suitability modeling as a first step along with on-the-ground rapid assessments performed at each potential site identified by the suitability model. A list of priority sites was created through this process and site-specific recommendations for management were developed. These priority sites serve as potential receiver sites for actively translocated BUOW or release sites for conservation-bred BUOW. The San Diego BUOW Partners Group, which consists of many stakeholders in the county including wildlife and regulatory

agencies, non-profits, and biological consultants, worked collaboratively to identify Rancho Jamul Ecological Reserve (RJER), which is owned and managed by the California Department of Fish and Wildlife (CDFW), as the first priority site for breeding node establishment. The activities described in this report support the RJER node establishment and fulfill a priority objective for the 9th LMG Cycle, ATHCUN-6, which was to implement the species management plan for burrowing owl.

The immediate aim of conservation breeding was to ensure persistence of the new node at RJER. Initial establishment was accomplished with the active translocation of five wild BUOW pairs by SDZWA with support from the Metropolitan Airpark Project (MAP) in early 2018. In nearly all cases, projects to establish new populations benefit from supplemental translocations, which support the population through initial population losses. Maintaining a minimum group size also uses the semi-colonial life strategy of this species to improve the odds that each subsequent year's fledglings will choose to settle at RJER rather than dispersing. Through the use of supplemental translocations from SDZWA's breeding program in 2019 and 2020, we have been able to ensure population persistence and establishment. SDZWA and CDFW are currently conducting five years of follow-up monitoring and management including vegetation management, supplemental feeding, and predator deterrence to minimize mortality and dispersal.

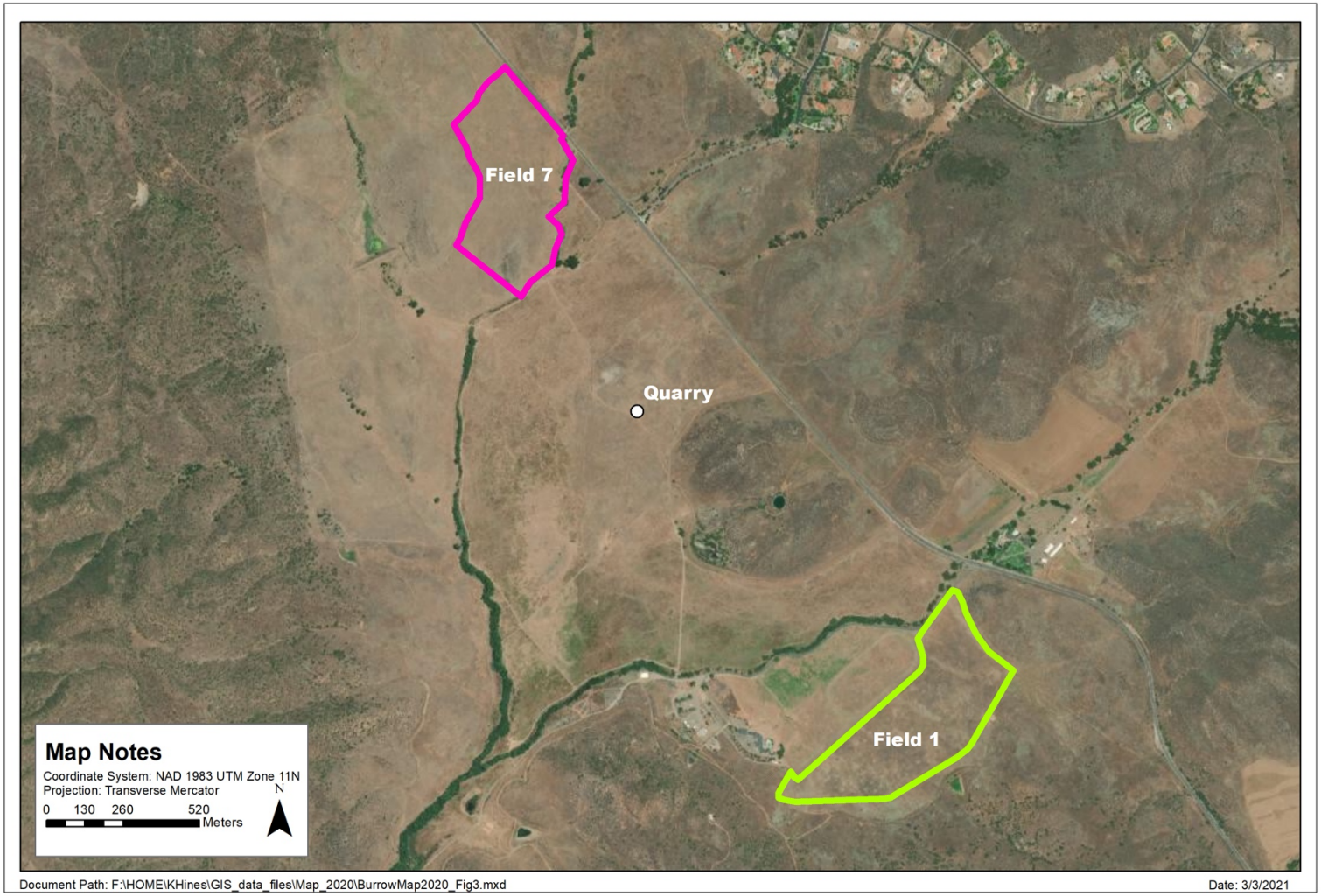
Project Location & Site Description

BUOW conservation breeding activities took place at SDZSP and LCDC.

RJER, located in Management Unit (MU) 3 of the MSP, consists of ~5,600 acres with large areas of coastal sage scrub, annual grasslands and riparian habitat and is part of the county's Multiple Species Conservation Program (MSCP) system. RJER offers extensive conserved grasslands with potential connectivity to the existing population at Otay Mesa. Two areas of RJER served as receiver sites for translocation/reintroduction of BUOW for this project.

The first is Field 1 (also known as the Burrowing Owl Habitat Management Area or BOHMA; Figure 1), a 60-plus-acre area that has been managed for BUOW breeding, foraging, and wintering habitat for over 10 years. Field 1 contains five maintained complexes of artificial burrows and four additional burrow pairs installed in 2018 for the initial conservation translocation (almost 30 burrows total). Squirrels are present at RJER around human-disturbed areas and in the Field 1 area. In Fall 2017, 165 natural squirrel burrows were detected across Field 1 as part of a natural squirrel dispersal study.

The second release area is Field 7 [50+ acres], which is located approximately 2 km north of Field 1 (Figure 1), was established after successful settlement at Field 1. Field 7 was selected over 3 other candidate areas due to compatibility with the grazing plan, good potential for attracting/supporting California ground squirrels (*Otospermophilus beecheyi*), good soils for burrowing, prey abundance, sufficient area for accommodating a minimum of five acclimation aviaries with appropriate spacing plus additional artificial burrows for use as satellite burrows, connectivity to foraging habitat (Hollenbeck Canyon Wildlife Area) and existing occupied sites (Field 1), and relatively easy accessibility for trucks and other equipment. Brush piles were installed to attract squirrels and increase the number of available natural burrows at Field 7.



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Burrowing Owl Study Sites at Rancho Jamul Ecological Reserve

FIGURE 1

Figure 1. BUOW release and monitoring areas at Rancho Jamul Ecological Reserve.

Methods & Approach

Previous BUOW conservation breeding programs have shown that the species breeds readily in managed care, producing many young (Leupin and Low 2001). The SDZWA conservation breeding program includes breeding owls that were wild caught (known breeding residents) and their progeny. To maintain a genetically healthy population of breeding owls, we employed a rotation strategy so new owls were brought into the program each year. Because of this rotation strategy, it was necessary to release not only offspring produced but breeding adult pairs as well. In addition, release was a condition of permission granted by the wildlife agencies to bring impacted wild owls into managed care. As such, the original wild pairs were held for 2-3 years.

Owls were translocated and released at RJER in 2019 and 2020. We used a common translocation method for BUOW—pairs were translocated just prior to the breeding season so they could lay eggs at the release site. The eggs and chicks serve to anchor the translocated adults to the release site. This method also aims to take advantage of the strong natal philopatry of the species to maximize future recruitment of offspring hatched at the release site.

One of the most significant obstacles to conducting translocations successfully is post-translocation dispersal away from the release site (Berger-Tal et al. 2019; Stamps and Swaisgood 2007; Batson et al. 2015). Long-distance movements following release have been shown to increase risk exposure and mortality rates (Stamps and Swaisgood 2007; Le Gouar et al. 2012; Shier and Swaisgood 2012). Temporarily holding relocated animals in acclimation enclosures at the release site may encourage individuals to remain in the vicinity upon release (Bright and Morris 1994; Batson et al. 2015). Previous BUOW breeding programs have shown that released BUOW will settle at the release site, but that mortality from predation is high in the first month after release (Leupin and Low 2001). For BUOW, soft-release methods such as adding a holding period of two weeks or more can increase post-release settlement, survival, and reproduction (Mitchell et al. 2011). For owls released in pairs, we used a holding period of 30 days in an acclimation aviary with provisioning, and for owls released as singles, we used a 14-day acclimation period. Longer holding periods were avoided to minimize long-term dependence or atrophy of flight muscles.

The semi-colonial behavior of BUOW may also play a role in limiting dispersal from the release site. The presence of established BUOW individuals sends a signal that the habitat is suitable for settlement. Without that minimum threshold density of established owls, released BUOW may be more likely to disperse from the release site. The use of natural or artificial cues to mimic occupancy by conspecifics is one important mechanism for retaining animals at the release site. Even territorial and less social species often settle near conspecifics, and the use of conspecific cues to attract or anchor animals has been used successfully across multiple species (Ahlering et al., 2010; Armstrong & Seddon, 2008; Kotliar & Burger, 1984; Reed & Dobson, 1993; Sarrazin et al., 1996; Stamps, 1988). In a study we conducted throughout Southern California, we found that BUOW translocated with conspecific cues were 20 times more likely to settle than those translocated without cues (Hennessy et al. 2020). For the release at Field 7, where no conspecifics were present, we used acoustic cues consisting of timed playbacks of pre-recorded BUOW vocalizations to dampen post-release dispersal.

Additionally, for many wildlife species, successful translocation is more likely with greater numbers of individuals released (Drake and Temple 2012, Popescu and Hunter 2012), and this general rule is likely to apply to a greater extent in semi-colonial species such as BUOW. Most BUOW active translocations currently include one or two pairs, but because of the adequate supply of BUOW from the conservation breeding program, we were able to release BUOW in larger groups and support the persistence of the new breeding node.

After release, supplemental food was provided through the breeding season to support settlement and survival of both adults and juveniles. Predator avoidance testing was conducted to reduce risk to naïve individuals. The mix of owls in this project provided opportunities for social learning and cultural transmission from wild owls to their progeny, enhancing the development of survival skills among owls from the breeding program. All of the protocols we used were developed to maximize settlement, survival, and reproduction by released BUOW and their offspring.

Remote cameras and visual surveys were used to monitor owl survival, nesting and productivity, and burrow occupancy. Each camera was mounted on a stake (2-4 feet tall) placed 1-3 meters from the burrow entrance. Photo downloads and field observations were conducted at least weekly during the breeding season (1 February – 31 August) depending on the supplemental feeding schedule and at least monthly during the non-breeding season (1 September – 31 January). Remote cameras allowed us to determine the maximum numbers of chicks (post-emergence to fledging) and the numbers of fledglings (juveniles that survived to 30 days post-emergence) at each burrow. Chicks were captured and banded to assist with monitoring the fates of individuals and to determine future juvenile recruitment at RJER. A sub-set of released individuals was tracked remotely through satellite GPS transmitters (backpack-style) that collected ~3 points/day from release through transmitter removal in late summer. Data were downloaded and processed remotely.

All activities were conducted in accordance with all permits and IACUC protocols. All captures and releases of owls received complete vetting as part of the CDFW and USFWS permissions processes.

Project Goals

The primary goal of this project was to support the establishment of the first recovery node for BUOW in San Diego County to help lower the risk of extirpation. Our project focused on two main areas to achieve this goal: (1) extending conservation breeding; and (2) translocation of owls to RJER. The objective for the conservation breeding task was to conduct Years 2-3 of a short-term breeding program at the SDZSP and Living Coast Discovery Center (LCDC) to provide a source of owls for supplemental translocations. Owl groups produced from this effort were soft released to RJER (and eventually additional priority sites as identified by the interagency BUOW Partners Group). Success will be measured through established quantitative metrics of owl settlement, survival, and reproductive success gathered through post-release monitoring.

Work Performed by Task

Task 1 – BUOW Conservation Breeding & Release

Budget: $50,000
Spent: $49,975.09
Match for Task: $21,139.87

At the commencement of this grant, the conservation breeding program consisted of two BUOW pairs plus one unpaired male owl at the SDZSP Bird Breeding Complex (BBC). The BUOW were brought into managed care before the onset of the 2018 breeding season. Both pairs initiated breeding at the BBC during 2018, with one successful nesting attempt that produced three fledglings (all female). Of these fledglings, two were released at RJER and the third was retained as a mate for the unpaired male. With three pairs of BUOW housed at the BBC, the SDZSP breeding facilities were at capacity for BUOW, and LCDC was subcontracted to enable the inclusion of an eventual fourth breeding pair.

Year 1 (2019)

Translocation and Outcomes

Two BUOW (both females hatched in 2018) were transferred from the SDZSP Conservation Breeding Program to an acclimation aviary at RJER on 25 February (1, Figure 2) and released on 26 March. These two owls were released in conjunction with nine others (4 pairs and one single female) that were translocated from Otay Mesa (Wisinski et al. 2019, Wisinski et al. 2020a). One (Blue X) settled and bred on site, while the fate of the second individual (Blue A/91) was unknown (50% settlement/survival). Blue X paired and nested with a returning BUOW fledged at Field 1 in 2018 (Green B/06), and the pair fledged 6 chicks together (Table 2). Blue X was outfitted with a satellite GPS transmitter prior to release to help monitor short-term outcomes following release. She remained at RJER throughout the breeding season and her transmitter was successfully removed on 16 July 2019.

Neither Blue X nor Blue A/91 was observed at RJER in 2020. One of Blue X's offspring (Green H/12) was observed alive at Field 1 through January 2020 but was found dead inside an artificial burrow on 23 March 2020; the cause of mortality was unknown.

Conservation Breeding and Outcomes

In 2019, all three BUOW pairs in the conservation breeding program successfully bred. Of the three pairs, one hatched all 7 of 7 eggs (100% hatch success). The second pair hatched 6 of 7 eggs (86%), and the third pair hatched 6 of 9 eggs (67%), for a total of 19 chicks. All chicks received routine health checks, which included West Nile Virus inoculations and application of temporary color bands to distinguish individuals. On 18 June 2019, one chick was found with a leg injury and was transferred to the SDZSP's Harter Veterinary Medical Center, where it was treated for the injury, but veterinarians determined that future quality of life would be compromised, and euthanasia was deemed necessary. The final 2019 breeding numbers totaled 18 fledglings: 11 males and 7 females.

In fall 2019, a new pre-release flight enclosure was built (using non-SANDAG funding sources) to allow release candidates to strengthen flight muscles and prepare for release. SANDAG funds contributed to

the final preparation of the enclosure habitat, including the purchase of plants, a feeding trough, and other supplies. No SANDAG funds were utilized for construction or other activities requiring prevailing-wage reporting. On 17 October 2019, 16 BUOW were transferred to the flight enclosure. Two of these birds (one of the original breeding pairs) were part of the breeding program for two years and were released as part of a planned rotation to maintain genetic integrity of the breeding population. The rest (9 males and 5 females) were fledglings hatched at the SDZSP in 2019. After transfer, a video surveillance system allowed wildlife care staff to maintain a protocol of minimal human contact inside and outside the enclosure, further preparing the owls for release. Two unrelated 2019 fledglings were held back from release and paired to replace the original wild pair, and a second pair of 2019 fledglings was formed and transferred to LCDC on 15 December 2019.

Year 2 (2020)

Translocation and Outcomes

A total of 18 BUOW were translocated to RJER to supplement the newly established node (1). All translocated individuals were transferred as pairs or as same-sex groups (2-3 individuals per aviary). The first translocation took place at Field 1 (Table 1, Figure 2) and comprised 8 non-paired individuals from the SDZSP Conservation Breeding Program (1 female, 5 males) and Project Wildlife (2 females). Males were housed in two sibling groups, and the non-related females were housed together. BUOW were held in acclimation aviaries from 14 – 29 Jan (note: female Blue M self-released on 23 Jan). This earlier and shorter soft-release protocol was implemented so that non-paired individuals would have sufficient time to both establish territories and find mates at the release site. No artificial acoustic cues were deployed during this translocation as wild BUOW were present at the release site. GPS satellite transmitters were outfitted on three of the non-paired males to help monitor short-term outcomes following removal of the aviaries. Transmitters were removed opportunistically from all surviving BUOW by the end of the breeding season.

The second translocation took place at Field 7 (Table 1, Figure 3), and was comprised of 10 BUOW (5 females, 5 males) released as breeding pairs. All individuals were from the SDZSP Conservation Breeding Program, with one pair a “wild” founder pair that was brought into the breeding program from Otay Mesa in 2017. BUOW were held in acclimation aviaries from 18 Feb – 20 Mar. This translocation was timed to optimize the chances that paired individuals would breed and lay eggs during the acclimation period. Four males in this cohort were transmittered to help monitor outcomes following removal of the aviaries. Transmitters were removed opportunistically from all surviving BUOW by the end of the breeding season.

Short-term settlement and survival of translocated individuals was high, with 15 of 18 individuals (83%) confirmed as having settled and survived for at least 30-days post-release. One individual (male Blue 1) was likely depredated by a raptor shortly after release, with his transmitter retrieved from underneath nearby trees on 7 Feb. Two individuals had unknown fates (conservation-bred female Blue M and Project Wildlife female Orange 42/B) and were not observed in our monitoring areas during the breeding season. Two females that were released at Field 7 settled at Field 1 (Blue A/92, Blue A/98); one of them (Blue A/92) dispersed from Field 7 to Field 1 following the removal of her mate (male Blue Z)

after he sustained a self-inflicted eye injury while in the acclimation aviary. Blue Z was taken to the Harter Veterinary Medical Center at the SDZSP for evaluation and medical care, and subsequently released back at Field 7 on 13 April. We continued to monitor his condition after release; we documented improvement of his condition and confirmed survivorship through the end of 2020.

At the time of aviary removal on 20 March, two of the paired individuals at Field 7 had initiated nesting (i.e. laid at least one egg). Severe rain events during the acclimation period resulted in the failure of two nest initiations by one pair. The originally wild pair of owls (Blue A/92 and Blue Z) also initiated nesting while in the acclimation aviary. However, the nest failed after the male was temporarily removed for treatment of the eye injury despite continuation of supplemental feeding.

All translocated individuals that settled (15 of 18) attempted to breed at RJER. Nine of the 18 translocated individuals (50%) successfully bred (i.e. had one or more juveniles fledge [survive to 45 days of age]) with a total of 35 fledglings. One translocated individual at Field 7 (male Blue 7) had two successful clutches with the same female at the same breeding burrow. On average, each nest had 4.85 (SE 0.93) eggs, 4.50 (SE 0.50) chicks, and 3.89 (SE 0.61) fledglings. We report on individual nest outcomes for all translocated BUOW at RJER in Table 2.

For context, during the breeding season, we monitored a total of 31 adult BUOW (15 female, 16 male) that made 27 nesting attempts across 21 unique pairings at RJER (Field 1, Field 7 and Quarry; Figure 1). A total of 11 nests were successful (i.e. at least one juvenile survived to 45-days of age), fledging a total of 58 juveniles, all but one of which were captured and banded. On average, each nest had 4.75 (SE 0.83) eggs, 5.45 (SE 0.61) chicks, and 5.27 (SE 0.56) fledglings. We suspect the presence of at least one additional BUOW nest outside of our monitoring areas. Two unbanded fledged juveniles were documented at Field 7 and the Quarry (one at each area). The juvenile captured at Field 7 was confirmed to be genetically unrelated to the owls from the nest at which it was captured, and all known juveniles from the nests at Field 7 were banded. There is the potential that one or both of these fledglings could have been related to an owl(s) from the SDZSP Conservation Breeding Program.

Conservation Breeding and Outcomes

The 2020 breeding season included two established breeding pairs, one new pair of 2019 fledglings housed at SDZSP, and the new pair that was transferred to LCDC. The three pairs at the SDZSP initiated nesting, but the pair at LCDC did not breed in 2020. During a rain event on 12 March 2020, an early clutch of 10 eggs was removed from a flooded nest chamber. The removed eggs were candled to confirm viability, and immediately placed into an incubator. An identical group of 10 dummy eggs was given to the nesting pair in the meantime, to retain the possibility that the eggs could be returned to them. When the first egg began to hatch two days later, the clutch was reintroduced to the parents. Unfortunately, the BUOW pair rejected the eggs, but they were still able to produce a second clutch.

Beginning in mid-March, both SDZWA and LCDC closed to the public due to the COVID-19 pandemic. However, both facilities maintained essential staff to carry out managed care and field monitoring functions.

All three pairs at SDZSP successfully bred, producing a total of 19 fledglings. One nest had seven chicks, and the other two had six chicks each. One of the adult female owls at SDZSP was found dead in her burrow on 26 June 2020 due to unknown causes. A necropsy was performed, but it was not possible to determine the cause of death. The pair housed at LCDC showed some indicators of nest initiation but did not lay eggs. LCDC staff consulted with SDZWA staff, but the reasons for breeding failure were unknown. Both birds of this pair were second-year individuals, so inexperience may have played a role.

In early June, SDZWA was subcontracted to relocate a pair of owls that were nesting at an active construction site (Wisinski et al. 2020b) and was granted permission by the wildlife agencies to bring this new wild pair (plus their offspring) into the conservation breeding program. On 17 June 2020, both adults and four hatchlings were successfully collected and brought to Harter Veterinary Medical Center at the SDZSP for routine evaluation and quarantine. This group of BUOW infused new genetic diversity into the breeding program and assisted with the formation of new breeding pairs. As the second founder pair is scheduled for release in 2021, the new adult pair will replace them. The four juveniles (all female) will be paired with offspring from the conservation breeding program for release in 2021.

Due in part to the success of the conservation breeding program, the BUOW population at RJER reached the existing habitat management capacity (i.e. acreage that can be grazed with current cattle herd size), and an additional release site needed to be identified for the 2021 releases. During July and August, we undertook a series of field visits and collaborative meetings based on the SWOT (Strengths, Weaknesses, Opportunities, Threats) decision-making framework (White et al. 2015). We conducted field visits with the land managers of three potential release sites to record information about current status and reintroduction potential. On 12 August 2020, we convened a BUOW node selection virtual meeting with the land managers and wildlife agencies. All three sites were discussed in terms of physical, biological, and management considerations. The group selected the Ramona Grasslands Conservation Bank (managed by San Diego Habitat Conservancy) as the 2021 reintroduction site. All release candidates are slated for release to this new site, which represents a potential third breeding node in San Diego County.

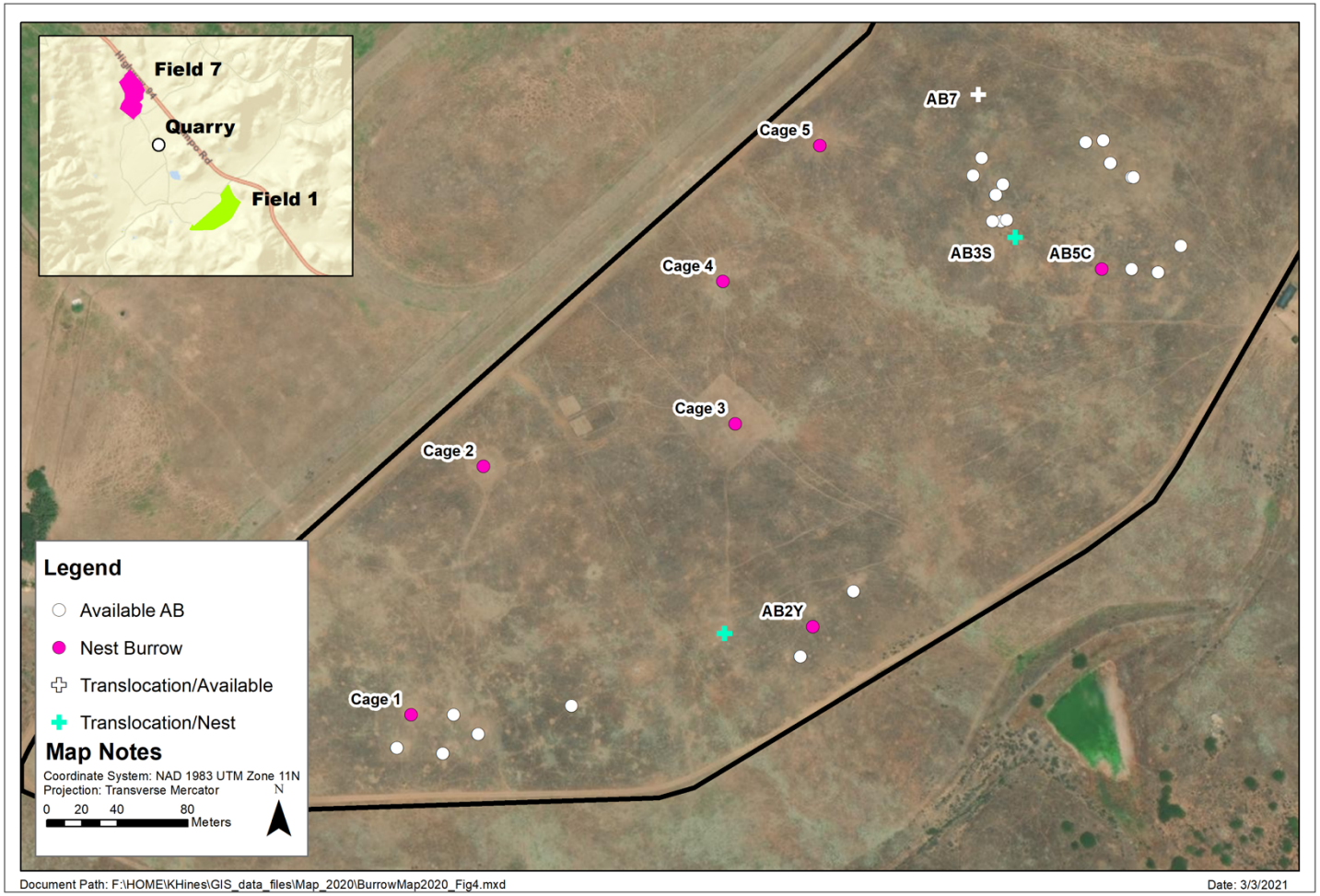
Table 1. Burrowing owls actively translocated to Rancho Jamul Ecological Reserve in 2019 and 2020 for breeding node supplementation.

Receiver Burrow	USGS/Airband	Auxiliary Band ID	Sex	Transfer Date	Release Date	Transmitter (Removal Date)	Notes
2019 Field 1							
Cage 2	1094-67722	Blue X	F	25-Feb-19	26-Mar-19	172959 (16 July 2019)	-
	1094-67741	Blue A/91	F	25-Feb-19	26-Mar-19	None	-
2020 Field 1							
ABF	4444-00257	Blue 2	M	14-Jan-20	29-Jan-20	179653 (13 July 2020)	-
	1094-67832	Blue A/94	M	14-Jan-20	29-Jan-20	None	-
AB7	1094-67834	Blue A/93	M	14-Jan-20	29-Jan-20	None	-
	4444-00210	Blue 1	M	14-Jan-20	29-Jan-20	179659 (7 Feb 2020)	Depredated on 3 Feb 2020
	4444-00258	Blue 7	M	14-Jan-20	29-Jan-20	179658 (13 July 2020)	-
AB3S	4444-00256	Blue M	F	14-Jan-20	23-Jan-20	None	Self-released on 23 Jan 2020
	1094-67835	Orange 40/B[1]	F	14-Jan-20	29-Jan-20	None	-
	1094-67836	Orange 42/B[1]	F	14-Jan-20	29-Jan-20	None	-
2020 Field 7							
AB2	1094-67833	Blue A/95	F	18-Feb-20	20-Mar-20	None	-
	4444-00259	Blue W	M	18-Feb-20	20-Mar-20	172948 (20 July 2020)	-
AB3	4444-00261	Blue 4	M	18-Feb-20	20-Mar-20	172958 (31 July 2020)	-
	1094-67837	Blue A/97	F	18-Feb-20	20-Mar-20	None	-

Table 1 cont'd. Burrowing owls actively translocated to Rancho Jamul Ecological Reserve in 2019 and 2020 for breeding node supplementation.

Receiver Burrow	USGS/Airband	Auxiliary Band ID	Sex	Transfer Date	Release Date	Transmitter (Removal Date)	Notes
2020 Field 7 (cont'd)							
AB6	1094-22091	Blue A/92[2]	F	18-Feb-20	20-Mar-20	None	Settled at Field 1
	1094-22092	Blue Z[2]	M	18-Feb-20	13-Apr-20	None	Sustained eye injury while in temporary holding; brought to vet hospital on 16 March, treated and re-released 13 April.
AB7	4444-00260	Blue 3	M	18-Feb-20	20-Mar-20	179660 (13 July 2020)	-
	1094-67838	Blue A/96	F	18-Feb-20	20-Mar-20	None	-
AB8	1094-67839	Blue A/98	F	18-Feb-20	20-Mar-20	None	Settled at Field 1
	4444-00262	Blue 5	M	18-Feb-20	20-Mar-20	172943 (13 July 2020)	-

[1]Rehabilitated individual from Project Wildlife.
[2]"Wild" founder from conservation breeding program.



San Diego Zoo Wildlife Alliance

BUOW Translocation and Nest Locations at RJER Field 1

FIGURE 2

Figure 2. Map of occupied burrow locations at RJER Field 1 in 2020, showing burrows used during the translocation process, as well as burrows used for nesting by wild and post-release translocated owls. Note that in 2019, two BUOW were released at the "Cage 2" burrow and the owl that remained on-site bred at the "Cage 3" burrow.

Table 2. All monitored nesting attempts by BUOW translocated from the San Diego Zoo Safari Park to RJER in 2019 and 2020.

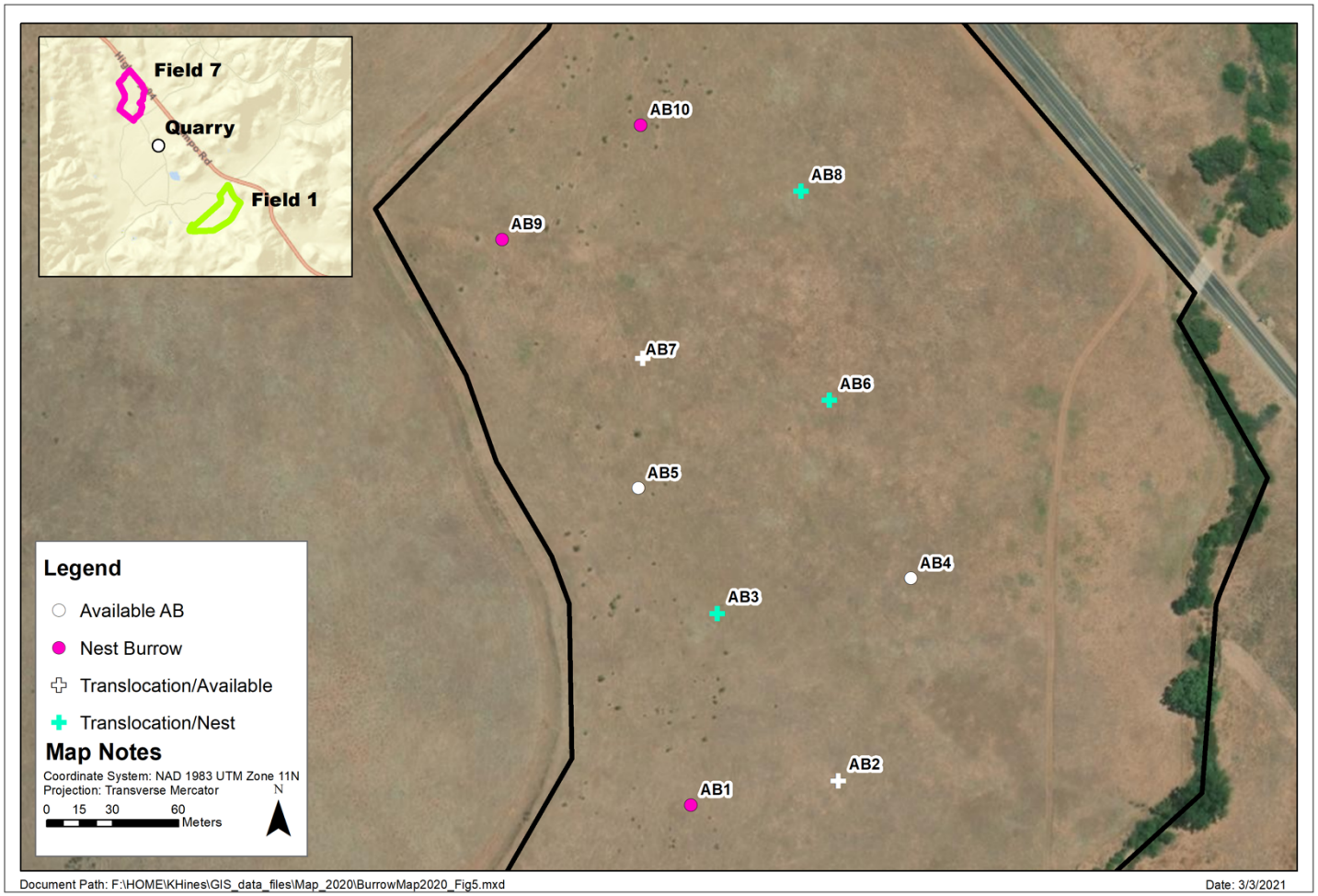
Burrow	Source	Adults (year banded[1])		First Egg Date	Hatch Date	Emergence Date	Max Eggs	Max Chicks	Juveniles Fledged
		Female	Male						
2019 Field 1									
AB2Y	Safari Park/ 2018 Cage 5	Blue X (2019)	Green B/06 (2018)	10-Apr-19	N/A	N/A	9	N/A	0
Cage 3 (renest)	Safari Park/ 2018 Cage 5	Blue X (2019)	Green B/06 (2018)	24-Apr-19	27-May-19	10-Jun-19	9	6	6
2020 Field 1									
ABF	2019 AB5/ Safari Park	Green H/59 (2019)	Blue A/93	26-Feb-20	26-Mar-20	17-Apr-20	11	4	4
AB2Y	Unbanded/ Safari Park	Green A/82	Blue 2	5-Apr-20	5-May-20	19-May-20	5	3	3
Cage 3	Project Wildlife/ Safari Park	Orange 40/B	Blue A/94	N/A[2]	N/A	N/A	0	N/A	N/A
Cage 3	Safari Park	Blue A/92 (2017)	Blue A/94	31-Mar-20	1-May-20	16-May-20	9	4	4
Cage 5	2019 AB5/ Safari Park	Green H/48 (2019)	Blue 7	9-Mar-20	10-Apr-20	28-Apr-20	7	5	5
Cage 5 (2nd Clutch)	2019 AB5/ Safari Park	Green H/48 (2019)	Blue 7	3-Jun-20	26-Jun-20	9-Jul-20	5	4	4
AB3S	Safari Park/ 2019 AB5	Blue A/98	Green H/52 (2019)	23-Apr-20	N/A	N/A	9	N/A	N/A
2020 Field 7									
AB2 (Aviary 1)	Safari Park	Blue A/95	Blue W	11-Mar-20	N/A	N/A	1	N/A	N/A
AB2 (Aviary 1) (renest)	Safari Park	Blue A/95	Blue W	13-Mar-20	N/A	N/A	2	N/A	N/A

Table 2 cont'd. All monitored nesting attempts by BUOW translocated from the San Diego Zoo Safari Park to RJER in 2019 and 2020.

Burrow	Source	Adults (year banded[1])		First Egg Date	Hatch Date	Emergence Date	Max Eggs	Max Chicks	Juveniles Fledged
		Female	Male						
2020 Field 7 (cont'd)									
AB3 (Aviary 2)	Safari Park	Blue A/97	Blue 4	N/A[2]	N/A	N/A	0	N/A	N/A
AB6 (Aviary 3)	Safari Park (Originally wild adults from Otay Mesa)	Blue A/92 (2017)	Blue Z (2017)	28-Feb-20	N/A	N/A	10	N/A	N/A
AB7 (Aviary 4)	Safari Park	Blue A/96	Blue 3	N/A[2]	N/A	N/A	0	N/A	N/A
AB6 (AB7 renest)	Safari Park	Blue A/96	Blue 3	30-Mar-20	2-May-20	16-May-20	8	7	6
AB8 (Aviary 5)	Safari Park	Blue A/98	Blue 5	N/A[2]	N/A	N/A	0	N/A	N/A
AB1	Safari Park	Blue A/95	Blue 4	3-Apr-20	4-May-20	22-May-20	9	3	3
AB8	Safari Park	Blue A/97	Blue 5	7-Apr-20	N/A	N/A	1	N/A	N/A
AB8 (AB8 renest #1)	Safari Park	Blue A/97	Blue 5	10-Apr-20	N/A	N/A	1	N/A	N/A
AB10 (AB8 renest #2)	Safari Park	Blue A/97	Blue 5	18-Apr-20	N/A	N/A	1	N/A	N/A

[1]Banding year was 2020 if not specified.

[2]Breeding confirmed through observation of copulation.



San Diego Zoo Wildlife Alliance

BUOW Translocation and Nest Locations at RJER Field 7

FIGURE 3

Figure 3. Map of occupied burrow locations at RJER Field 7 in 2020, showing burrows used during the translocation process, as well as burrows used for nesting by wild and post-release translocated owls.

Task 2 – Administrative

Budget: $3,000
Spent: $3,000
Match for Task: $2,435.66

Administrative tasks included preparation of quarterly reporting, data compilation, coordination with SDZSP Bird Department staff, and collaboration with the LCDC. Group meetings were held each quarter to enable collaboration and information-sharing among all SDZWA and LCDC partners, and notes were disseminated to all participants afterward, with a list of action items.

Conclusions

We successfully accomplished our specified goals of expanding the conservation breeding program and translocating BUOW to RJER in support of breeding node establishment. Furthermore, we documented high levels of settlement, survival, and reproductive success—all important factors for successful population establishment and growth. Our rates of settlement (83%), breeding (83% initiated, 50% successful), and reproduction (3.89±0.61 fledglings per nest) were comparable to a similar program in British Columbia; Mitchell et al. (2011) documented 86% settlement, 86% nest initiation, 48% breeding success, and 2.4±0.3 fledglings per nest). The owls produced in the conservation breeding program enabled the establishment of a second breeding node (through supplemental translocations) and the initiation of a third breeding node. These translocations directly support the MSP and BUOW Plan by creating sub-occurrences of five or more BUOW pairs within San Diego County. We would not have been able to accomplish this solely through translocation of BUOW impacted by development; the funding from SANDAG was instrumental in expanding the conservation breeding program and enhancing the BUOW population in the county. However, the work of ensuring the long-term persistence of BUOW in the county is by no means done and this project represents the beginning of a longer-term strategy.

We will continue to monitor the population at RJER in coordination with CDFW and may take action in the future if needed to ensure the sustainability of the new population. Continued vegetation management at RJER and the adjacent Hollenbeck Canyon Wildlife Management Area may result in an increase in suitable habitat which would allow for further expansion of the BUOW population through natural dispersal and/or translocation. Management actions may include supplemental feeding during years with low prey numbers or additional translocations to augment or expand the population.

We are also embarking on the establishment of another new breeding node in Ramona. BUOW produced in the conservation breeding program with the support of this grant will form the initial release cohort for 2021. We hope to replicate our successes at RJER, creating a third breeding node and further supporting persistence of the species in the county. Plans for future node establishment beyond 2021 will likely include owls from the conservation breeding program.

Photos

All photos were taken as part of Task 1.

2019: 1st Quarter

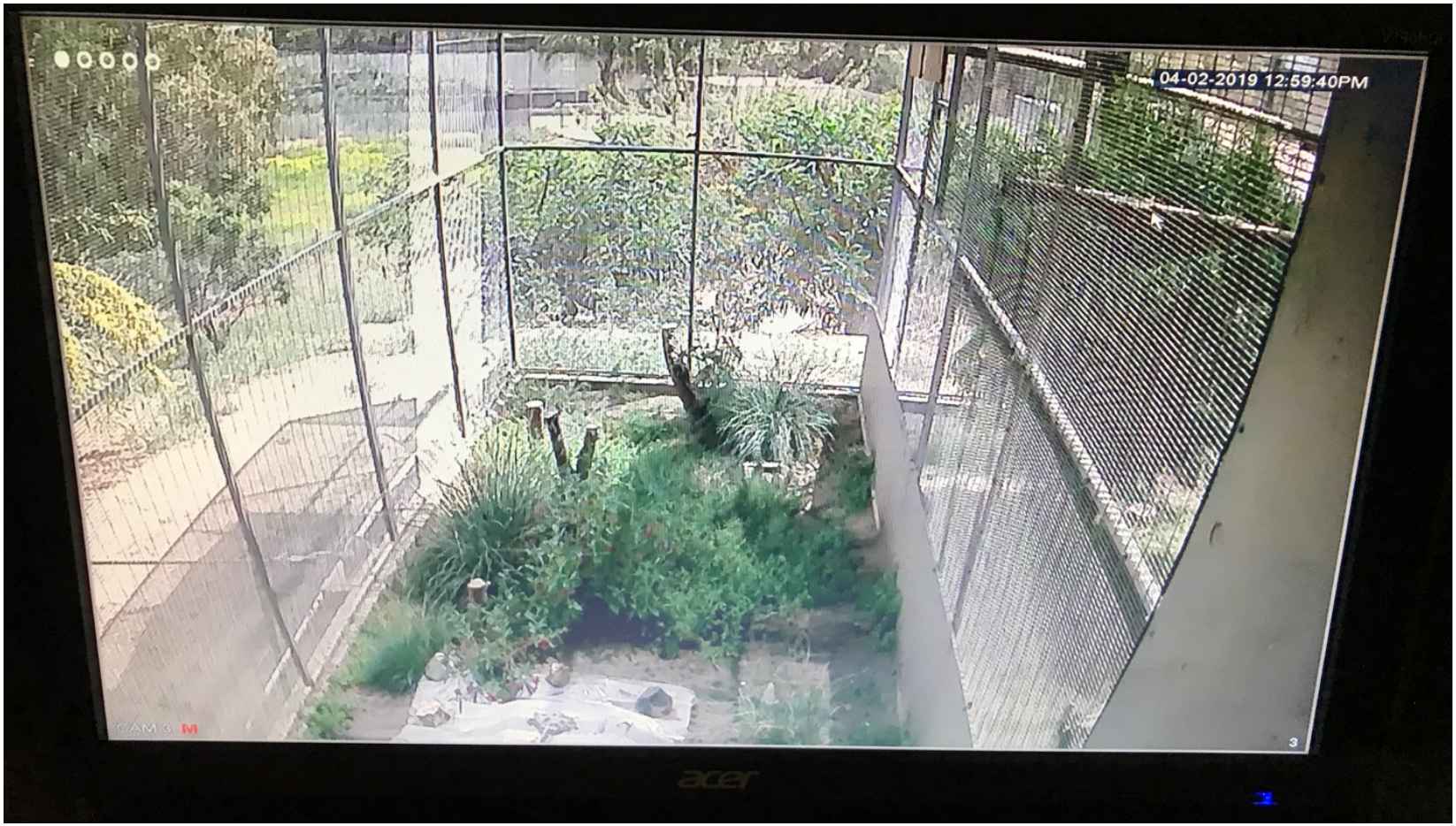


Photo 1. View of one of the breeding enclosures at the Safari Park Bird Breeding Complex. Credit: San Diego Zoo Wildlife Alliance

Photo 2. Field camera view of two burrowing owls during the acclimation period at Rancho Jamul Ecological Reserve. Credit: San Diego Zoo Wildlife Alliance

2019: 2nd Quarter

Photo 1. Non-intrusive surveillance video camera installed in breeding enclosure. Credit: San Diego Zoo Wildlife Alliance

Photo 2. Burrow camera view of five newly hatched chicks and one unhatched egg. Credit: San Diego Zoo Wildlife Alliance

Photo 3. Two burrowing owl chicks in hand for health checks and banding at the Safari Park. Credit: San Diego Zoo Wildlife Alliance

Photo 1. Plants, burrows, and perches in the BUOW flight enclosure at the San Diego Zoo Safari Park. Credit: San Diego Zoo Wildlife Alliance

Photo 2. Blue X (standing on top of burrow, back right) with five juveniles at the breeding burrow at Rancho Jamul Ecological Reserve. Credit: San Diego Zoo Wildlife Alliance

Photo 1. Sixteen BUOW from the conservation breeding program were transferred to the new flight enclosure at the San Diego Zoo Safari Park to strengthen their flight muscles and prepare them for release. Credit: San Diego Zoo Wildlife Alliance

Photo 2. A work crew of San Diego Zoo Wildlife Alliance staff and volunteers, along with California Department of Fish and Wildlife staff, installs artificial burrows at Field 7 (the 2020 BUOW release site) at Rancho Jamul Ecological Reserve. Credit: San Diego Zoo Wildlife Alliance

Photo 1. Remote cameras documented the pairing of Blue A/93, a conservation-bred burrowing owl reintroduced to Rancho Jamul Ecological Reserve in January 2020, with a wild female owl hatched at Rancho Jamul in 2019. Credit: San Diego Zoo Wildlife Alliance

Photo 2. A burrowing owl is transferred to an acclimation aviary at Rancho Jamul Ecological Reserve by Colleen Wisinski, SDZG Conservation Program Specialist, in February 2020. Credit: San Diego Zoo Wildlife Alliance

2020: 2nd Quarter

Photo 1. An egg from the burrowing owl conservation breeding program is assessed for health and fertility in April 2020, using a method known as "egg candling." Credit: San Diego Zoo Wildlife Alliance

Photo 2. A female burrowing owl sleeps while incubating eggs as part of the conservation breeding program. Credit: San Diego Zoo Wildlife Alliance

Photo 3. Two burrowing owl hatchlings from a clutch of 7 eggs produced by a BUOW pair at the San Diego Zoo Safari Park. Credit: San Diego Zoo Wildlife Alliance

Photo 1. Four burrowing owl chicks rest after being transferred with their parents from a construction site to the San Diego Zoo Safari Park. Credit: San Diego Zoo Wildlife Alliance

Photo 2. San Diego Zoo Wildlife Alliance staff conduct a field visit in July 2020 with biologists from San Diego Habitat Conservancy to Ramona Grasslands Conservation Bank, the site selected for burrowing owl reintroduction in 2021. Credit: San Diego Zoo Wildlife Alliance

Photo 1. Fledgling burrowing owl from an unknown nest at RJER. This fledged juvenile showed up at the Field 7 translocation area, but did not hatch at any of the Field 7 or Field 1 burrows, suggesting the presence of a successful nearby but outside of the translocation/monitoring areas. Credit: San Diego Zoo Wildlife Alliance

Photo 2. Conservation-bred male Blue 7 (top right), with his mate and their second clutch of the season (4 juveniles). It is uncommon for BUOW to double-clutch in San Diego, and we suspect supplemental feeding allowed this pair to fledge two separate broods. Credit: San Diego Zoo Wildlife Alliance

Photo 3. Blue Z (front), the male that sustained an eye injury, seven months after rehabilitation and release seen here with a female released from the conservation breeding program (Blue A/96). Credit: San Diego Zoo Wildlife Alliance

References

Ahlering, M.A., Arlt, D., Betts, M.G., Fletcher, R.J., Nocera, J.J., and M.P. Ward. 2010. Research needs and recommendations for the use of conspecific attraction methods in the conservation of migratory songbirds. Condor 112:252–264.

Armstrong, D.P. and P.J. Seddon. (2008). Directions in reintroduction biology. Trends in Ecology & Evolution 23:20-25.

Batson, W.G., Gordon, I.J., Fletcher, D.B., and A.D. Manning. 2015. Translocation tactics: a framework to support the IUCN Guidelines for wildlife translocations and improve the quality of applied methods. Journal of Applied Ecology 52: 1598-1607.

Berger-Tal, O., Blumstein, D.T., and R.R. Swaisgood. (2019). Conservation translocations: a review of common difficulties and promising directions. Animal Conservation. https://doi.org/10.1111/acv.12534

Bowen, P.J. 2001. Demography and distribution of the burrowing owl in Florida. Florida Field Naturalist 29(4):113–142.

Bright, P.W. and P.A. Morris. 1994. Animal translocation for conservation: performance of dormice in relation to release methods, origin and season. Journal of Applied Ecology 31:699-708.

Center for Biological Diversity. 2015. Excluded from protection: burrowing owls and the California Endangered Species Act. Oral presentation by Jeff Miller, Center for Biological Diversity, Alameda Creek Alliance. California Burrowing Owl Consortium Conference, San Jose State University, San Jose, California, October 24, 2015.

Conway, C.J., Macias-Duarte, A., Garcia, V., and C.A. Finley. 2010. Migratory linkages of burrowing owls on department of defense installations and adjacent lands, final report. Department of Defense, Legacy Resource Management. Retrieved from: http://www.denix.osd.mil/nr/upload/DoD-Legacy-final-report_09-243_ver-2.pdf.

DeSante, D.F., Ruhlen, E.D., D.K. Rosenberg. 1996. The distribution and relative abundance of burrowing owls in California during 1991–1993: Evidence for a declining population. The Institute for Bird Populations, Point Reyes Station, California.

DeSante, D.F., Ruhlen, E.D., and D.K. Rosenberg. 2004. Density and abundance of burrowing owls in the agricultural matrix of the Imperial Valley, California. Pages 116–119 in W.D. Shuford and K.C. Molina (editors). Ecology and Conservation of Birds of the Salton Sink: An Endangered Ecosystem. Studies in Avian Biology 27. University of California Press, Berkeley, California. 169 pp.

DeSante, D.F., Ruhlen, E.D., and D.K. Rosenberg. 2007a. Density and abundance of burrowing owls in the agricultural matrix of the Imperial Valley, California. Pages 103–108 in Barclay, J., K. Hunting, J. Lincer, J. Linthicum, and T. Roberts (editors). Proceedings of the California burrowing owl symposium, November

2003 (Bird Populations Monographs No. 1). The Institute for Bird Populations and Albion Environmental, Inc., Point Reyes Station, California. 197 pp.

DeSante, D.F., Ruhlen, E.D., and R. Scalf. 2007b. The distribution and relative abundance of burrowing owls in California during 1991–1993: Evidence for a declining population and thoughts on its conservation. Pages 1–41 in J. Barclay, K. Hunting, J. Lincer, J. Linthicum, and T. Roberts (editors). Proceedings of the California burrowing owl symposium, November 2003 (Bird Populations Monographs No. 1). The Institute for Bird Populations and Albion Environmental, Inc., Point Reyes Station, California. 197 pp.

Drake, D. and S.A. Temple. 2012. Captive Propagation and Translocation. In The Wildlife Techniques Manual Volume 2. Management. N. Silvy, Ed. Johns Hopkins University Press, Baltimore, MD. pp 293-306.

Gervais, J.A., Rosenberg D.K., and L.A. Comrack. 2008. Burrowing owl (*Athene cunicularia*). Pages 218–226 in W.D. Shuford and T. Gardali (editors). California bird species of special concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento, California. 450 pp.

Hennessy, S, Wisinski, C, Ronan, N, Gregory, C, Swaisgood, R, and Nordstrom, L. 2020. Assessing California's Relocation Guidelines for Burrowing Owls Impacted by Renewable Energy Development. California Energy Commission. Publication Number: CEC-500-2020-051. Available at: https://ww2.energy.ca.gov/2020publications/CEC-500-2020-051/CEC-500-2020-051.pdf

Klute, D.S., Ayers, L.W., Green, M.T., Howe, W.H., Jones, S.L., Shaffer, J.A., Sheffield, S.R., and T.S. Zimmerman. 2003. Status assessment and conservation plan for the western burrowing owl in the United States. Biological Technical Publication FWS/BTP-R6001-2003. U.S. Department of Interior, Fish and Wildlife Service, Washington, D.C. 120 pp.

Kotliar, N.B. and J. Burger. (1984). The use of decoys to attract Least Terns (*Sterna antillarum*) to abandoned colony sites in New Jersey. Colonial Waterbirds 7:134-138.

Le Gouar, P., Mihoub, J.B., and F. Sarrazin. 2012. Dispersal and habitat selection: behavioural and spatial constraints for animal translocations. In: Ewen JG, Armstrong DP, Parker KA, Seddon P, editors. Reintroduction biology: integrating science and management. Blackwell Publishing, Oxford. pp. 138-164.

Leupin, E.E. and D.J. Low. 2001. Burrowing Owl reintroduction efforts in the Thompson-Nicola region of British Columbia. Journal of Raptor Research 35:392-398.

Lincer, J. L. and P. H. Bloom. 2007. The Status of the Burrowing Owl (*Athene cunicularia*) in San Diego County, California. In Proceedings of the California Burrowing Owl Symposium, J.H. Barclay, J.W. Hunting, J.L. Lincer, J. Linthicum, T.A. Roberts, Eds. p. 90-102. Bird Populations Monograph No. 1, Institute for Bird Populations and Albion Environmental, Inc., Point Reyes Station, CA.

Mitchell, A.M., Wellicome, T.I., Brodie, D., and K.M. Cheng. 2011. Captive-reared burrowing owls show higher site-affinity, survival, and reproductive performance when reintroduced using a soft-release. Biological Conservation 144:1382–1391.

Popescu, V.D. and M.L. Hunter Jr. 2012. Assisted Colonization of Wildlife Species at Risk from Climate Change. In Wildlife conservation in a changing climate. Brodie, J.F., E.S. Post, D.F. Doak, Eds. University of Chicago Press, Chicago, IL. pp. 347-368.

Reed, J. and A. Dobson. (1993). Behavioural constraints and conservation biology: Conspecific attraction and recruitment. Trends in Ecology & Evolution 8:253-256.

(SDMMP) San Diego Management and Monitoring Program. 2013. Management Strategic Plan for Conserved Lands in Western San Diego County. 3 Volumes. Prepared for the San Diego Association of Governments. San Diego. Version 08.27.2013.

(SDMMP) San Diego Management and Monitoring Program and The Nature Conservancy. 2017. Management and Monitoring Strategic Plan for Conserved Lands in Western San Diego County: A Strategic Habitat Conservation Roadmap. 3 Volumes. Prepared for San Diego Association of Governments. San Diego, CA.

(SDZ ICR) San Diego Zoo Institute for Conservation Research. 2017. Burrowing Owl Conservation and Management Plan for San Diego County. San Diego, CA. 86 pp. Available at: https://sdmmp.com/view_article.php?cid=SDMMP_CID_212_5a569e38e1c7e

Sarrazin, F., Bagnolinp, C., Pinna, J.-L., and E. Danchin. (1996). Breeding biology during establishment of a reintroduced Griffon Vulture Gyps fulvus population. Ibis 138:315-325.

Shier, D.M. and R.R. Swaisgood. 2012. Fitness Costs of Neighborhood Disruption in Translocations of a Solitary Mammal. Conservation Biology 26:116-12.

Stamps, J. (1988). Conspecific attraction and aggregation in territorial species. American Naturalist 131:329-347.

Stamps, J.A. and R.R. Swaisgood. 2007. Someplace like home: Experience, habitat selection and conservation biology. Applied Animal Behaviour Science 102:392-409.

Unitt, P. 2004. San Diego County bird atlas. Proceedings of the San Diego Society of Natural History 39:287-289.

(USFWS) U.S. Fish and Wildlife Service. 2008. Birds of conservation concern 2008. U.S. Department of Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia. Retrieved from: http://www.fws.gov/migratorybirds/NewReportsPublications/SpecialTopics/BCC2008/BCC2008.pdf.

White Jr., T.H., Y. de Melo Barrosb, P.F. Develeyc, I.C. Llerandi-Románd, O.A. Monsegur-Riverad, and A.M. Trujillo-Pinto. 2015. Improving reintroduction planning and implementation through quantitative SWOT analysis. Journal for Nature Conservation 28:149-159.

Wilkerson, R.L. and Siegel, R.B. 2010. Assessing changes in the distribution and abundance of burrowing owls in California, 1993–2007. Bird Populations 10(1):1–36.

Wilkerson, R.L. and R.B. Siegel. 2011. Distribution and abundance of western burrowing owls (*Athene cunicularia hypugaea*) in southeastern California. The Southwestern Naturalist 56(3):378–384.

Wilkerson, R., R.Siegel, D. Palmer, D. Bittner, and J. L. Lincer. 2011. An Overview of the Status of Burrowing Owls in California and Several Other Western States. Presented at the 2011 Western Raptor Symposium, J.L. Lincer and J.D. Bittner, Co-chairs. Riverside Convention Center, Riverside, CA. 8-9 February.

Wisinski, CL, Marczak, S, Hennessy, SM, Hines, K, Stevens, M, Perez, S, Angel, D, and Nordstrom, LA. 2019. Burrowing owl mitigation implementation report for SDC secondary barrier replacement. Report to U.S. Customs and Border Protection and RECON Environmental. San Diego Zoo Institute for Conservation Research, Escondido, CA. 31 p.

Wisinski C.L., Marczak S., Hennessy S.M., Stevens M., Perez S., Angel D., Hines K., Swaisgood R.R., and Nordstrom L.A. 2020a. Project Report 2019: Advancing Burrowing Owl Conservation in San Diego County through Mitigation Measures using Science and Adaptive Management. San Diego Zoo Institute for Conservation Research, Escondido, California. 50 pp.

Wisinski C.L., Marczak S., Hennessy S.M., Angel D., Stevens M., Perez S., Hines K., and Nordstrom L.A. 2020b. Burrowing owl mitigation implementation report for SDC secondary barrier replacement addendum. Report to U.S. Customs and Border Protection and RECON Environmental. San Diego Zoo Institute for Conservation Research, Escondido, CA. 9 pp.

Appendices

Appendix 1. Burrowing Owl Conservation Breeding and Release Plan (separate document)