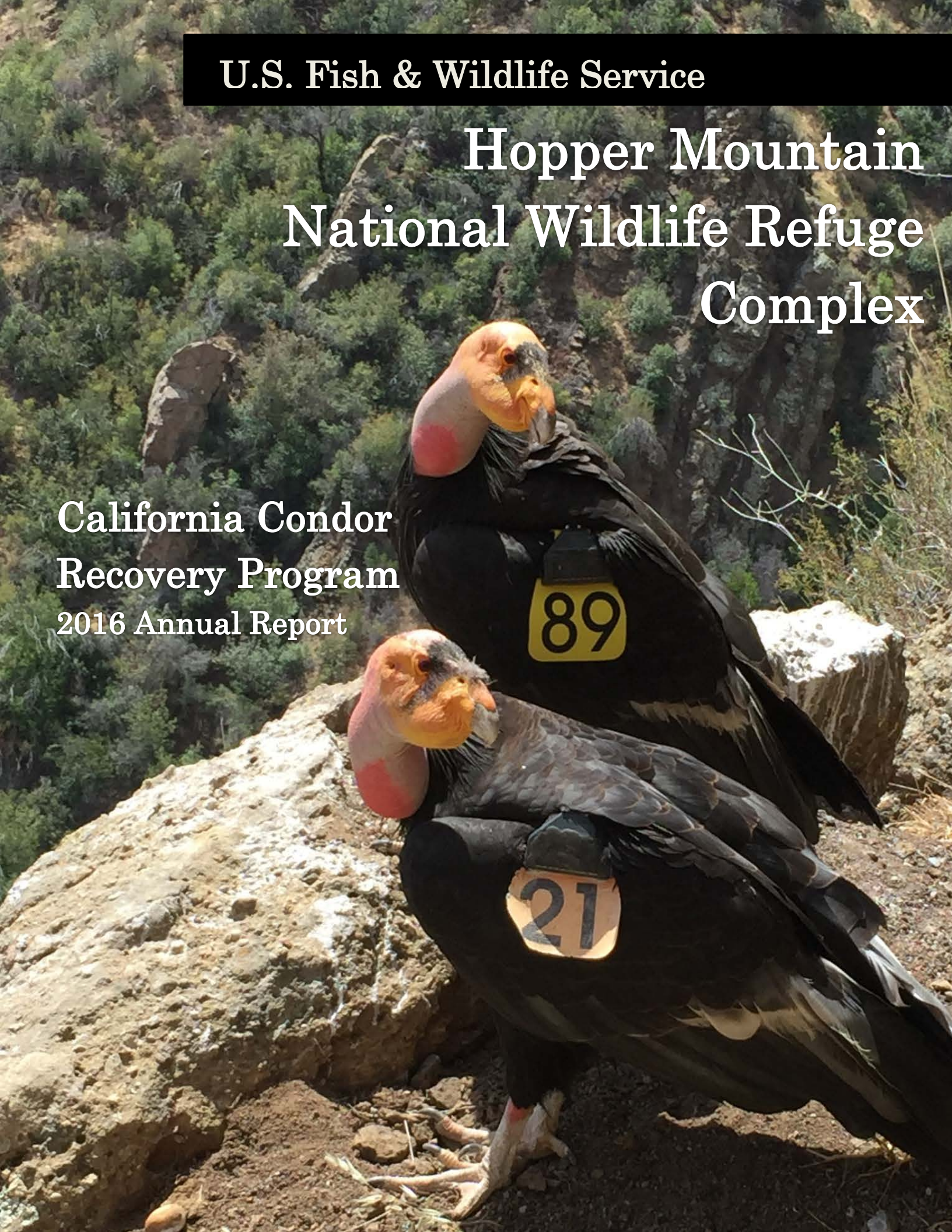
U.S. Fish & Wildlife Service

Hopper Mountain National Wildlife Refuge Complex

California Condor Recovery Program

2016 Annual Report



On the Cover: Condors #21 and #289 at the porch of their nest cavity high above Agua Blanca Creek.
Photo Credit: Edward Owens, USFWS

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Executive Summary

The Hopper Mountain National Wildlife Refuge Complex (Complex) manages a reintroduced California condor population in Southern California. The Bitter Creek and Hopper Mountain National Wildlife Refuges are used as the primary management locations for the release, monitoring, and recapture of condors in this region.

As of December 31, 2016, the California condor population managed directly by the U.S. Fish and Wildlife Service (Service) consisted of 80 free flying condors. Two wild chicks fledged from six nests in 2016. Two of these nests were monitored using remote nest cameras. The release of captive bred condors was delayed by a month due to an infestation of soft-bodied ticks [*Argas ricei*]. After the infestation was identified and exterminated, eight captive-reared condors were released at Bitter Creek National Wildlife Refuge during the months of November and December. An additional three condors meant for release were not due to the delay. They will be released early in 2017. As a result of the successful wild nests and captive releases, the population increased by 2%.

The reintroduced condor population continues to recolonize its former range, exemplified by increased condor activity in the northern Tehachapi and southern Sierra Nevada Mountains, including flights over Blue Ridge National Wildlife Refuge. Condors continued to inhabit the northern Tehachapi Mountains where they interact with humans in the residential mountain communities of Bear Valley Springs, Stallion Springs, and Alpine Forest Park. The increase in activity in the Tehachapi Mountains has also meant more condors within the footprint of wind energy facilities, which is of concern.

The field team attempted to trap the population twice during the year to monitor for lead exposure which occurs when condors ingest carrion or gut piles that have been shot with lead ammunition. Trapping has become more difficult as the population's range has expanded and individuals have become more reliant on non-proffered food sources. In 2016, nine condors (12% of the population) evaded trapping. Lead exposures continue to occur in the population, with 15 condors (20%) requiring treatment for elevated blood lead levels in 2016.

A total of 11 condors were declared dead in 2016. The carcasses of five free-flying condors were recovered, and three went missing in the wild and were declared dead. One condor, an eleven year old male, died of lead poisoning. A newly fledged condor from 2015 was found dead near its nest, but the cause of death could not be

determined. There are three condor deaths whose necropsy is still pending. Three wild chicks died prior to fledging. One of these was euthanized after found in the nest severely underdeveloped, with microtrash impaction and several broken bones. The necropsies of the other two chicks are still pending.

The Complex used partnerships to increase the level of condor education and outreach. The Service, in partnership with the Santa Barbara Zoo, continued showcasing condor nesting behavior and management on the Condor Cave Facebook page. The Condor Cave has increased its following by 147% with a total of 11,396 followers as of December 31, 2015. A condor nest camera was again streamed live on the internet through a partnership with the Cornell Lab of Ornithology, the Santa Barbara Zoo, and Western Foundation of Vertebrate Zoology. This year, the camera began on the hatch day of a nest and streamed for five and a half months. While streaming, it was viewed about one million times, from over 150 countries, for a total of 19 million minutes (36 years). A question and answer session with a condor biologist was also streamed live through the nest camera on one occasion this season. Five hundred people watched the Q&A live with an additional 2,600 views of the recording. The CondorKids program also continued in 2016 at the Fillmore Unified School district with all 12 third grade classes, 200 students, participating. The Institute for Wildlife Studies non-lead outreach coordinator conducted 14 events reaching 1,200 people. Other outreach activities included tours of each wildlife refuge, educational booths, presentations to interest groups, elementary, high school, and college students, and interviews with media outlets including local television affiliates, local newspapers, National Public Radio, Wired Magazine, and Scholastic Science World.

Southern California Population Highlights

Population Size

(as of December 31, 2016)

	Adults (≥6 years old)	Juveniles (<6 years old)	Total
Males	22	18	40
Females	21	19	40
Total	43	37	80

For more information on the change in population size see Figure 3.5.1 on page 42

Nesting

	Successful Nests	Failed Nests	Total
Nests in 2016	2	4	6
All Nests since 2001	35	40	75

For more information on annual nesting success see Figure 3.4.1 on page 36

Captive Releases

	Number of Condors
Releases in 2016	8
Total Number of Releases since 1992	141

For more information on the 2016 captive releases see Table 3.5.2 on page 41

Condor Deaths

	Number of Condors
Deaths reported in 2016	11
Total Number of Deaths since 1992	108

For more information on the condor deaths in 2016 see Table 3.3.1 on page 35

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1.0 Introduction

The California condor [*Gymnogyps californianus*] is a federally listed endangered species. The current recovery priority ranking for the California condor is 4C. The "4" designation indicates that the California condor is a monotypic genus that faces a high degree of threat and has a low potential for recovery. The "C" indicates conflict with construction, development projects, or other forms of economic activity.

California condors are among the largest flying birds in the world, with a wingspan measuring up to 2.9 meters (9.5 feet; Photo 1.0.1). Condors are a long-lived species with an estimated lifespan of 60 years. They are slow to mature and typically begin to reproduce at six years of age. Condors often form long-lived pairs and fledge one chick every other year. If a nestling fledges relatively early (in late summer or early fall), its parents may nest again the following year (Snyder and Hamber 1985).

California condor habitat can be categorized into nesting, foraging, and roosting components (USFWS 1975). Condors forage in the open terrain of foothill grassland, oak savanna, woodland habitats, and on beaches of steep mountainous coastal areas. Condors maintain wide ranging foraging patterns throughout the year, which is an important adaptation for a species that may be subjected to an unpredictable food supply (Meretsky and Snyder 1992).

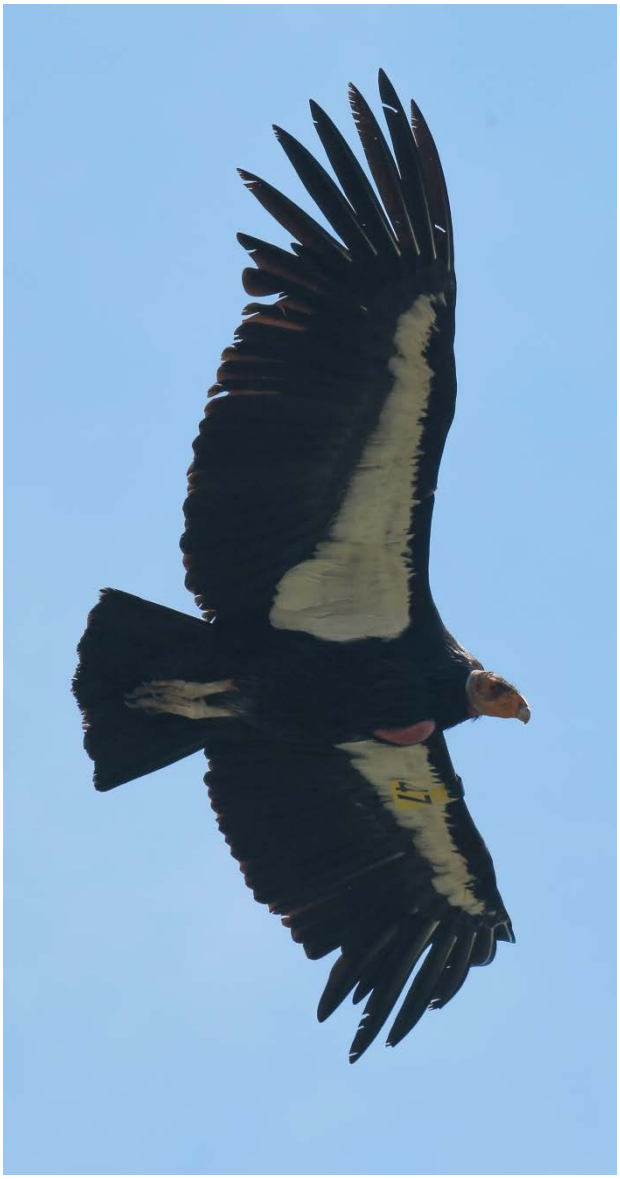


Photo 1.0.1: California condor #247 in flight. *Photo credit Shelly OBrien, USFWS Volunteer*

Condors at interior locations feed on the carrion of mule deer, tule elk, pronghorn antelope, feral hogs, domestic ungulates, and smaller mammals. The diet of condors feeding on the coast also includes the carrion of whales, sea lions, and other marine species (Koford 1953; USFWS 1984; Emslie 1987; Burnett et

al. 2013). California condors are primarily a cavity nesting species and typically choose cavities located on steep rock formations or in the burned out hollows of old growth conifers such as coastal redwood and giant sequoia trees (Koford 1953; Snyder et al. 1986). Less typical nest sites include cliff ledges, cupped broken tops of old growth conifers, and in several instances, nests of other species (Snyder et al. 1986; USFWS 1996). Condors repeatedly use roosting sites on ridgelines, rocky outcrops, steep canyons, and in tall trees or snags near foraging grounds or nest sites (USFWS 1984).

The U.S. Fish & Wildlife Service (Service) Hopper Mountain National Wildlife Refuge Complex (Complex) serves as the lead office for the California Condor Recovery Program (Recovery Program) and is one of many partners that support this multi-state and international recovery effort. The Complex has participated in the California condor reintroduction effort since 1992. The Service operated a number of different release sites both on refuges and on U.S. Forest Service lands and has annually released condors from the captive breeding facilities. Over time, these releases led to the establishment of the Southern California condor population, the group of condors directly managed by the Complex's Condor Field Team (field team).

Over the last 24 years, the field team has been responsible for the continued monitoring and management of the reintroduced population, working both on and off refuge. Today, two of the wildlife refuges in the Complex, Bitter Creek National Wildlife Refuge (Bitter Creek NWR) and Hopper Mountain National Wildlife Refuge (Hopper Mountain NWR) are the primary management locations for the Southern California condor population (Photo 1.0.2), which currently inhabits portions of San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Kern, Tulare, Fresno, and Inyo Counties.

Photo 1.0.2: Condor #206 perched with a Common Raven at Bitter Creek NWR. *Photo credit: Chloe Tremper, Great Basin Institute*

The California Condor Recovery Plan (Recovery Plan) provides the overarching guidance for field activities. The primary objective driving the reintroduction effort is to establish one of the two wild, self-sustaining populations of 150 individuals with 15 breeding pairs (USFWS 1996). The Recovery Plan consists of five key actions: 1) establish a captive breeding program, 2) reintroduce California condors into the wild, 3) minimize mortality factors, 4) maintain condor habitat, and 5) implement condor information and educational programs (USFWS 1984). In accordance with the

Recovery Plan, "Released California condors should be closely monitored by visual observation and electronic telemetry" (USFWS 1984).

To support the second key action in the Recovery Plan, the field team manages a condor release site at Bitter Creek NWR and monitors the free-flying population of condors to identify threats and reduce adverse effects to condors, including minimizing mortality factors. Each refuge provides facilities designated for trapping and holding condors, which is necessary for attaching tags and transmitters to condors and performing routine health checks. Also in accordance with the Recovery Plan, "Condor blood, feathers, eggshells, and other tissues will be collected opportunistically and analyzed for heavy metals, pesticides, and other potential contaminants" (USFWS 1984).

The field team is comprised of a number of different positions including Service employees, partner employees, and volunteers. In 2016, the Service employed one full-time permanent supervisory wildlife biologist, two full-time term wildlife biologists, and one full-time term biological science technician.

The Santa Barbara Zoo has been an essential partner for the Recovery Program at the Complex. Since 2007 the zoo has assisted with nest management and research in the Southern California condor population with a full time permanent condor nest technician. In 2015 the Santa Barbara Zoo added an additional condor technician to assist with other condor management activities and to make up for a Service biological science technician position that was discontinued in 2014. This full time position is currently funded through June of 2018. The Santa Barbara Zoo also has partnered with the Complex on a major education and outreach project funded by the Urban Refuge Initiative. This Program is called CondorKids.

In addition to the various Service and Santa Barbara Zoo positions, the Complex has four research associate positions that are filled throughout the year. These positions are funded through a cooperative agreement with the Great Basin Institute. Great Basin Institute research associates commit to working 40 to 50 hours a week for a period of six months for a daily stipend. These positions are also AmeriCorps volunteers and are eligible to receive an educational award which is dependent on the number of hours worked.

Some field activities are also supported by unpaid volunteers or other program partners. Unpaid volunteers primarily assist with monitoring nests during the eight month nesting season, but also assist with tracking via radio telemetry on a more limited basis. A variety of support also comes from other program partners. The Los Angeles Zoo provided assistance in caring for sick and injured condors, and helped during handling events and nest entries. The Friends of the California Condor Wild and Free helped with outreach events and maintenance projects. The Cornell Lab of Ornithology and the Western foundation of Vertebrate Zoology assists with a live-streaming condor nest camera online. The Institute for Wildlife Studies conducts a variety of non-lead outreach activities in coordination with the field

team. Several Universities collaborate on condor research relevant to conservation needs.

1.1 Funding

In 2016, the Complex received $691,047 in U.S. Fish and Wildlife Service Recovery funds (1113). The Complex used these resources to fund the field team and their activities as well as a condor coordinator position. Refuge management funds (126x) also contributed significantly to condor related activities.

In addition to Service funds, various non-government funds contributed to condor recovery activities at the Complex. The Santa Barbara Zoo's Department of Conservation and Research (Photo 1.0.3) and Condor Survival Fund at the Santa Barbara Museum of Natural History also made significant contributions.

Photo 1.0.3: A Santa Barbara Zoo field vehicle on Tejon Ranch while tracking condor activity. The Zoo's Conservation and Research team are vital contributors to the field team's effort to monitor the California condors in Southern California. *Photo credit: Devon Pryor, Santa Barbara Zoo*

2.0 Actions

The condor field team at the Complex performs seven primary actions with the goal of achieving a self-sustaining population of condors in California (Figure 2.0.1). The actions performed are: Monitoring Resource Use, Lead Monitoring and Mitigation, Detecting Mortalities, Nest Management, Captive Releases & Transfers, Behavioral Modification, and Outreach. These actions are meant to address the major threats condors face in the wild (Figure 2.0.1).

2.1 Monitoring Resource Use

The loss and modification of California condor foraging, roosting, and nesting habitat is recognized as a historic threat to the recovery of the species. As noted in the 1979 Recovery Plan (USFWS 1979), adequate nest sites, roost sites, and foraging habitat with adequate food are the basic habitat needs of the condor. The 1996 Recovery Plan acknowledges the presence of sufficient remaining condor habitat in the Southwestern United States but notes that maintaining this habitat is a key recovery action (USFWS 1996). The field team monitors nesting, roosting, and foraging habitat use across Southern California using data from global positioning system (GPS) transmitters attached to condors. Transmitters are assigned to individuals of different sexes and age classes while also considering breeding status or captive release circumstances. GPS transmitter locations are used to understand condor resource use over a large geographic and temporal scale.

The field team's goal is to equip all California condors in the Southern California population with either two very high frequency (VHF) transmitters attached to retrices (Kenward 1978), or a combination of one VHF transmitter and one patagial mounted (Wallace 1994) GPS transmitter. Some condors in the population do not have transmitters because transmitters are dropped or malfunction in between trapping sessions, or when not trapped for a prolonged period of time.

Use of VHF Transmitters

VHF transmitters allow condors to be tracked in real time. The field team uses handheld VHF receivers and Yagi antennas to locate condors by following the direction of the VHF signal in order to obtain visual observations on specific condors, such as new releases or nesting condors. VHF transmitters are an important tool in identifying when a condor has died (see 2.3 Detecting Mortalities). The VHF transmitters used are produced by Holohil Systems Incorporated (Model # RI-2C, 10 grams). In addition to hand held receivers, remote telemetry stations at Bitter Creek NWR and Hopper Mountain NWR are also constantly scanning for condors wearing VHF transmitters. Data from these stations are manually downloaded periodically to aid in identifying missing birds.

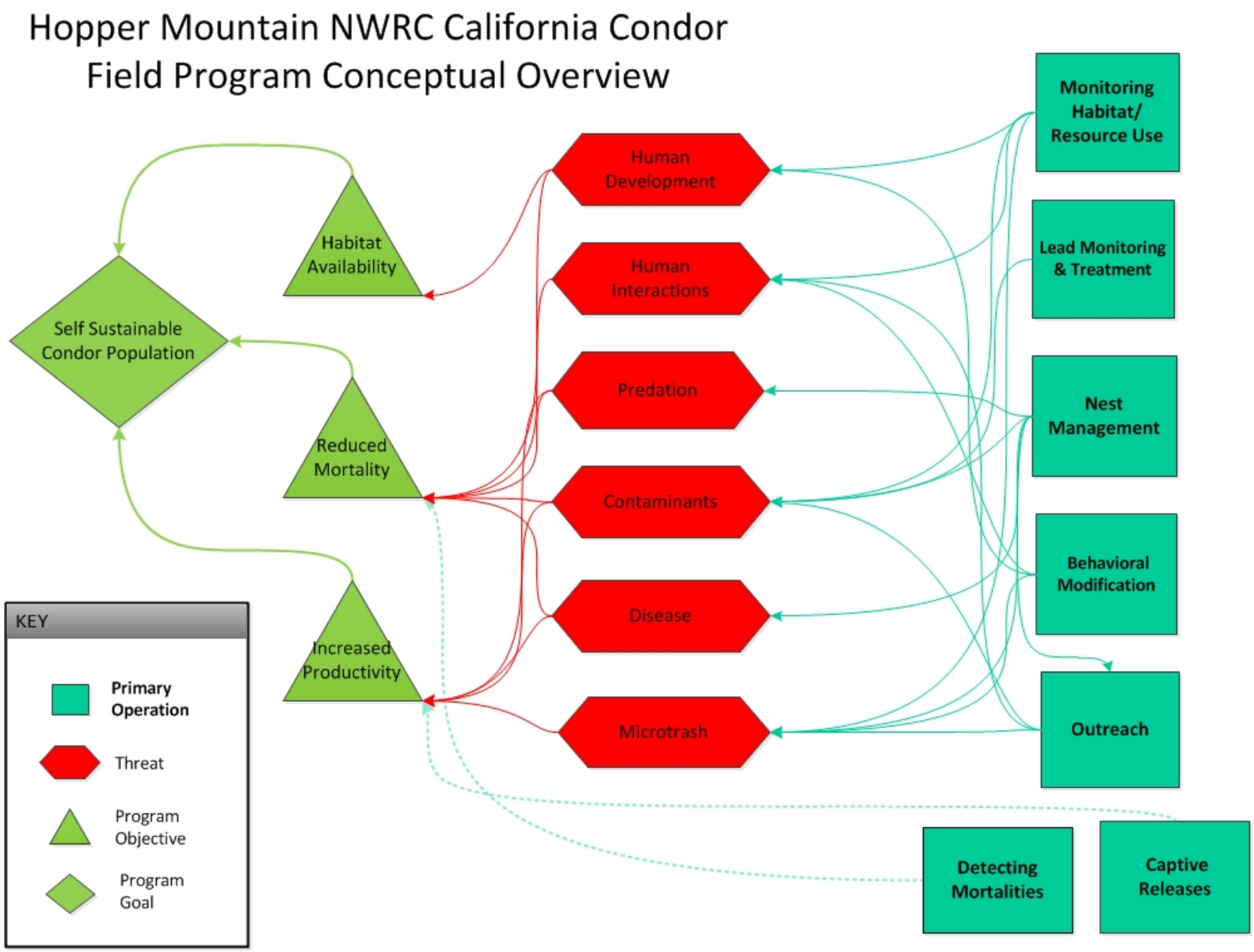


Figure 2.0.1: A conceptual model for the Hopper Mountain NWRC California Condor Field Program. The program's goal is to establish a wild self-sustaining population of condors. The three program objectives are limited by one or more of the six identified threats, which are in turn addressed by the seven primary operations.

Photo 2.1.1: Condor #625 wearing a MTI GPS/GSM transmitter. *Photo Credit: Stephanie Herrera, Great Basin Institute.*

Photo 2.1.2: Condor #518 wearing a prototype CTT GPS/GSM transmitter. *Photo credit: Joseph Brandt, USFWS.*

Use of GPS Transmitters

In 2016, GPS transmitters were produced by two manufacturers of solar-powered GPS transmitters that are patagial mounted to a subset of the condor population during routine handling. The transmitters produced by Microwave Telemetry Inc. (MTI; Photo 2.1.1) were very similar in design to the ARGOS/GPS transmitters that were previously used on condors in Southern California (from 2005 to 2014). The MTI transmitters collect GPS locations every 2 to 15 minutes depending on peak voltage periods. The GPS location data collected by these transmitters are transmitted using cell towers via the GSM (Global System for Mobile Communications) network.

The transmitters manufactured by Cellular Tracking Technologies (CTT; Photo 2.1.2) also use cell towers to transmit the GPS locations, but use a GSM network or CDMA (Code-Division Multiple Access) network depending on the transmitter. The CTT transmitters collect locations every 15 minutes.

The field team monitors condor locations produced by the GPS transmitters on a daily basis to target locations of interest for on-the-ground investigation, an action referred to as ground-truthing. Non-proffered feeding events and potential threats are prioritized for ground-truthing. A non-proffered feeding event occurs when condors feed on carrion or other food items that are not provided by the condor field team.

GPS transmitter locations also inform program-wide objectives via long-term research projects including efforts to map condor habitat (Cogan et al. 2012), assess the impact and distribution of lead on the landscape (Kelly et al. 2014), and monitor wind energy development as a potential threat. Findings from these studies may influence management strategies and policy aimed at addressing the threats to condor survival.

2.2 Lead Monitoring and Mitigation

Lead poisoning is a major ongoing concern for all wild California condors, including those in the Southern California population. The Ridley-Tree

Condor Preservation Act (2008) regulates the use of lead ammunition in California and may reduce the amount of lead contaminated carrion available to scavengers throughout the condor range. Despite this regulation, there is still potential for condors to encounter lead fragments from animals shot with lead ammunition (Finkelstein et al. 2012, Kelly et al. 2015). The purpose of monitoring and mitigating lead exposure in California condors is to reduce lead related mortalities and to provide guidance on management decisions and policy making.

Trapping Condors

Each year the field team attempts to trap and handle the entire Southern California condor population to monitor blood lead levels and, if necessary, treat condors for lead exposure. Some condors are tested opportunistically at additional times throughout the year when a lead exposure is suspected or when they are trapped and handled for other purposes. Trap sessions are separated into two periods: January through July and August through December. Normally trapping is conducted for two months during each session: June through July and November through December.

Blood Lead Tests

While handling each condor, the field team collects three blood samples from the medial metatarsal vein using blood vials containing Edetate (EDTA). One sample is used immediately for a field blood lead test using a portable lead analyzer. Additional blood samples collected from condors are refrigerated and sent to the California Animal Health and Food Safety Laboratory System at University of California, Davis for lab analysis of lead concentrations, and the Microbiology and Environmental Toxicology Department at the University of California, Santa Cruz, for lead isotope analysis. In addition, feather samples collected from trapped condors are used to monitor lead exposure over longer periods of time. Background lead exposure levels of condors are considered to be below 10 µg/dL (Cade 2007, Finklestien et al. 2012). A blood lead level higher than 10 µg/dL is an indication of lead exposure (Finklestien et al. 2012).

Treatment of Elevated Blood Lead Levels

Condors with a field blood lead value below 35 µg/dL are released back into the wild while condors with a field blood lead value greater than or equal to 35 µg/dL are transported to the Los Angeles Zoo for treatment. Treatment involves radiographing the condor to identify possible metallic objects in the digestive system and administering chelation treatment to remove lead from the bloodstream (Photo 2.2.1). The field team also samples the blood lead levels of wild condor chicks during routine nest entries and treats them at the nest, requiring additional nest entries if necessary (see: 2.4 Nest Management section).

Photo 2.2.1: Los Angeles Zoo Condor Keepers prepare to chelate a lead poisoned condor. *Photo credit: Los Angeles Zoo*

Chelation treatment consists of daily intramuscular injections of Calcium EDTA given in conjunction with subcutaneous fluids. Lead toxicosis can result in crop-stasis, or the inability to transfer food past the crop, which can result in severe weight loss and starvation. Treatment time varies between weeks to months depending on the level of lead exposure. Zoo technicians are able to identify metallic objects in radiographic images but are not able to determine the type or composition of these objects unless recovered. Los Angeles Zoo staff closely monitors condors with metallic-positive radiographs. When possible, they recover castings and fecal material, and remove metallic objects for analysis. A condor's treatment ends when its lab blood lead level is less than 35 µg/dL and it is no longer showing clinical signs of lead toxicosis.

2.3 Detecting Mortalities

Identifying the causes of California condor mortalities is an important aspect of California condor recovery. Despite decades of research, the reasons for the species' decline in historic populations are poorly documented. Understanding the factors contributing to mortalities in the reintroduced wild populations is essential to the conservation of the species (Rideout et al. 2012). It is important to quickly identify and locate dead condors in order to determine the cause of death and to detect any immediate threats that may affect other condors. Detection of mortalities by radio telemetry and GPS monitoring is one of the highest priority operations conducted by the field team.

The field team usually detects condor mortalities using VHF transmitters attached to each condor. All deployed VHF transmitters have an automatic mortality signal function. After a 12-hour period of inactivity, the VHF transmitter will emit a beep with a frequency about twice as fast as the normal rate, also called a mortality signal. When a mortality signal is detected, it can indicate the VHF transmitter has fallen off the condor via a molted feather, the condor has not moved for some time (mortality signals can occur in the morning before the condor has moved from its roost), or the condor is dead.

GPS transmitters can also alert the field team to potential condor mortalities. When reviewing condor GPS transmitter locations, stationary GPS transmitter locations for a single condor over an

unusually long period may indicate mortalities.

Condors are monitored throughout the day using radio telemetry at both Hopper Mountain NWR and Bitter Creek NWR. If a condor goes undetected for more than one week, the field team will expand their search for the missing condor by mobile tracking. Mobile tracking involves driving to various off-refuge locations throughout the Southern California condor range to search for the signal of the missing condor (Photo 2.3.1).

Condor chick mortalities are detected during routine nest monitoring (see: Nest Management section). Monitoring nests regularly allows the field team to identify chick mortalities immediately or shortly after they occur.

All condor carcasses recovered from the wild population are transferred to the National Fish and Wildlife Forensics Laboratory in Ashland, Oregon, for postmortem examination in order to determine cause of death.

Photo 2.3.1: Linda Uyeda tracking condors using radio telemetry. *Photo Credit: Josh Felch, USFWS*.

2.4 Nest Management

Nesting in the Southern California condor population began in 2001. Between 2001 and 2006, only two condor chicks fledged from 16 nests. The field team identified the leading cause of nest failure as the consumption of small, human-made materials, also called microtrash, brought to nests by parent condors. Documented microtrash items include nuts, bolts, washers, copper wire, plastic, bottle caps, glass, and spent ammunition cartridges (Mee et al. 2007; Photo 2.4.1). When chicks ingest large quantities of microtrash, it can result in digestive tract impaction, evisceration, internal lesions, and death (Grantham 2007; Snyder 2007; Rideout et al. 2012).

Photo 2.4.1: Microtrash removed from a wild chick in 2008. *Photo Credit: USFWS*.

In 2007, the Service partnered with the Santa Barbara Zoo to create an intensive nest management strategy referred to as the California Condor Nest Guarding Program. The program is modeled after a nest guarding program for the endangered Puerto Rican Parrot (Lindsey 1992). It combines monitoring nests with direct intervention to detect threats and prevent nest failure. The

goals of the California Condor Nest Guarding Program are to identify the leading causes of nest failure and to increase the number of wild fledged condor chicks in Southern California.

Nest Searching

The field team locates nests using visual observations, radio telemetry, and ground-truthing GPS locations of breeding age condors (Mee et al. 2007; Snyder et al. 1986). The field team first identifies pairs by tracking courtship behaviors (Photo 2.4.2 & Photo 4.4.3). Existing pairs will often re-nest in previously used cavities or in cavities located close to previously used cavities. A nest is identified following visual confirmation of an egg. In the case of difficult-to-view cavities, nests are indicated by parent attendance behavior (switch outs in attendance).

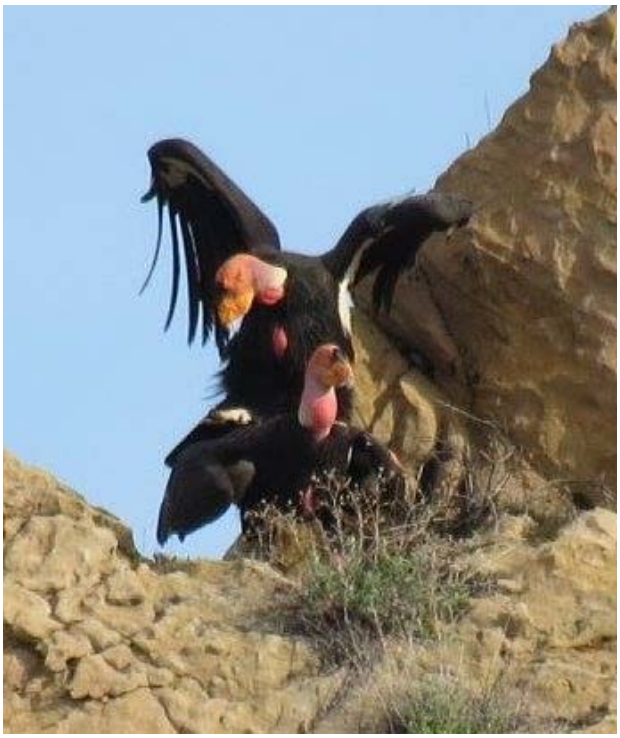


Photo 2.4.2: Condor #374 attempts to copulate with #79. *Photo Credit: Chloe Temper, Great Basin Institute.*

Photo 2.4.3: Condor #156 and #247 in a pair flight. *Photo Credit: Shelly O'Brien, USFWS Volunteer*

Nest Observations

The field team observes nests to determine that they are still active and to monitor for any problems. Nest observers travel to a designated nest observation point and watch for activity from that location. Typically, each nest is observed from the nest observation point two to three times per week, for two to four hours at a time. Remote nests are observed less frquently, or not at all. Nest cavities that are not fully visible are monitored for attendance using radio telemetry or GPS transmitter locations until the chick reaches an age where it can be observed straying outside the obscured cavity.

The field team also monitors some nests with nest cameras (Photo 2.4.4). Nest cameras are typically installed in nests during the first nest entry conducted during the egg stage of the nest (Photo 2.4.5). Not all nests are suitable for cameras. Nests need to be large enough for the camera to fit without obstructing the activity of the parent or chick and have a location to mount the camera so

that the viewing angle and lighting are effective at capturing most of the activity at the nest. Nest locations may also be too remote and thus very difficult to access for camera setup and maintenance.

Nests with cameras are not typically watched from an observation point. Instead, nest camera footage is streamed over a wireless network and archived. The field team reviews the footage every three to four days. Reviewers monitor parental attendance, chick activity levels, and any signs of distress or abnormal behavior.

Nest cameras allow observers to review nesting activity much more efficiently due to the ability to speed up the video during times of inactivity, and more closely review events of interest. Nest cameras are programmed to record during all daylight hours, allowing them to capture infrequent events that are often missed by less comprehensive direct observations. The level of observation detail is greatly increased because of the proximity of the camera to the egg, chick, and/or parents.

Photo 2.4.4: Condor #111 at the KR16 cavity second entrance whit the nest camera and microphone installed. *Photo Credit: Edward Owens, USFWS.*

Photo 2.4.5: Members of the condor field team installs the solar panel and antenna used for the nest camera installed in KR16. *Photo Credit: Alyssa Davidge, Great Basin Institute.*

Nest Entries

The field team monitors condor nests with regularly scheduled nest entries. Nest entries occur to check egg fertility and to confirm the hatch of the egg when it cannot be seen by an observer or nest camera. The field team then enters nests to give the chick a health exam to assess the chick's development and overall health. This includes palpating the chick's stomach and crop for foreign bodies or blockages, taking a blood sample, weighing, and measuring tail feather length. Nests are sifted for any foreign material during each entry. The chick is also vaccinated against West Nile virus while being examined. Nests are entered twice during the chick stage to examine the condor chick. These entries occur at 60 days and 120 days. In previous years nests were entered four times when the chick was 30, 60, 90, and 120 days old. During the 120-day nest entry, the chick is fitted with a patagial tag and VHF transmitter (Photo 2.4.4). Biologists do not enter the nest after 120 days in order to avoid possible premature fledging.

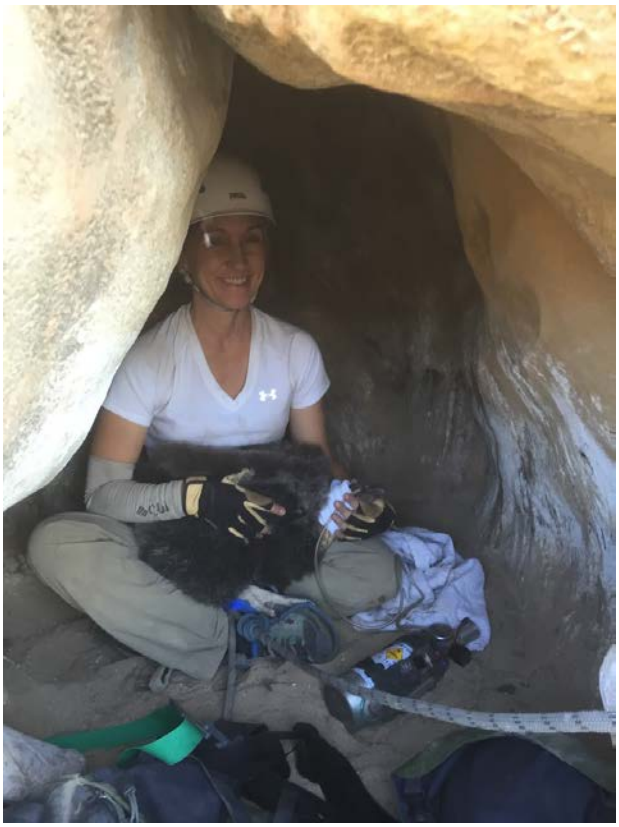


Photo 2.4.6: Los Angeles Zoo Condor Keeper, Chandra David, handles condor #814 for a 90 day exam at nest LW16. *Photo Credit: Edward Owens, USFWS*.

Nests with nest cameras are also entered during the egg stage (this is when the camera is installed) and when the chick is ready to be tagged at 120 days of age. Nest cameras allow the chick's development and health to be monitored remotely with the nest camera.

Some condor nests are very remote or too difficult to access. These nests are monitored through visual observation, or VHF and GPS tracking of the parents. If a chick fledges from a remote nest, the patagial tag and VHF transmitter will be fitted during the biannual trapping, at which time the bird will receive a West Nile Virus vaccination.

In order to enter condor nests safely, field team members are specially trained in using ropes to descend and ascend the steep cliff faces where nests are located, and in handling condor eggs and chicks of various ages. The Service conducts a ropes training at a local rock climbing area every year at the start of the nesting season, and the Los Angeles Zoo captive breeding center provides the handling training for the field team.

Nest Interventions

The field team conducts nest interventions when problems arise at the nest to ensure success of the nest. During the egg stage, nonviable eggs are removed and replaced with dummy eggs, which are later switched with viable captive-laid eggs. Additional interventions will occur as needed to mitigate threats detected through observations, such as chick injuries or poor development. If a significant amount of microtrash, more than 40 items, is collected during the 60-day entry, the nest is entered again at 90 days.

The field team uses nest cameras during some interventions to closely monitor the results of the intervention. In these instances, footage from the cameras is shared with veterinarians and behavioral experts to assess a chick's status and recovery while it remains in the nest post treatment. The presence of cameras has allowed for interventions that would otherwise not be attempted without the ability to closely monitor the chick via the camera.

Fledgling Observations

When chicks fledge, they are monitored much like newly released captive-bred

condors (see: Captive Releases and Transfers section). Through observation, we aim to ensure fledglings are integrating into the population, and displaying normal behavior and continuing to receive parental care.

Nest Failure

In the event of a nest failure, biologists enter the nest to recover the remains of the egg or chick. Recovered eggs are collected and frozen in a conventional freezer for use in contaminants research. Chick carcasses are submitted for necropsy to the U.S. Fish and Wildlife Service Wildlife Forensics Laboratory in Ashland, Oregon.

2.5 Captive Releases and Transfers

During the fall of each year, the field team releases captive-bred juvenile California condors into the wild at Bitter Creek NWR. The purpose of releasing captive-bred condors is to augment the wild population, offset mortalities that occur in the wild, and ensure genetic diversity in the Southern California population of condors.

The California condor is one of many endangered species managed to maximize the genetic diversity present in the original population, minimize genetic loss, and emphasize optimal productivity (Ralls and Ballou 2004; USFWS 1996). As outlined in the 1996 Condor Recovery Plan, it is necessary to increase productivity beyond the California condor intrinsic rate of reproduction through a captive breeding program (USFWS 1996). Captive-bred California condors selected for release in the wild must be physically and behaviorally healthy, have been successfully socialized with other release candidates, have been kept in isolation from humans to prevent taming, and have undergone aversion training to condition avoidance of power poles (Bukowinski et al. 2007, Clark et al. 2007, USFWS 1996).

Husbandry

Prior to release, condors spend time in a flight pen (or captive enclosure) at Bitter Creek NWR (Photo 2.5.1). These pre-release condors spend at least six weeks in the flight pen to allow familiarization with the new surroundings and interactions with wild condors perching or feeding nearby. During this time, the field team monitors pre-release condors two to four days per week during four-hour observation periods to examine and record social behavior and physical health. On the day prior to release, biologists place identification tags and VHF transmitters on each condor and move condors into a secondary enclosure within the flight pen.

Photo 2.5.1: Captive-bred California condors await release in a flight pen. *Photo Credit: Linda Uyeda, Santa Barbara Zoo.*

Releases

The field team typically releases California condors during the fall months (September through November) because the weather is cooler and there are fewer thermal updrafts. These weather conditions are conducive to keeping newly released condors close to the release site, where supplemental food and water sources are available.

Condors are usually released in trios or pairs to encourage socialization. The field team monitors the newly released condors for a minimum of 30 days, paying careful attention to social interactions, feeding, and roost selection. Additional releases take place only after the previously introduced condors roost appropriately off the ground and become familiar with the location of water and supplemental feeding sites.

Carrion is provided near the release pen in order to lure other free-flying condors in to feed and interact with the newly released condors. Supplemental feeding is an integral component of the condor release program (USFWS 1996). Supplemental food and water act as a substitute for the parental care that the released condors would have otherwise received had they fledged from a wild nest.

The field team will trap a newly released condor and return it to captivity (temporarily or permanently) if it exhibits undesirable behavior in the wild. This behavior includes approaching humans, not socializing with other condors, roosting on the ground, and/or the inability to locate supplemental food.

2.6 Behavioral Modification

The California condor is an inquisitive species whose habitat overlaps with human development. The frequency with which the condor encounters human activity and development has led to isolated incidences of habituation. Condors that have become overly habituated to human activity and structures are at greater risk to behavioral conditioning, which ultimately affects their ability to survive in the wild. A habituated condor may also cause other condors to become habituated, given the social nature of the species. Condors have also caused property damage, and jeopardize human safety in the event a habituated condor approaches people.

Categories of Undesirable Behavior

Cade et al. (2004) grouped undesirable behavior into three categories. Type I behavior is considered normal and is categorized by condors remaining at least 15 meters from people, exploring anthropogenic objects infrequently, landing on human-made structures limited to those that resemble natural perches or offer adequate protection from predators, and abandoning the undesirable behavior after one to two deterrence activities, i.e., “hazing” or “aversion training” (Cade et al. 2004). Hazing is defined as “an activity directed at a condor by humans in attempt to discourage a behavior” while aversion training is defined as “making an undesirable activity or behavior unpleasant without direct human interaction” (Grantham 2007).

Type II behavior is an "intermediate category", and is exemplified by condors "landing or flying closer than 15 meters to humans, but maintaining an 'individual distance' when approaching or being approached by humans" and "circumventing humans when investigating their belongings, allowing close human approach only when a clear escape route is present" and "fleeing when hazed" (Cade et al. 2004).

Type III behavior is of utmost concern, and "consists of condors allowing close human approach when no escape route is present (no fear of being boxed in), seeking out and initiating contact with humans, allowing touching and handling (including capture)" and "not responding to hazing, and showing no fear of humans" (Cade et al. 2004). These types of behaviors have also been observed in similar vulture species in the United States including the black vulture [*Coragyps atratus*] (Lowney 1999).

Although lowest on the undesirable behavior spectrum, even Type I behaviors can cause risks to condors. While this category is not associated with approaching humans, it does result in condors approaching or landing on human structures. In many cases, these structures are hazardous because condors can become entangled or entrapped on or in structures or ingest poisonous household or industrial items, leading to injury or death (Photos 2.6.1 and 2.6.2).

Photo 2.6.1: Condor #412 entangled and hanging from a communications tower in May 2011. The injuries from this incident were so severe the condor was euthanized. *Photo credit: USFWS*

Photo 2.6.2: Condor #63 covered in motor oil at Rancho la Cruz. *Photo credit: USFWS*

Behavioral Management

The field team employs aversion training, hazing, and trapping of habituated condors as means to manage Type I and II behaviors, and to prevent Type III behaviors and subsequent injury to condors. In the early stages of reintroducing condors into the wild, a number of mortalities were attributed to

power line collisions and electrocution. As a result, pre-release flight pens feature mock power poles that deliver nonfatal electric shocks to any condor landing on the structure. This aversion training has proven very effective in conditioning pre-release condors to avoid these structures once they join the free-flying population. Collaboration between the field team and Southern California Edison bolstered this aversion training with the installation of life-sized mock power poles outside both of the flight pens at Bitter Creek NWR and Hopper Mountain NWR in 2014, which serve as a means to train wild fledged chicks, and to reinforce the training in the rest of the flock.

The field team identifies habituation sites and habituated condors using radio telemetry, GPS transmitter data, visual monitoring, and by responding to reports of condors engaged in undesirable behavior. Hazing, in combination with removing any potential attractants, has been effective at discouraging condor activity at many locations.

Hazing techniques include making loud noises, clapping and waving hands, using slingshots with non-injurious food items (e.g. grapes and gumdrop candies), spraying streams of water from hoses and water guns, and using restrained dogs. Hazing is an effective deterrent only when done quickly and consistently. Inconsistent hazing can allow condors to develop a tolerance of the hazing techniques thereby lessening its effect.

Anti-perch deterrents help discourage condors from landing on human structures and are recommended to residents who have condors perching on their homes. Examples of anti-perch deterrents include bird spikes, shock strips, spring wire, bird spiders or motion-activated sprinklers.

The capture of condors due to habituation issues is considered a last resort, but on rare occasions is necessary for the safety of the individual condor or the benefit of the condor population. The capture of an individual is necessary if the condor exhibits Type III behavior, exhibits Type II behavior and no longer responds to deterrence activities, or exhibits Type II behavior and the recurring stimulus presents an immediate risk of physical harm or death. Often times, the captive condor is given a “time out” period in the flight pen, usually lasting a few months or longer, and then released back into the wild. In some circumstances, however, the habituated condor’s behavior warrants a permanent return to captivity.

Access to the location where the undesired behavior is occurring is also an important factor. Without access to the affected individual, the only course of action to correct persistent or harmful undesirable behavior is to capture and remove that individual from the wild in attempt to break the pattern of behavior.

2.7 Outreach

The field team performs outreach to create awareness and to educate the public about issues pertaining to California condor conservation in Southern California. Performing outreach for condors also helps further the Service’s national goals of connecting people with nature and broadening

awareness of endangered species conservation and the National Wildlife Refuge System (Photo 2.7.1).

Photo 2.7.1: Condorkids students from the Fillmore Unified School District visiting the Santa Barbara Zoo to learn about condor conservation. *Photo Credit: Lauren Gonzales, Santa Barbara Zoo*

Condor Cave

The "Condor Cave" is a Facebook page that is being managed in partnership with the Santa Barbara Zoo. The page has been active since 2012 and highlights the condor conservation efforts taking place in Southern California. The page showcases condor courtship and nesting behaviors using footage from the condor nest cameras.

Online Condor Nest Camera

The Cornell Lab of Ornithology's All About Birds website (http://cams.allaboutbirds.org/) hosts live streaming nest cameras for many different species. The field team has partnered with them along with the Santa Barbara Zoo and the Western Foundation of Vertebrate Zoology to host a condor nest camera online. 2015 was the first year that a wild condor nest camera was streamed live online to the public.

CondorKids

The Complex also partnered with the Santa Barbara Zoo to create a new education program called CondorKids. CondorKids is an education program that uses the California condor to introduce students to conservation and connect them with nature. Funded by the Urban Refuge Initiative and National Fish and Wildlife Foundation, CondorKids provides a third grade curriculum for students that meets Common Core and National Science Standards. The curriculum teaches skills in science, technology, engineering, and math (STEM) through diverse lesson plans that cover topics such as geography, biology, history, and conservation. All curriculum and lesson plans are available online to any interested teacher. Locally, CondorKids targets urban youth in Ventura County. For these local groups it also provides students the opportunity to experience condor recovery first hand by offering field trips to the Hopper Mountain NWR, Bitter Creek NWR, or the Santa Barbara Zoo.

Non-lead Outreach

The Institute for Wildlife Studies Southern California Non-lead Outreach Coordinator is stationed at the Complex office in Ventura. This position conducts much of the non-lead education and outreach in the range of the Southern California condor population. The major non-lead outreach activities include attending and setting up educational booths at sportsman shows (Photo 2.7.2), conducting shooting events at local shooting ranges, making contacts with local ranchers and providing them with

free non-lead ammunition, and providing presentations for other interested outdoor organizations and groups.

Other Outreach Activities

The field team performs a number of additional types of outreach activities with the intention of creating awareness and educating the public about condor conservation issues. The Service authorizes refuge tours, co-hosts events with program partners such as the Friends Group, and presents to local schools. When possible, the Service accommodates media requests and contributes to several social media outlets and scientific publications.

Outreach is also targeted to help resolve immediate management issues. A common example of this is providing information to communities and local residents within condor range where the potential for condor habituation with humans and human structures is likely. In these cases, the field team provides information to residents about how best to discourage condor habituation. This includes safe techniques for flushing condors off residences, information about installing anti-perching devices, and removing items that may attract condors to their homes.

Photo 2.7.2: Non-lead outreach table at the Hunters Education Instructors Training Conference in Squaw Valley, CA. *Photo Credit: Institute for Wildlife Studies*

3.0 Outcomes

3.1 Monitoring Resource Use

GPS Transmitter Locations

In 2016, 37 of 88 condors in the Southern California condor population wore GPS transmitters for at least part of the year. GPS transmitter data produced 1,048,575 locations. Nine condors wearing MTI transmitters produced 430,402 locations and 29 condors wearing CTT transmitters produced 618,173 locations. Due to anticipated changes in cellular structure from 2G to 3G technology, all MTI units were removed throughout the 2016 year for refurbishment. CTT units newly deployed in 2016 were also equipped with 3G modems. Five CTT transmitters, specifically designed to test geofencing capabilities, were deployed in 2016. The results are summarized in Appendix II.

Population Distribution

Condor activity across the landscape, based on this subset of California condors, spanned approximately 12,795 square miles (the area of a single buffered polygon derived from a kernel density estimate of all GPS locations; Figure 3.1.1). Condors from the Southern California population ranged from North of the Santa Monica Mountains in the south to the Southern Sierra Nevada Range in Fresno County to the North. They ranged West into the Sierra Madre Mountains of San Luis Obispo County and the easternmost flights were in the San Gabriel Mountains North of Ontario in eastern Los Angeles County. The Tehachapi Mountains of Kern County was the area with the largest concentration of condor activity, followed by the southern portion of the Sespe Wilderness in Ventura County near Hopper Mountain NWR (Figure 3.1.2). Condors also concentrated activity near Bitter Creek NWR, though less so than the Tehachapi Mountains or the southern Sespe Wilderness.

Exceptional Flights

As in previous years, a number of condors made flights into areas where the population has not been very active. Nine individuals wearing GPS transmitters, condors #20, #262, #360, #449, #493, #625, #636, #648, and #683, flew within 10 miles of the Blue Ridge National Wildlife Refuge (Blue Ridge NWR) in 2016 (Figure 3.1.3). Four of these condors, #20, #493, #625, and #648, flew directly over Blue Ridge, with these flights representing the first documented presence of condors at the refuge since their reintroduction to the wild in 1992. Condors #625 and #20 (a.k.a. AC4), each flew up to the Blue Ridge NWR area on three separate occasions.

Additionally, condor #20 was the only GPS-equipped individual in the Southern California condor population with frequent activity in the San Rafael and Dick Smith Wilderness areas in 2016 (Figure 3.1.4). Condor #20, released

in 2015 after 30 years in the captive breeding program, was an original wild condor and had been observed spending time in the Santa Barbara county backcountry prior to his capture in 1985. Condor #20 has not had any documented activity close to Hopper Mountain NWR since his 2015 release.

Activity Near Wind Turbines

Twenty seven of the 39 condors wearing GPS transmitters were detected within 2 miles of industrial wind turbines in the eastern Tehachapi Mountains in 2016 (Table 3.1.1; Figure 3.1.5). The earliest documented activity near turbines in 2016 was on 2 April when a single individual flew within 1.25 miles of the nearest turbine. The next detections within 2 miles of wind turbines occurred in June. The majority of condor activity near wind turbines in 2016 documented between the months of July and October. There continued to be less frequent detections of activity near wind turbines through December. Within this time period, all but three of the 27 condors had at least one GPS location with speeds less than 10 km per hour, indicating that these condors were perched on or close to the ground at the time the locations were detected. The number of condors coming in close proximity to operational wind energy facilities has increased since the previous year.

Nest Distribution

Nesting activity in 2016 occurred on public and private land. Four nests were located on the Los Padres National Forest, three of which were in the Sespe Condor Sanctuary. One nest was located on the Bureau of Land Management lands to the south of Hopper Mountain NWR. One nest was located on private land east of Hopper Mountain NWR and south of the National Forest (Figure 3.1.6).

Non-proffered Feeding

The field team confirmed 15 non-proffered feeding events in 2016 (Photo 3.1.1). The most common types of carrion observed at non-proffered feedings were cow, ground squirrel, and elk. There were three new types of carrion observed when compared to previous years (2008-2015, Figure 3.1.2) ground squirrel, rabbit, and a domestic cat. It is likely that this represents only a small portion of the number of non-proffered feeding events that occurred in 2016, as these feeding events were only discovered incidentally while tracking the Southern California population of condors.

Photo 3.1.1: A group of condors perched near a non-proffered elk carcass in the Tehachapi Mountains. *Photo Credit: Kristy Johnson*

Table 3.1.1: 2016 condor activity within 2 miles of industrial wind turbines. Twenty-seven condors were detected both perched and flying within 2 miles of industrial wind turbines within the Tehachapi wind resource area. Stationary locations are defined as any location with a speed less than 10 km/hr.

SB#	Stationary locations? (y/n)	Number of individual days active within 2mi of a wind turbine
20	y	11
79	y	9
98	y	1
107	y	15
156	y	17
161	y	26
247	y	12
262	y	2
289	y	30
326	n	2
360	y	33
374	y	18
449	y	23
480	y	27
487	y	16
493	n	1
509	y	35
513	y	25
518	y	30
526	y	38
585	y	24
599	y	47
625	n	1
636	y	28
648	y	26
733	y	27
791	y	3
Total	24(y)	527

Table 3.1.2: Confirmed Non-proffered feeding events in 2016, 2008-2015, and in total by type of carrion. Non-proffered carrion is any food item that is not provided for condors by the condor field team.

Carrion Type	Current 2016		Years Prior 2008-2015		All Years 2008-2016	
Cow	4	27%	54	34%	58	34%
ground squirrel	3	20%	0	0%	3	2%
Elk	2	13%	2	1%	4	1%
Pig	1	7%	57	36%	58	36%
Deer	1	7%	23	14%	24	14%
Horse	1	7%	7	4%	8	4%
Sheep	1	7%	6	4%	7	4%
Unknown	0	0%	5	3%	5	3%
Coyote	0	0%	2	1%	2	1%
Bison	0	0%	2	1%	2	1%
Goat	0	0%	1	1%	1	1%
Donkey	0	0%	1	1%	1	1%
Rabbit	1	7%	0	0%	1	1%
house cat	1	7%	0	0%	1	1%
Total	15		160		175	

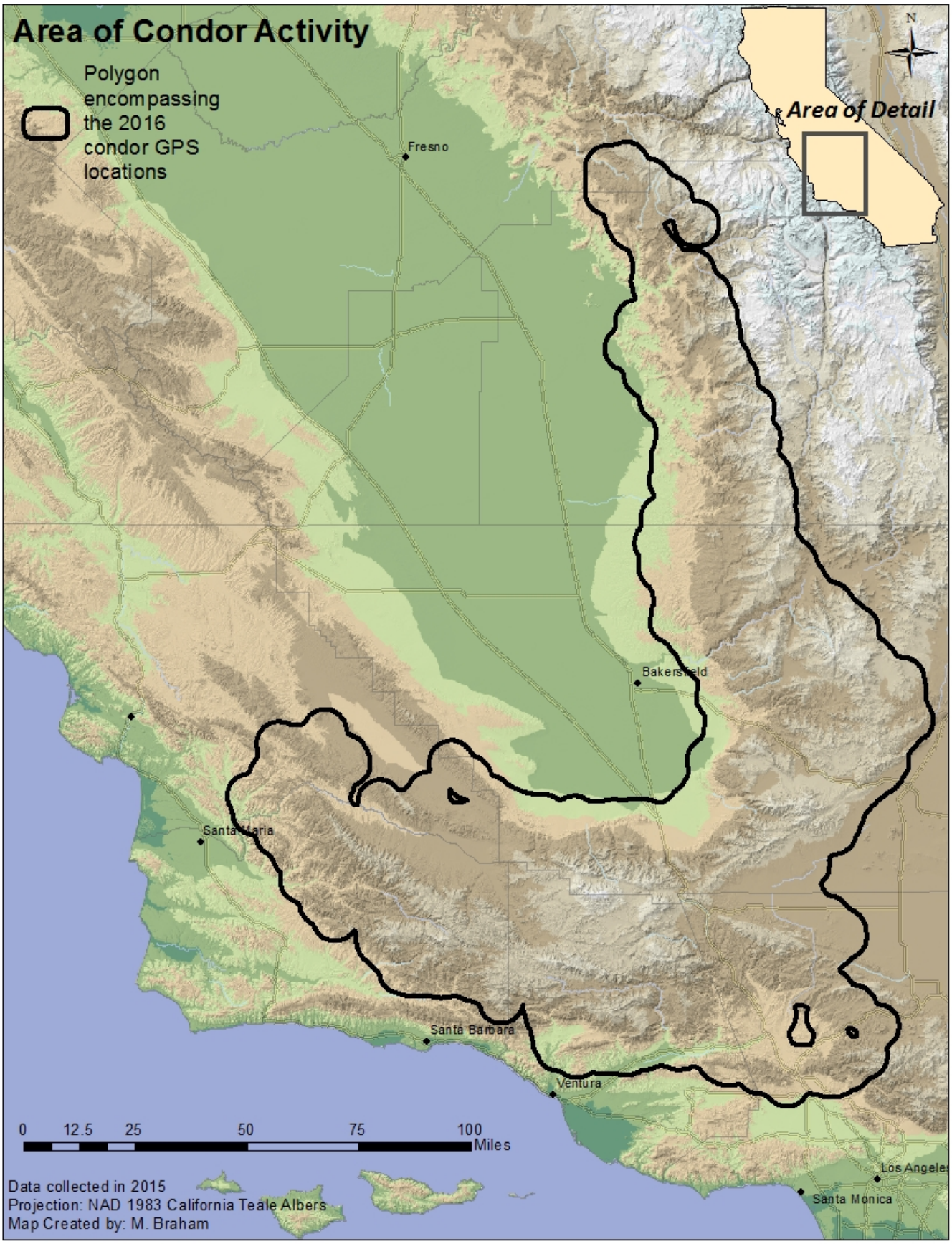


Figure 3.1.1: 2016 estimated area of activity of the Southern California condor population. To estimate the area of condor activity, a polygon created using a 3 mile buffer of the 100 percent isopleth of a fixed kernel density estimate and smoothed with the Polynomial Approximation with Exponential Kernel (PAEK) algorithm with a 2 mile smoothing tolerance.

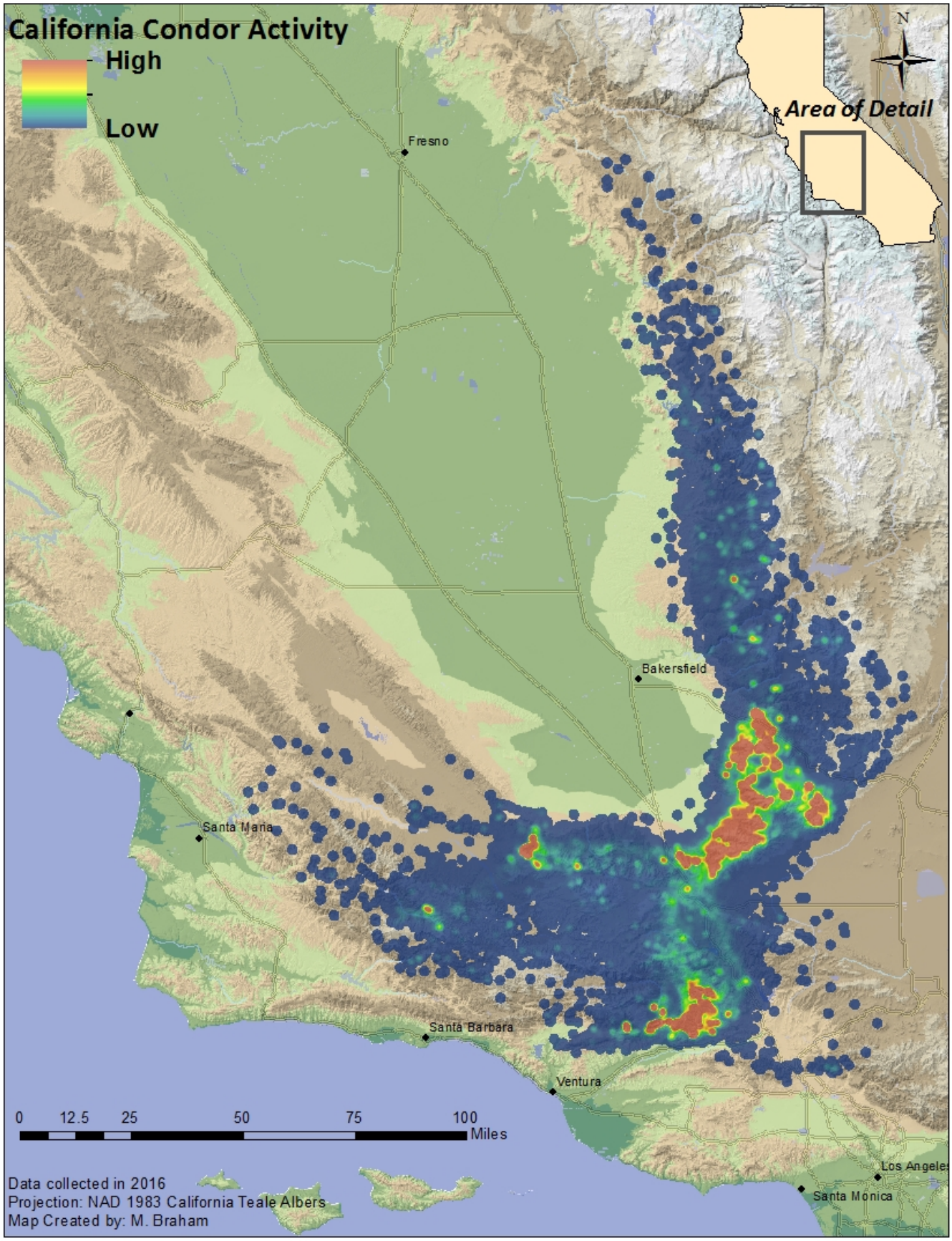


Figure 3.1.2: Southern California condor activity in 2016 estimated using a fixed kernel density estimate (KDE) for all California condors wearing GPS transmitters. KDE averaged across individuals (n=37) using a neighborhood of one kilometer (cell size = 100 meters) and stretched using two and a half standard deviations. KDE provided by Melissa Braham, Survey Technician (Division of Forestry and Natural Resources, West Virginia University).

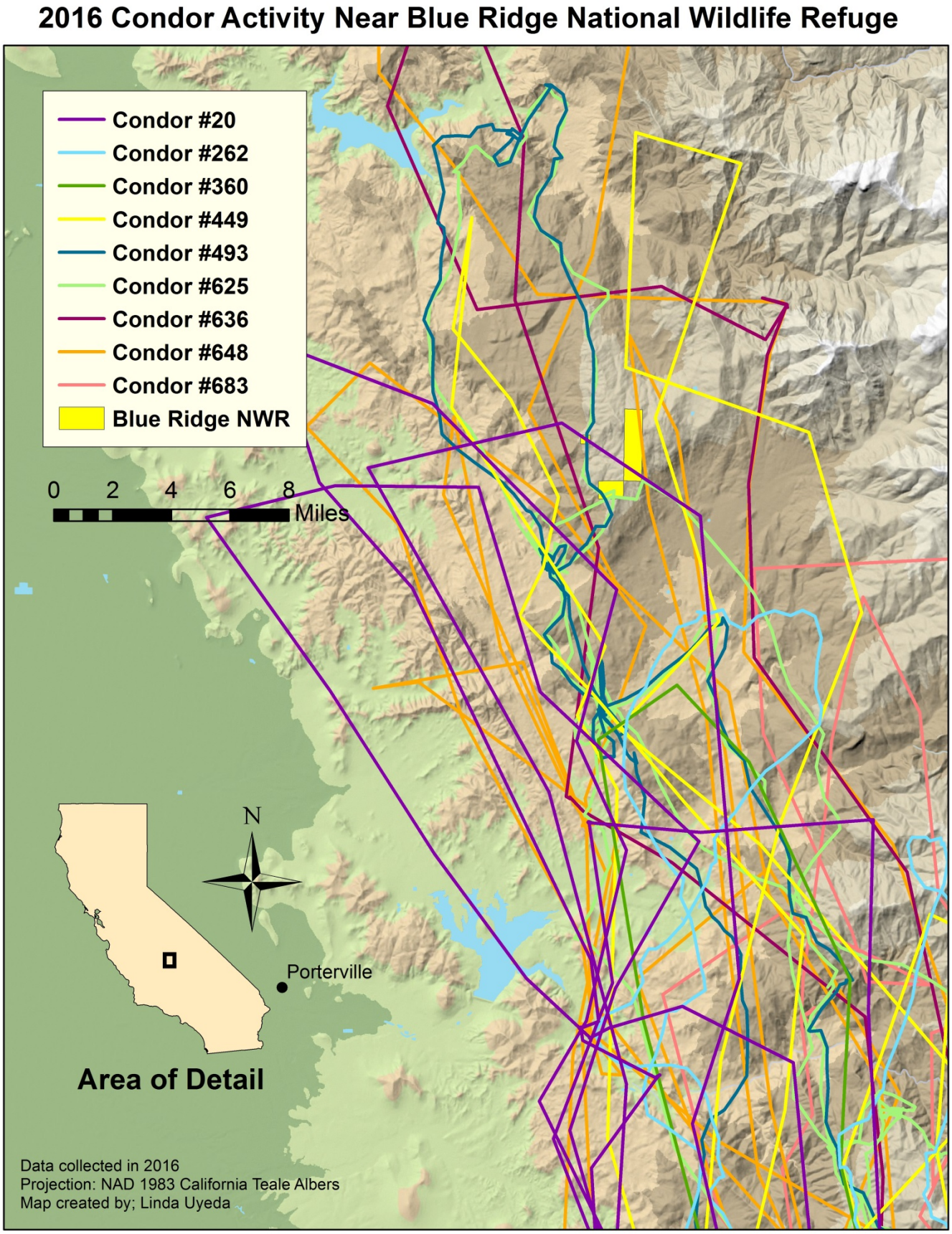


Figure 3.1.3: 2016 condor activity near Blue Ridge NWR. Condors #20, #262, #360, #449, #493, #625, #636, #648, and #683 were detected flying within 10 miles of Blue Ridge NWR. Four of these condors, #20, #625, #636, and #648 had flights that went directly over the Refuge.

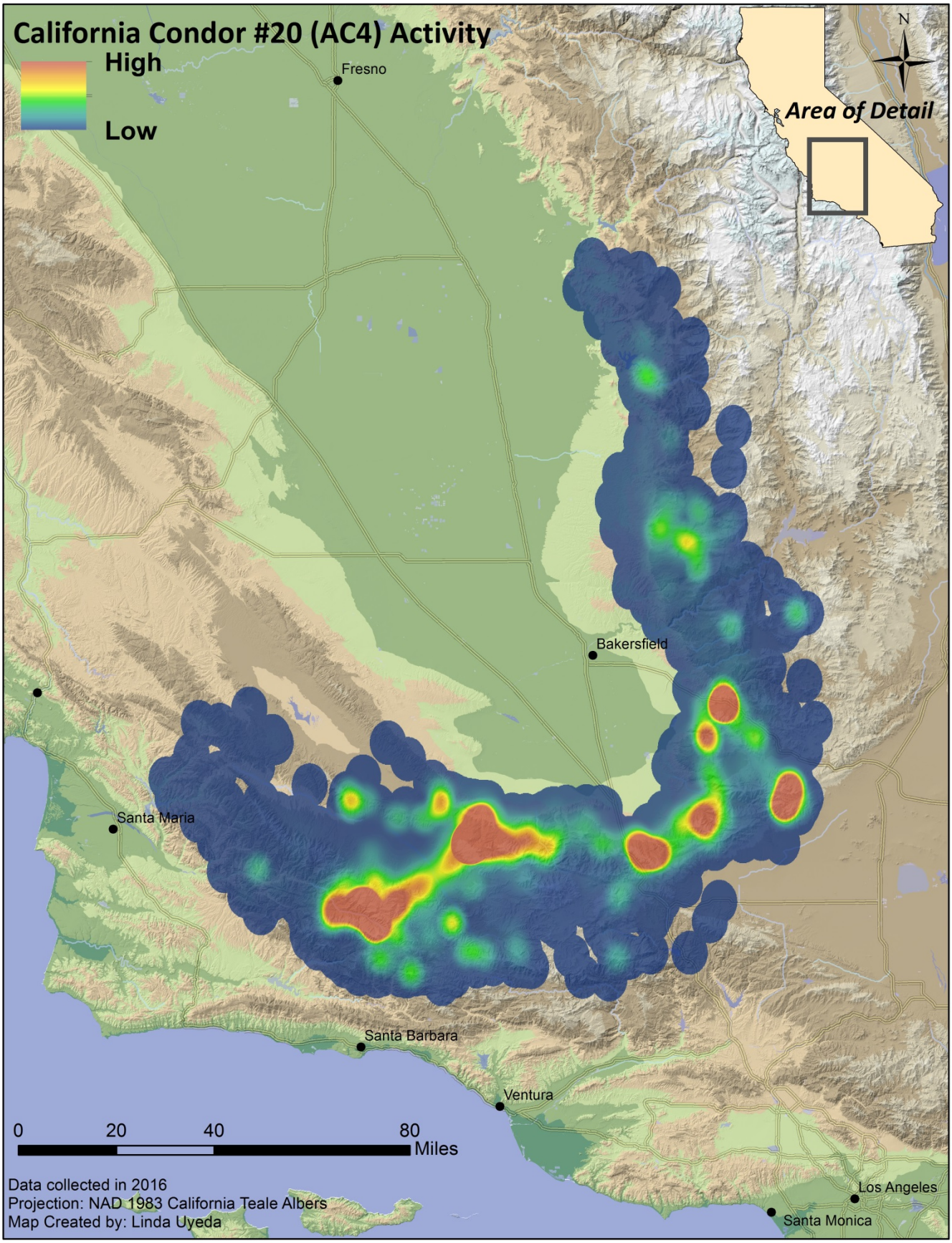


Figure 3.1.4: California condor #20 activity in 2016 estimated using a fixed kernel density estimate (KDE) based on locations obtained by GPS transmitter. Data stretched using two and a half standard deviations.

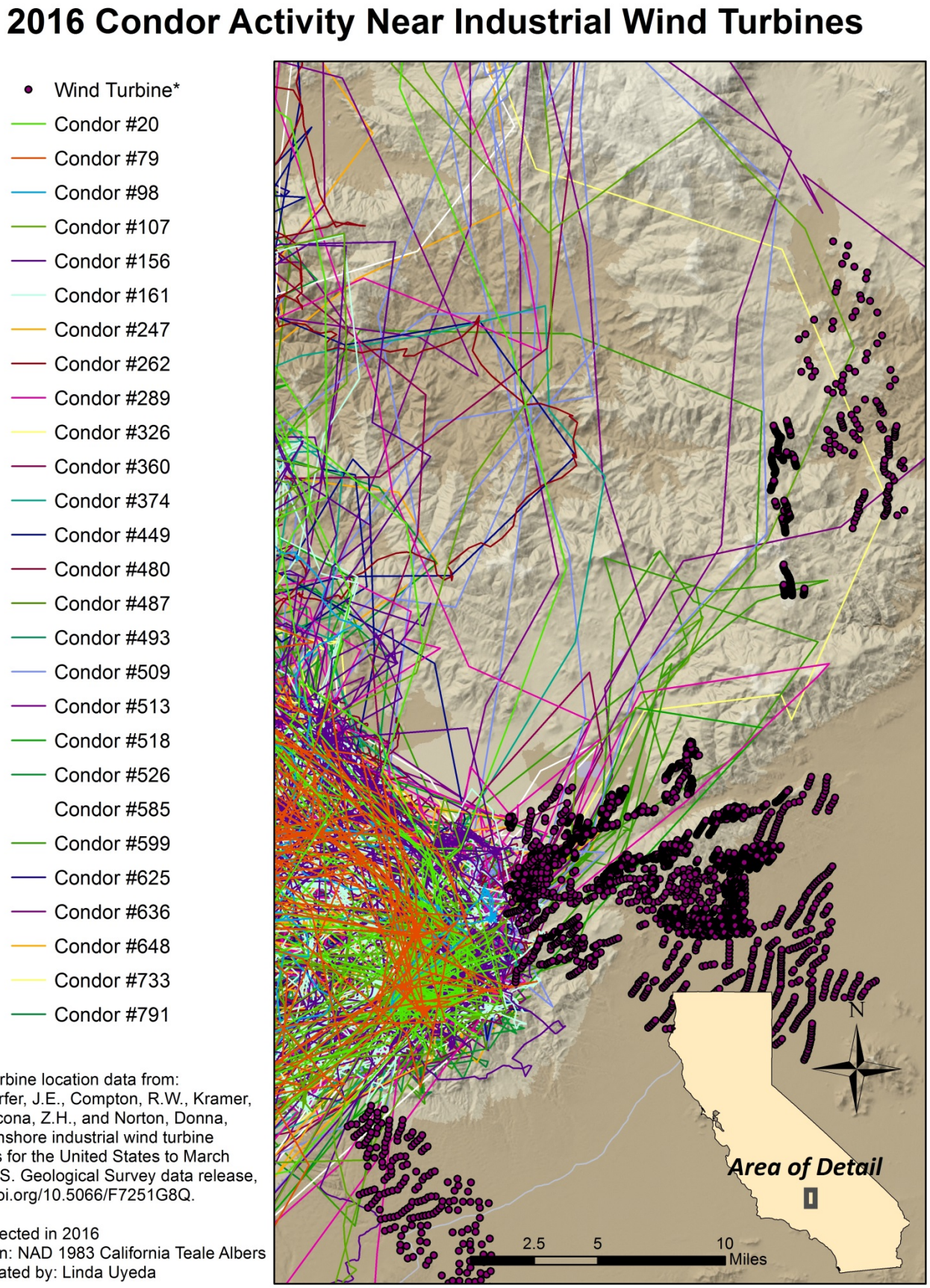


Figure 3.1.5: 2016 condor activity near industrial wind turbines. 27 of the 37 condors wearing GPS transmitters (73%) flew within two miles of an operational turbine in the Tehachapi Wind Resource Area in Kern County.

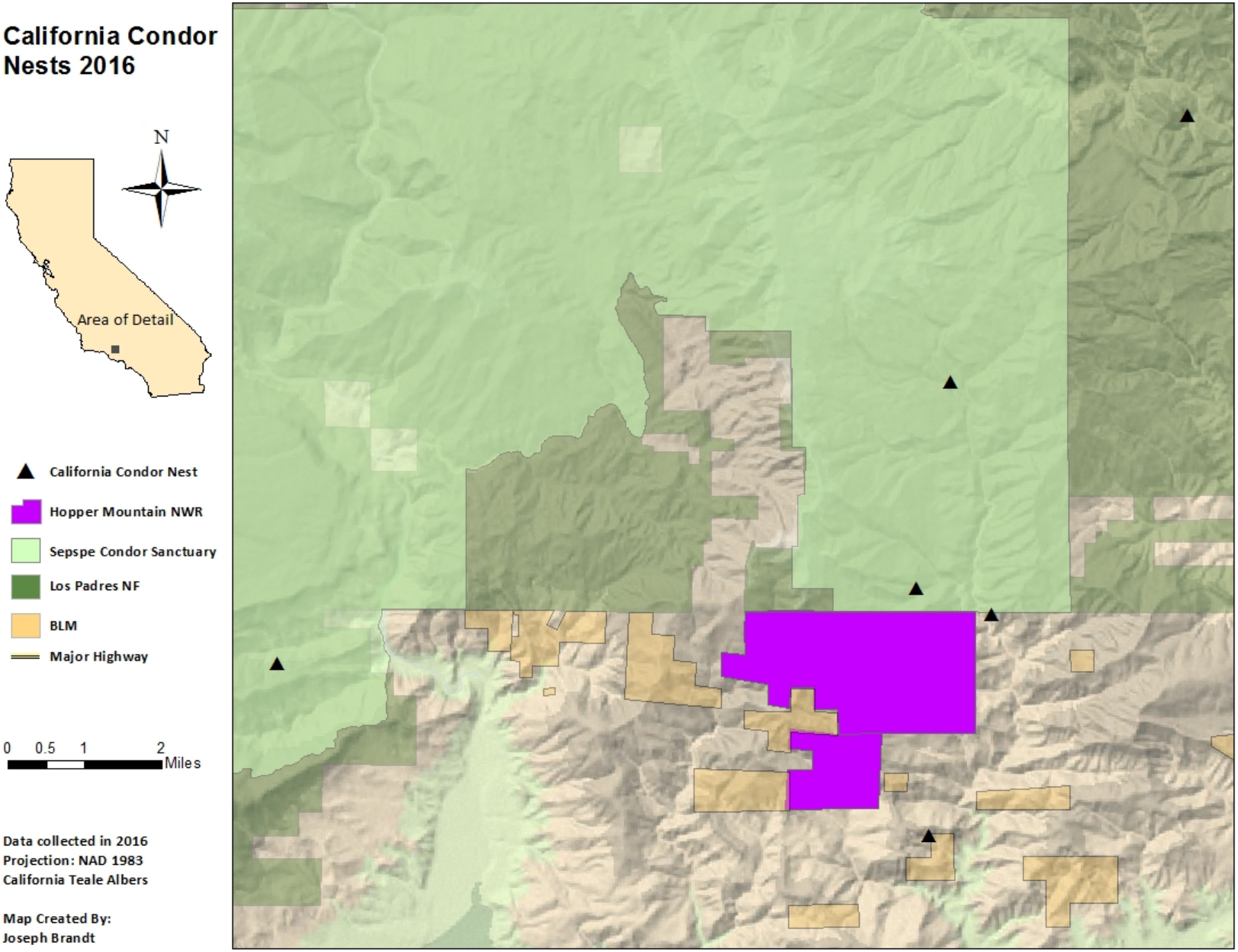


Figure 3.1.6: Locations of condor nests in 2016 (n = 6 nests)

3.2 Lead Monitoring and Mitigation

Trapping Effort

In an attempt to increase trapping success in the 2016, the field team began trapping in May, which is a month earlier than the usual June/July trapping period. The November/December period was not extended because of other management activities taking place at that time.

The field team and volunteers spent approximately four to five days per week in blinds trapping during the months when trapping occurred (Photo 3.2.1).

Photo 3.3.1: Condors #449, #467, and #584 at the double door trap entrance at the Hopper Mountain NWR flight pen. *Photo Credit: Nadya Seal Faith, Santa Barbara Zoo*

Trapping Success

During the two 2016 trapping sessions, 66 of the 77 (86%) targeted condors were trapped (Table 3.2.1). There were 77 trappable condors, which differs from the end of the year population size of 80. The number of trappable condors differs from the end of year population number because it does not include newly released condors in the fall 2016, newly wild-fledged condors, or condors that died prior to the start of a trapping period.

Condors (excluding chicks) were handled for testing on 23 separate days in 2016 with 1 to 17 condors handled on each occasion. Eleven of these handling days occurred May through July and 12 occurred November through December. Each condor requires about 30-45 minutes of handling time and, depending on the number of condors, between two to 15 biologists assisting at each handling event.

Blood Lead Test Results

Sixty six condors in the Southern California population were tested a total of 146 times in 2016 (excluding wild chicks). Seven condors were tested a single time. Forty condors were tested twice. Seventeen condors were tested three times and two condors were tested four times. The blood lead test results in 2016 were similar to results from the previous years, with the largest proportion of the test results falling within the 10 to 30 µg/dL range (Figure 3.2.1). When using the highest lab blood lead level for each condor tested, 64 of the 66 condors (97%) had lab blood lead levels above background levels (10 µg/dL).

The field team conducted 8 blood lead level tests on 5 wild condor chicks during the 2016 nesting season. Condor chick #822 had a blood lead level of 46 µg/dL when tested at 60 days of age, but was not treated based on the moderate level of exposure and difficulty of treating a chick at the nest location. This chick was retested at 90 days of age and had a lower blood lead level of 32 µg/dL.

Condor chick #846 had a blood lead level of 330 µg/dL when the chick was 126 days old. This high level of exposure was not treated because thee chick was very mobile at that age and there was concern of causing the chick to prematurely fledge. Condor #846 did not have any detectable signs of clinical lead toxicosis based on camera and visual observations, and went on to fledge in spite of not being treated.

Treatment of Elevated Blood Lead Levels

The field team transported 15 individual condors to the Los Angeles Zoo for 18 chelation treatments in 2016. Of the nine treated condors, three condors, (#584, #625, and #487) received chelation treatment on two separate occasions.

Table 3.2.1: Comparison of condors trapped between sessions and in total for 2016. The number of condors targeted for trapping was the number of wild condors that needed to be trapped during each session. This number differs from the total population because condors that are newly released or fledged are typically not re-trapped until the following year.

Trap Session	Number of Individual Condors Targeted	Number of Individual Condors Trapped	Percentage of Targeted Condors Trapped
Jan - Jul	75	64	85%
Aug - Dec	72	60	83%
Total for 2015	75	66	88%

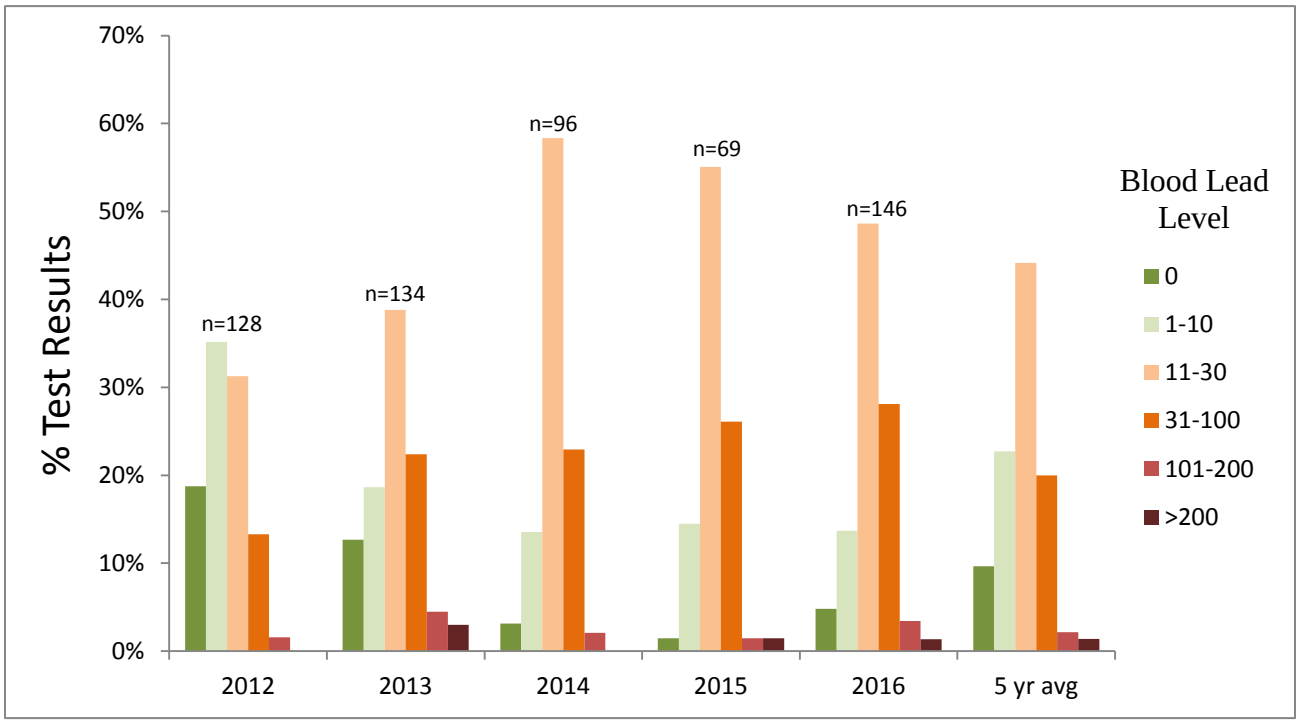


Figure 3.2.1: Summary of condor blood lead levels by year from 2012-2016 and the 5 year average (2012-2016). All of the lead values given represent lab blood lead values. Values returned as "not detected" are indicated by zero. Number of tests performed on the Southern California population of condors each year represented as "n" for each year.

3.3 Detecting Mortalities

Eight free-flying condors and three chicks died in Southern California during 2016 (Table 3.3.1). In addition to these deaths, two condors have gone undetected in the wild for greater than a year and are presumed dead with approximate death dates in 2015 (dates of last detection). Of the 2016 mortalities, one condor died of lead toxicosis, two condors struck powerlines, one condor chick was euthanized due broken bones and a microtrash impaction, two condors died of undetermined causes, one condor chick fell from its nest cliff, three condors are missing in the wild and presumed dead, and one condor's cause of death is still pending.

Photo 3.3.1: Condor #365 located ill but still alive on ground in ravine in Bear Valley Springs. *Photo Credit: Josh Felch, USFWS*

Death of Condor #365

Adult male condor #365 was found on the ground and unable to stand in a ravine in the community of Bear Valley Springs in Tehachapi on May 26, 2016. An effort was made to evacuate him and transport him to Los Angeles Zoo, but he died minutes after being placed in a kennel. Postmortem examination revealed lead particulates in the ventriculus and highly elevated liver and bone lead levels confirming the cause of death as lead toxicosis (Necropsy Report #16-0165). An old, healed gunshot wound to one of his toes was also discovered, but was not related to the cause of death.

Death of Condors #683 and #759

Condor #683 was reported to the field team as being found dead below powerlines in Bear Valley Springs by a Southern California Edison (SCE) line crew on the night of June 23, 2016. SCE stated that there was an interruption at that segment of power line at 12:48 on June 23, 2016, suggesting that condor #683 likely struck the lines around that time. There was significant singeing of feathers on the condors underside, wings, and tail indicating that the cause of death was electrocution via a mid-span powerline strike (final necropsy report still pending). Condor #759 was recovered on the side of the road near Bealville on May19, 2016. Like condor #683, postmortem examination revealed injuries consistent with electrocution via a mid-span powerline strike (final necropsy report still pending).

Death of Condor #780

Terra-Gen Operating Company, LLC personnel reported getting a mortality signal for both of condor #780's VHF transmitters to the field team on October 3, 2016. The mortality signals seemed to be emanating from ridges near Oak Creek Canyon to the east of Covington Mountain in Tehachapi. A field team member conducted a search of the area

the following day and located the remains of condor #780 on a ridge just south of Oak Creek Canyon. Horse manure, a cleaned deer carcass, and a rubber glove were found in the vicinity. The cause of death is still pending.

Death of Condor #804

The scavenged remains of fledgling condor #804 were recovered from the canyon below its nest cavity a few days after a field team member reported a mortality signal. The recovery mission was delayed a few days due to weather conditions. A necropsy of the carcass was unable to determine the cause of death due to advanced decomposition and scavenging (Necropsy Report #16-0017).

Death of Condors #815 and #822

The heavily scavenged remains of condor chick #815 were located on the cliff above the nest on September 19, 2016. The cause of death was not able to be determined via postmortem examination, but predation was listed as the most plausible cause of death considering recent normal, test-flight activity (Necropsy Report #16-0253). Condor chick #822, offspring of sire condor #21, was recovered below the nest cavity on October 13, 2016. The cause of death was determined to be blunt force trauma as a result from a fall from the nest (Necropsy Report #16-0280).

Death of Condor #845

Condor chick #845 was evacuated from the nest due to an apparent injury and stunted growth, and was later euthanized at the Los Angeles Zoo (see 3.4 Nest Management). The chick had suffered multiple bone fractures in both wings and ingested microtrash (Necropsy Report #16-0239).

Missing Condors

Three free-flying condors went missing in the wild and were declared dead in 2016. Adult condors #452 and #482 went missing in the wild with last detection via VHF signal March 29, 2015 from Hopper Mountain NWR and last visual on December 24, 2015 at the Bitter Creek NWR flight pen, respectively. Adult condor #21's GSM transmitter stopped working on June 30, 2016. His last hits were limited to a remote canyon of the Sespe Wilderness near his nest territory. Field team members conducted a search of the area of his last known location, but no remains were ever located. Search efforts were hindered because he did not have any working VHF transmitters at the time. Without the carcasses, the cause of death for these three condors remains unknown.

Photo 3.3.1: Last sighting of condor #21, taken by game camera installed in AB16 on June 12, 2016. *Photo Credit: USFWS*

Table 3.3.1: California condor mortalities in 2016. Only six carcasses of a free flying condors, one recently fledged, were located this year. An additional free flying condor was located alive but died during the extraction effort. Three are presumed dead because they have been missing in the wild for more than a year. Two condor chicks died while still in the nest and one chick was euthanized.

Studbook ID	Sex	Hatch Date	Mortality Date	Cause of Death	Location of Death
21	Male	14-May-80	29-Jun-16	Unknown - missing in the wild	Unknown
365	Male	15-Apr-05	27-May-16	Lead toxicosis	Bear Valley Springs, Tehachapi
452	Male	21-May-07	30-Mar-15	Unknown - missing in the wild	Unknown
482	Male	30-Apr-08	25-Dec-15	Unknown - missing in the wild	Unknown
683	Male	10-Apr-13	23-Jun-16	Electrocution - powerline strike	Bear Valley Springs, Tehachapi
759	Male	21-May-14	18-May-16	Electrocution – powerline strike	Near Bealville
780	Male	14-Apr-15	1-Oct-16	Pending - open LE case	Near Oak Creek Canyon to the east of Tehachapi
804	Female	30-May-15	8-Jan-16	Undetermined	Santa Paula Canyon, below nest area in Los Padres NF
815	Male	4-Apr-16	16-Sep-16	Undetermined - predation likely	Near Hopper Mtn NWR, above nest area in Los Padres NF
822	Male	9-Apr-16	10-Oct-16	Trauma - fall from nest cliff	Near Hopper Mtn NWR, below nest area in Los Padres NF
845	Unknown	25-Apr-16	31-Aug-16	Euthanized due to microtrash, broken bones, and stunted growth	Los Angeles Zoo

3.4 Nest Management

The first egg of the 2016 nesting season was laid on February 8, and the nesting season ended on November 20 with our last chick fledge. There were six active nests during the season (Table 3.4.1). Three of this year's breeding pairs had nested the previous year, and the other three were all seasoned breeders that had re-paired for their first year with a new mate.

Nesting Success

Nesting success, defined as the total number of chicks to fledge out of the total number of nests, has increased dramatically since nest guarding was implemented across all nests in 2007 (Figure 3.4.1). Two of the six nests in 2016 had chicks that fledged resulting in 33% nesting success.

Table 3.4.1: Nesting attempts and outcomes for the 2016 breeding season. Sire Studbook Number is the studbook number of the male attending the nest. Dam Studbook Number represents the studbook number of the female attending the nest. Foster Eggs are captive laid eggs used to replace the wild laid egg when it was not viable. Chick Studbook Number is the studbook number of the chick that hatched in the wild nest.

Nest Identification	Date Nest Located	Sire Studbook Number	Dam Studbook Number	Egg Identification	Lay Date	Foster Egg Used	Foster Egg Identification	Date Hatch	Chick Studbook Number	Number of Nest Entries	Nest Fate
KR16	9-Feb	509	111	FW116	8-Feb	Y	LA216	4-Apr	815	5	Failed 17-Sept
LW16	13-Feb	247	156	FW216	11-Feb	Y	LA116	1-Apr	814	5	Fledged 22-Sept
AB16	18-Mar	21	192	FW316	9-Feb	N	NA	9-Apr	822	4	Fledged 13-Oct
DG16	25-Aug	206	513	FW416	28-Feb	N	NA	25-Apr	845	1	Failed 31-Oct
HW16*	NA	365	487	FW516	10-Mar	N	NA	NA	NA	0	Failed 21-Apr
HB16	18-Apr	374	79	FW616	22-Mar	N	NA	18-May	846	2	Fledged 20-Nov

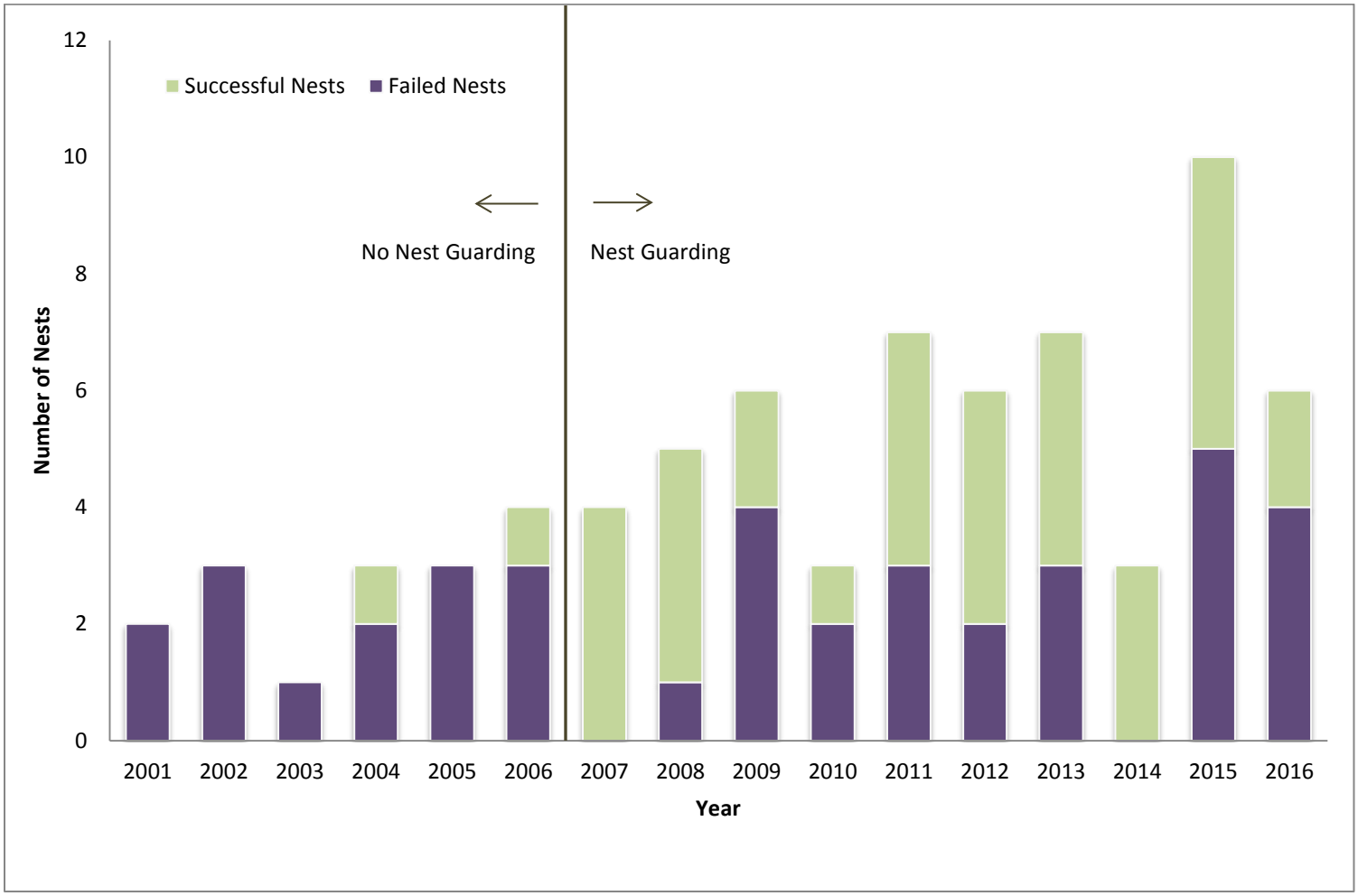


Figure 3.4.1: Nesting success before and after implementation of the Nest Guarding Program. Nests are defined by pairs or trios of condors that produce at least one egg. Nesting success is any nest where a chick fledges from the nest.

Nest Observations

In 2016, nests were observed over the course of the season using direct observation and nest cameras. Nest cameras were used for monitoring two of the nests: KR16 and HB16. KR16 was streamed live online to a worldwide audience through a partnership with Cornell Lab of Ornithology, while HB16 was accessible only on a local network. Both cameras were installed during the egg stage.

Chicks and fledglings were directly observed for a total of 517 observation hours taking place over 219 observer days. Unpaid volunteer observer hours accounted for 39% of all observation hours (Table 3.4.2). For nests with cameras, observers checked nest activity daily and reviewed camera footage in detail every two to three days each week. Observers spent 283 hours reviewing 5,357 hours of video footage.

Table 3.4.2: Nest observation hours by personnel type.

Personnel Type	Observation Hours
Service Staff	4
Santa Barbara Zoo Staff	123
GBI Research Associates	189
Unpaid Volunteers	201
Total Observation Hours	517

Nest Entries

The field team performed 17 nest entries (Photo 3.4.1) over the course of the year. In addition to these scheduled entries, the team also went out to inactive nests seven times for nest cam network maintenance and equipment retrieval. Each entry required two to four personnel for eight to twelve hours. Santa Barbara Zoo provided assistance on seven of these entries, and Los Angeles Zoo staff assisted on four nest entries. The nest cameras were a useful tool in ensuring proper chick development in lieu of more frequent nest entries.

Two of the 2015 nests, HW16 and DG16, were monitored less frequently and not entered due to their remoteness. One of these, HW16, was determined to have failed before hatching. Both the location and the fail date were determined using telemetry and GPS data to monitor parental attendance; this nest was never visually confirmed.

The other nest, DG16, took several months to find its exact location, largely due to challenging terrain and lack of functioning vhf transmitters on the female. The nest was located and entered on August 31, and the chick was evacuated to the Los Angeles Zoo and euthanized that same day. The chick was found emaciated with multiple broken bones, trash impaction, and stunted growth. In 2015, this pair's chick was also evacuated and euthanized after biologists discovered it was partially paralyzed, and had multiple broken bones. The cause of both chicks' injuries is unknown.

Photo 3.4.1: Wildlife Biologist, Eddie Owens, ascends up from condor nest LW16. *Photo Credit: Molly Astell, USFWS.*

The KR16 camera nest required an emergency entry to place a dummy egg when the team discovered the pair's egg was no longer present, and planned an entry to swap it with a pipping egg when it became available. There was also an entry to adjust the nest camera equipment, though no physical exam was conducted on the chick. The nest failed at chick-day 166. The chick's body was found two days later on the cliff just above the nest, and recovered. The necropsy was unable to determine the cause of death, but stated it was most likely predation. Although this nest was monitored with a live-streaming nest camera, the chick was capable of exploring outside of the nest and frequently was seen on the upper cliff; the camera was therefore unable to provide additional information as to the cause of death.

The field team collected a blood sample during the 120-day entry from the HB16 chick, #846, as per protocol. Lab results showed the chick had a blood lead level of 330 µg/dl. Although this high level was cause for concern, the field team decided the best course of action was not to re-enter the nest, due to the risk of forcing the chick to fledge prematurely and possibly die. This decision was also based on our ability to rely on the nest camera to keep a close and continuous eye on the chick's health, and to share clips with veterinarians as needed. The field team observed the chick daily, and never saw behavior indicating a need for an emergency evacuation. This bird fledged on chick-day 186.

The sire of the AB16 nest, #21, was last seen at the nest on June 24, 2016, and was later determined to be dead, missing in the wild. This left dam #192 as the sole attending parent after chick-day 76. The chick appeared in good health and with normal development, but was found dead and intact below the nest on chick-day 187. Necropsy results are still pending.

Two of the non-camera nests, AB16 and LW16, had a significant amount of micro-trash during the 60-day entry, and required the additional 90-day entry (Table 3.4.3).

Table 3.4.3: Microtrash recovered from nests of each pair during 2002-2016 seasons. Values represent the total number of trash items collected from each nesting attempt or associated chick each year (*Nest failed prior to the chick being 90 days of age, value was not included in the average or nest count).

	Year														
Pair	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
21/192	-	-	109	235	1*	233	-	60	-	3*	-	164	-	244	-
21/289	-	-	-	-	-	-	-	-	-	-	-	-	-	-	104
125/111	0	44	57	43	-	43	11	10*	26	3	9*	189	16	-	-
509/111	-	-	-	-	-	-	-	-	-	-	-	-	-	93	31
206/255	-	-	-	-	-	39	-	52	32*	-	-	-	-	-	-
206/370	-	-	-	-	-	-	-	-	-	-	34	-	-	-	-
206/513	-	-	-	-	-	-	-	-	-	-	-	-	-	0	unk*
107/112	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-
107/161	-	-	unk	-	46	19	26	103	-	56	-	49	-	125	-
98/155	125	-	-	-	-	-	-	-	-	-	-	-	-	-	-
98/216	-	-	-	5*	-	-	-	-	-	-	-	-	-	-	-
98/112	-	-	-	-	na	-	-	-	-	-	-	-	-	-	-
98/289	-	-	-	-	-	-	322	12*	-	-	-	-	-	unk*	-
247/79	-	-	-	-	-	-	0	unk	0*	10	1	31	21	15*	-
247/156	-	-	-	-	-	-	-	-	-	-	-	-	-	-	72
374/180	-	-	-	-	-	-	-	-	-	-	66	-	46	-	-
374/79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
326/518	-	-	-	-	-	-	-	-	-	-	-	-	-	45	-
326/364	-	-	-	-	-	-	-	-	-	0*	-	-	-	-	-
237/214	-	-	-	-	65	-	115	-	-	-	-	-	-	-	-
237/255	-	-	-	-	-	-	-	-	-	36	-	53	-	12	-
262/449	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-
365/487	-	-	-	-	-	-	-	-	-	-	-	-	-	unk*	unk*
100/108	54	-	-	-	-	-	-	-	-	-	-	-	-	-	-
328/216	-	-	-	-	-	-	-	-	-	22	1*	3*	-	-	-
289/239	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-
63/147	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-
107/156	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-
?/156	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-
Average	49	44	83	139	56	84	95	72	26	25.4	26	69	21	75	54

3.5 Captive Releases and Transfers

In 2016, the field team released 8 condors into the wild at Bitter Creek NWR (Table 3.5.1). Releases occurred during the months of November, and December. All condors eight condors were juveniles, released into the wild for the first time. Prior to release, all released condors were held in the flight pen at Bitter Creek NWR for a minimum of six weeks starting in late August. Prior to moving captive bred condors to Bitter Creek NWR, a predator exclusion fence was also constructed in 2016.

Predator Exclusion Fence

In May of 2016, construction of a predator exclusion fence around the Bitter Creek Flight Pen was completed. Work on the fence began in January 2016. This fence provides additional protection to the condors in the flight pen and to newly released condors that often spend a large amount of time near the flight pen after being released. The predator fence was a recommendation from the facilities and husbandry review conducted in 2014 (USFWS 2014). The fence encompasses an area of about five acres and is 1900 feet in length (Photo 3.5.1). It has a total height of 11 feet (a fence height of ten feet with two strands of barbed topped with smooth wire angling out at a 45 degrees) with a two inch gap tolerance when all doors to the fence are closed. Artificial perches were also placed just outside the fence to provide additional safe roost locations for newly released condors.

Photo 3.5.1: The predator exclusion fence built around the flight pen at Bitter Creek NWR. *Photo credit: Molly Astell, USFWS*

Transport and Husbandry

A total of 18 condors intended for release and one captive mentor were held in in the Bitter Creek NWR flight pen in 2016. Five of these birds were transferred from the Ventana Wildlife Society (VWS) on August 15, because the Chimney Fire threatened the VWS flight pen located near San Simeon, CA. On August 23, four condors were transferred from San Diego Zoo Safari Park to Bitter Creek. Three condors, including the captive mentor, #46, were transported from Los Angeles Zoo on August 25. The final nine condors came on September 9 from the World Center of Birds of Prey and the Oregon Zoo.

Eleven of these condors were intended for release at Bitter Creek. The five condors that came from VWS would be transferred back to them when the wildfire was no longer a threat and two other condors would be transferred to Pinnacles National Park to be released into the wild at that location.

Visual health checks on the condors in the flight pen were conducted daily and four-hour observations were made on the captive condors two to three days a week. While held in captivity, these condors were given regular fresh food and water, which necessitated at least one field team member or volunteer at the Refuge at all times.

Soft Bodied Tick Infestation

Shortly after all prerelease condors were transferred to Bitter Creek NWR, one condor from San Diego Zoo Safari Park, #796, appeared to be ill and was transferred to the Los Angeles Zoo for examination and care on September 12. The exam revealed a dermopathy on the condor's lower abdomen and the feathered portions of its legs (Photo 3.5.2).

Photo 3.4.2: Dermopathy of condor #796. In total 10 of the 19 condors being held at the Bitter Creek NWR showed these symptoms to varying degrees. *Photo credit: Los Angeles Zoo*

On September 14, all captive condors at Bitter Creek were examined. Three additional condors (all from San Diego Safari Park) were also found to have similar dermopathy. These condors were also transferred to the Los Angeles Zoo. Working closely with the veterinary staff at San Diego Zoo Global, Santa Barbara Zoo, and Los Angeles Zoo additional exams, skin scrapes, and biopsies were conducted, but the cause of the skin condition could not be determined by the results. In total 10 of the 19 condors held in the Bitter Creek flight pen showed signs of the dermopathy.

There was a strong suspicion that an ectoparasite was the cause, but parasites were not found on any of the condors with symptoms. The parasite was finally discovered when tape was placed on the perches in the flight pen overnight and a

number of adult and larval stage soft bodied ticks were discovered stuck to the tape the following day. The ticks were collected and sent to Dr. Walter Boyce, a wildlife parasitologist at the Wildlife Health Center of UC-Davis. He identified the ticks to be *Argas ricei*, a well-known pest of nesting raptors.

To eradicate the infestation, both the condors and the flight pen needed to be treated, because this species of tick spends much of its time off the host hidden under bark and in the cracks of dead tree limbs that are used as perches in the flight pens. All captive condors at Bitter Creek NWR were transported to Los Angeles Zoo or the flight pen at the Hopper Mountain NWR. They were treated twice (once during removal and again one week later) with Ivermectin and topical Pyrethrin. All of the perches in the flight pen at Bitter Creek were sprayed with Prescription Treatment P.I. Contact Insecticide (active ingredients: Pyrethrins and Piperonyl Butoxide) and then removed from the flight pen and replaced with new perches. The perimeter of the flight pen, the ground around the perches, and the nest box in the flight pen were also sprayed. Once the perches were removed the ground of the entire flight pen and the nest box was dusted with diatomaceous earth. The ground around the perches was then sprayed again two days later and new perches were installed 24 hours after the final spraying. The new perches were also dead tree limbs and were pressure washed after being installed.

The captive condors awaiting release were returned to the flight pen at Bitter Creek NWR after the perches were installed. On the day prior to their release their legs and lower abdomen were examined for tick bites. Following the treatment of the birds and flight pen no indication of an infestation was detected. Additional steps to prevent another infestation will be taken each year prior to moving prerelease condors into the flight pen.

Photo 3.4.3: Two newly released condors perched in an artificial snag outside the flight pen at Bitter Creek NWR
Photo credit: Luisa Bergeron, Great Basin Institute

Condor Releases

Releases began at Bitter Creek NWR on November 10, 2016. The day prior to release each captive condor was handled so that VHF transmitters could be attached, and to examine the condor for any symptoms or tick infestation. The eight captive bred condors were released from the Bitter Creek NWR flight pen in

groups of two or three over the next two months (Photo 3.4.3, Table 3.5.1).

Three condors, #76, #77, and #805, were not released in 2016 due to the delay in starting releases while trying to identify and correct the soft bodied tick infestation. They will be released in January of 2017 when weather and staffing permit.

Post Release Monitoring

The eight new releases were closely monitored for appropriate feeding and roosting behaviors after release. This monitoring required an average of two people per week for approximately 10 hours per day from November 10 to December 31 (Table 3.5.2). Releasing the birds in smaller groups, rather than all at once, allowed the field team to focus on the behaviors of each group making sure that they exhibited proper roosting and feeding behavior before releasing the next group.

Population Increase

Loss from mortalities and gains from new releases and wild reproduction netted a 2% increase to the Southern California population in 2016 (Figure 3.5.1)

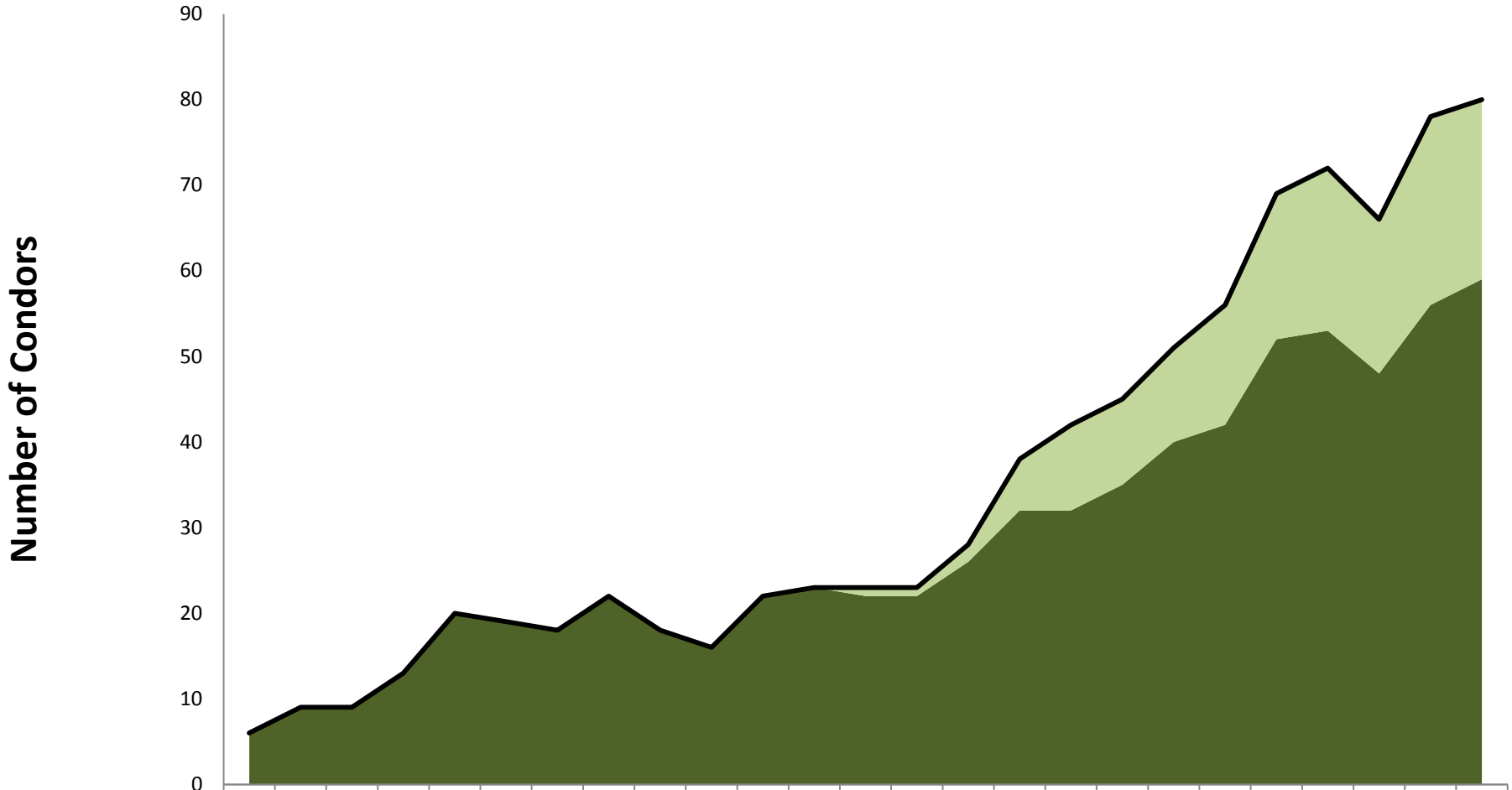
Photo 3.4.2: Santa Barbara Zoo Condor Biologist, Linda Uyeda, handles condor #772 as Nesting Technician, Nadya Seal Faith, attaches a VHF transmitter. Condor #772 was released into the wild at Bitter Creek NWR the following day. *Photo Credit: Devon Pryor, Santa Barbara Zoo*

Table 3.5.1: Condors released at the Bitter Creek NWR in 2016. SB# = Studbook #; LAZ= Los Angeles Zoo; SDZSP=San Diego Zoo Safari Park; WCBP=World Center for Birds of Prey; NA=not applicable. A successful fate indicates that the released condor was alive and remained in the wild population without having to be recaptured for 90 days following its initial release. * Condor was released after long period of captivity original release date was in December of 1992. ** Condors were not released until January of 2017. See 2017 Annual Report for details.

SB#	Sex	Hatch date	Hatch location	Transfer date	Release date	Fate	Age at Release (in years)
772	m	23-Mar-15	Los Angeles Zoo	26-Aug-16	10-Nov-16	Successful	1.6
794	m	11-May-15	World Center for Birds of Prey	8-Sep-16	10-Nov-16	Successful	1.5
749	f	29-Apr-14	San Diego Safari park	23-Aug-16	1-Dec-16	Successful	2.6
796	m	9-May-15	San Diego Safari park	23-Aug-16	1-Dec-16	Successful	1.6
797	f	9-May-15	Los Angeles Zoo	23-Aug-16	1-Dec-16	Successful	1.6
771	f	24-Mar-15	Oregon Zoo	8-Sep-16	14-Dec-16	Successful	1.7
784	m	25-Apr-15	Los Angeles Zoo	23-Aug-16	14-Dec-16	Successful	1.6
807	m	29-Jun-15	Oregon Zoo	8-Sep-16	14-Dec-16	Successful	1.5
76*	f	23-Mar-92	Los Angeles Zoo	8-Sep-16	Jan 2017**	NA	NA
77*	f	21-Apr-92	Los Angeles Zoo	8-Sep-16	Jan 2017**	NA	NA
805	m	2-Jun-16	Los Angeles Zoo	26-Aug-16	Jan 2017**	NA	NA

Table 3.5.2: Captive release efforts in 2016 at Bitter Creek NWR.

	January	February	March	April	May	June	July	August	September	October	November	December
Number of condors released	0	0	0	0	0	0	0	0	0	2	3	6
Approximate staff hours tracking new releases	0	0	0	0	0	0	0	0	0	0	400	600
Total number of calf carcasses provided	14	18	17	12	7	7	12	7	3	0	16	21



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Wild Fledged	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	6	10	10	11	14	17	19	18	22	21
Captive Released	6	9	9	13	20	19	18	22	18	16	22	23	22	22	26	32	32	35	40	42	52	53	48	56	59
Total Population	6	9	9	13	20	19	18	22	18	16	22	23	23	23	28	38	42	45	51	56	69	72	66	78	80

Figure 3.5.1: Number of wild California condors from 1992 through 2016. The size of the population represents the number of condors in the Southern California flock at the end of each year (Dec 31).

3.6 Behavioral Modification

In 2016, condors visited ten general known areas of human development. Of these, the most frequented areas were the communities of Bear Valley Springs (BVS), Stallion Springs, Alpine Forest Park, and Valley View Estates in the Northern Tehachapi Mountains, and a private ranch near Oak Creek Canyon. Condors visited the other five developed areas: the California Correctional Institution in the Northern Tehachapi Mountains, an oil pad near Lake Piru, a private inholding on Winters Ridge of Tejon Ranch, ITT Towers on the Angeles National Forest, and a church, Rancho de la Cruz, near Bitter Creek NWR, much less frequently.

Monitoring activities and efforts by field team personnel at the communities in the Northern Tehachapi Mountains were similar to 2015. The field team spent about 8 hours each week monitoring and hazing condors from private homes in the communities, educating residents, and providing assistance with automated hazing devices and other deterrents. Continued guidance was also provided to the communities of BVS and Stallion Springs concerning the modification and covering of their dip tanks to prevent the entrapment and drowning of condors. The field team corresponded directly and frequently with the caretakers of the private ranch near Oak Creek Canyon, and to a lesser degree, the staff of California Correctional Institution, providing both education and technical support.

In addition to providing direct assistance to residents and landowners, the field team also performed outreach to help address condor habituation concerns. These activities are reported below in section 3.7 Outreach.

3.7 Outreach

Using outreach to raise awareness about condor conservation continued to be a growing activity of the field team in 2016. The field team continued to expand its following on social media, initiated new programs, and built upon existing efforts outreach efforts.

Condor Cave

Interest in the Condor Cave Facebook page increased, with a total of 11,396 followers as of December 31, 2016. This was a 147% increase over the previous year. Since its inception in 2012 the page has more than doubled its number of followers each year. The Santa Barbara Zoo staff plays the primary role in developing the content for this page providing two to three posts a week. Posts include photos, nest camera videos, and updates from the field.

Online Condor Nest Camera

The live streaming condor nest camera went live on April 4, 2016, moments before hatch at KR17, allowing observers to watch the development of condor chick #815 for until September 25, 2016, when the chick left the nest cavity. During the five and a half months that the camera was online it was viewed over one million times from 150 countries and watched for 19 million minutes (36 years).

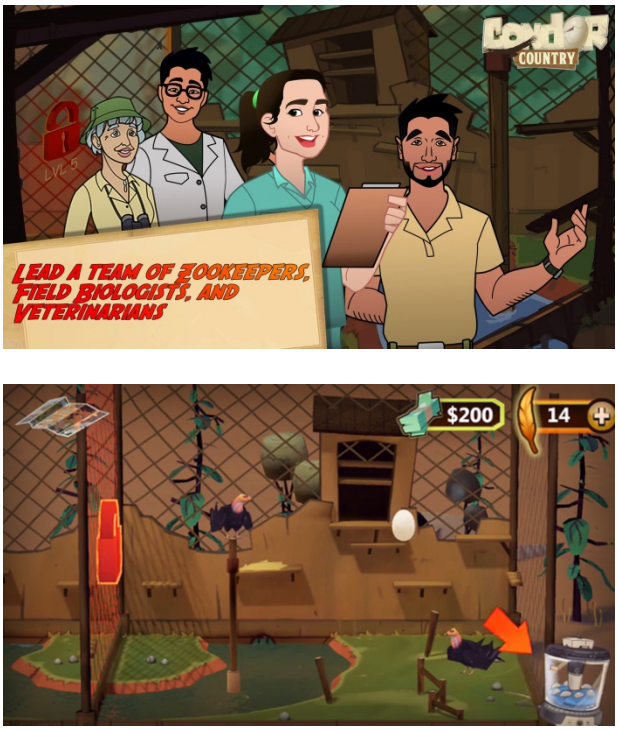


Photo 3.7.1: Images from the mobile game, Condor Country. *Photo Credit: Cerberus Interactive*

CondorKids

The CondorKids third grade curriculum was used by the Fillmore Unified School District during the in 2016 school year. All 12 third grade classes participated reaching over 300 students. Students and teachers took a field trip to the Santa Barbara Zoo where they were able to view condors on exhibit and interact with many of the field team members.

Condor Country

The field team worked with the Santa Barbara Zoo and the mobile game developer Cerberus Interactive to create the first ever mobile game focused on endangered species recovery. Condor Country allows players to simulate real-life conservation practices used by the California Condor Recovery Program on their mobile device. The game is available for download on IOS and Android devices. The game was released to the public on October 18, 2016 and has been downloaded by thousands of people. Funding for Condor Country was through the Urban Refuge Initiative.

Non-Lead Outreach

The Institute for Wildlife Studies' Non-lead Outreach Coordinator for Southern California was involved in 14 outreach activities, often with other field team members, directly reaching 1,200 people in southern California. These activities included booths, presentations, shooting demonstrations and interviews (Table 3.7.1, Photo 3.7.2). Topics included non-lead ammunition, ammunition laws and ballistic performance, the role of hunting in conservation, the effects of lead on condors and other wildlife, and non-lead outreach efforts in California. An additional booth in Northern California for the International Sportsman Exposition directly reached 1,300 people.

Condor Habituation

Outreach activities were the primary means of addressing behavioral modification in the Northern Tehachapi Mountain communities. The field team posted educational flyers at the BVS Police Department, Post Office, and Bear Valley Market. Flyers were electronically distributed via the BVS Community Services District website, Stallion Springs Community Services District website, and Alpine Forest Park Property Owner's Association website. Each community service district also provided flyers through community newsletters and sent them to residents by mail (Appendix III).

Other Outreach Activities

The field team led and assisted with twelve tours of Hopper NWR and Bitter Creek NWR (Table 3.7.2). The tour recipients included local Audubon chapters, secondary schools, colleges, a natural history club, a veteran's home and the general public.

In addition to the non-lead outreach presentations, information about other condor recovery efforts was provided through presentations and educational booths at various locations or events in 2016 (Table 3.7.3). These included presentation to various schools and colleges, hosting online Q&A sessions for students and the public, and setting up booths at various events at local zoos or other conservation meetings.

The field team responded to media interviews about various aspects of condor conservation and the launch of the live streaming condor nest camera on The Cornell Lab of Ornithology website and the release of Condor Country. These media outlets included: KEYT Channel 3 News, 23ABC News Bakersfield, National Public Radio, Wired Magazine, Scholastic Science World, and local newspapers.

Photo 3.7.2: Non-lead outreach booth set up at the Bakersfield Sportsman's Expo. *Photo credit Russell Kuhlman, Institute for Wildlife Studies*

Table 3.7.1: Non-Lead outreach presentations given in 2016. The Institute for Wildlife Studies (IWS) non-lead outreach coordinator organized and lead these activities with assistance from others on the field team.

Description	Location	Date
IWS Non-lead Outreach Coordinator, Russell Kuhlman staffed a booth at the International Sportsman Exposition	Sacramento, CA	21-Jan-2016-24-Jan-16
IWS Non-lead Outreach Coordinator, Russell Kuhlman staffed a booth and gave a presentation at the CDFW Advanced Hunter Education Class	San Diego, CA	20-Feb-16
IWS Non-lead Outreach Coordinator, Russell Kuhlman staffed a booth at the Central California Sportsman Exposition	Bakersfield, CA	26-Feb-2016-28-Feb-16
IWS Non-lead Outreach Coordinator, Russell Kuhlman, staffed a booth at Wind Wolves Nature Preserve's Nature Festival	Wind Wolves Nature Preserve, Bakersfield, CA	19-Mar-2016 20-Mar2016
IWS Non-lead Outreach Coordinator, Russell Kuhlman, and IWS personnel staffed a booth and gave a presentation to an advanced hunter education class	San Diego, CA	2-Apr-16
IWS Non-lead Outreach Coordinator, Russell Kuhlman and Supervisory Wildlife Biologist, Joseph Brandt staffed a booth at the Hunter Education Instructors Conference	Lemoore, CA	9-Apr-16
IWS Non-lead Outreach Coordinator, Russell Kuhlman, staffed a booth and presented to the Southern California Chapter of the California Deer Association	San Bernardino, CA	24-May-16
IWS Non-lead Outreach Coordinator, Russell Kuhlman, staffed a booth, gave a presentation and shooting demonstration to a CDFW Advanced Hunter Education Class	Apple Valley, CA	24-Sep-16
IWS Non-lead Outreach Coordinator, Russell Kuhlman, staffed a booth and presented at the Mojave Youth Hunt	Mojave, CA	30-Sep-2016-2-Oct-2016
IWS Non-lead Outreach Coordinator Russell Kuhlman staffed a booth at the Seneca Oil Company interagency BBQ	Fillmore, CA	6-Oct-16
IWS Non-lead Outreach Coordinator, Russell Kuhlman staffed a booth and a shooting demonstration at the Winchester Gun Club	Santa Barbara, CA	29-Oct-16
IWS Non-lead Outreach Coordinator Russell Kuhlman staffed a booth and gave a presentation at the Orange County Predator Hunter's Group	Huntington Beach, CA	3-Nov-16
IWS Non-lead Outreach Coordinator, Russell Kuhlman, gave presentation at the Southern California Department of Fish and Wildlife Commissioners' meeting	La Canada, CA	4-Nov-16
IWS Non-lead Outreach Coordinator Russell Kuhlman staffed a booth and donated non-lead ammunition to the Central Chapter of the California Waterfowl Association	Bakersfield, CA	22-Nov-16

Table 3.7.2: Outreach tours performed in 2016. BCNWR=Bitter Creek NWR, HMNWR=Hopper Mountain NWR, UCSB=University of California Santa Barbara, FCCWF=Friends of the California Condor Wild and Free, SBZ=Santa Barbara Zoo, BBC=British Broadcasting Corporation, GBI=Great Basin Institute, FUSD=Fillmore Unified School District.

Description	Location	Date
Supervisory Wildlife Biologist, Joseph Brandt, Wildlife Biologist, Josh Felch, SBZ Nest Technician, Nadya Seal Faith, SBZ Condor Biologist, Linda Uyeda, GBI Research Associate ,Mitch Deskovick, and GBI Research Associate Chloe Tremper, led a tour for Pasadena Audubon Young Birders	Bitter Creek NWR	25-May-16
Supervisory Wildlife Biologist, Joseph Brandt, SBZ Condor Biologist, Linda Uyeda, GBI Research Associate Sandra Mayne, and GBI Research Associate Luisa Bergeron, and IWS Non-lead Outreach Coordinator, Russell Kuhlman, assisted with FCCWF tour of BCNWR for Kern County Audubon	Bitter Creek NWR	7-Jun-16
Supervisory Wildlife Biologist, Joseph Brandt, Wildlife Biologist, Eddie Owens, SBZ Condor Biologist, Linda Uyeda, GBI Research Associate, Betty Lee, GBI Research Associate, Eliana Moustakas, and Volunteer, Vince Gerwe, led a tour of BCNWR for Taft College with assistance from SBZ and SDZSP staff	Bitter Creek NWR	27-Sep-16
Refuge Manager, Dan Tappe, assisted with FCCWF tour of HMNWR for general public	Hopper Mountain NWR	8-Oct-16
Supervisory Wildlife Biologist, Joseph Brandt, led a tour of HMNWR for Santa Ynez Valley Natural History Club	Hopper Mountain NWR	15-Oct-16
Wildlife Biologist, Josh Felch, and SBZ Condor Biologist, Linda Uyeda, assisted with FCCWF tour of BCNWR for general public	Bitter Creek NWR	15-Oct-16
Project Leader, Mike Brady, Supervisory Wildlife Biologist, Joseph Brandt, Wildlife Biologist, Josh Felch, Wildlife Biologist, Eddie Owens, Biological Science Technician, Molly Astell, SBZ Condor Nest Technician, Nadya Seal Faith, GBI Research Associate, Mitch Deskovick, and GBI Research Associate, Betty Lee led a tour of BCNWR for Veterans Home of California out of Ventura with assistance from SBZ staff	Bitter Creek NWR	19-Oct-16
Wildlife Biologist, Eddie Owns, led a tour of HMNWR for Los Angeles Audubon Society	Hopper Mountain NWR	22-Oct-16
Wildlife Refuge Assistant, Laura Shaskey, assisted with FCCWF tour of BCNWR for Hueneme High School	Bitter Creek NWR	26-Oct-16
Supervisory Wildlife Biologist, Joseph Brandt, Complex Wildlife Biologist, Jason Storlie, Wildlife Refuge Specialist, Laura Shaskey, led a tour of BCNWR for San Joaquin Valley Management Partnership	Bitter Creek NWR	9-Nov-16
Project Leader, Mike Brady, California Condor Field Coordinator, Steve Kirkland, Wildlife Biologist, Eddie Owens, Biological Science Technician, Molly Astell, GBI Research Associate Luisa Bergeron, GBI Research Associate, Eliana Moustakas, and GBI Research Associate, Claire Revekant, led a tour of BCNWR for Los Angeles Conservation Corps	Bitter Creek NWR	30-Nov-16
Supervisory Wildlife Biologist, Joseph Brandt, GBI Research Associate, Betty Lee, and GBI Research Associate, Eliana Moustakas led tour of BCNWR for Peak-to-Peak School and Wind Wolves Preserve staff	Bitter Creek NWR	13-Dec-16

Table 3.7.3: Outreach presentations given in 2016. FCCWF=Friends of the California Condor Wild and Free, HMNWRC=Hopper Mountain National Wildlife Complex, IWS=Institute for Wildlife Studies, SBZ=Santa Barbara Zoo, STEM = Science, Technology, Engineering, and Math

Description	Location	Date
Supervisory Wildlife Biologist, Joseph Brandt, participated in a live on-line Q&A on Cornell Lab of Ornithology Allaboutbirds.org BirdCams webpage regarding the condor nest camera live stream with Cornell Lab of Ornithology	Ventura, CA	14-Apr-16
Supervisory Wildlife Biologist, Joseph Brandt, participated in a live on-line Q&A for FWS Conservation Connect	Ventura, CA	21-Apr-16
Project Leader, Mike Brady, Wildlife Biologist, Eddie Owens, and Biological Science Technician, Molly Astell, staffed a booth at Los Angeles Zoo Earth Day Weekend	Los Angeles Zoo, Burbank, CA	23-Apr-16
Wildlife Biologist, Josh Felch, Wildlife Biologist Eddie Owens, and Office Assistant, Marina Martinez, staffed a booth at Los Angeles Zoo Earth Day Weekend	Los Angeles Zoo, Burbank, CA	24-Apr-16
Wildlife Biologist, Josh Felch, gave a presentation for an after-school tutoring program for under-privileged at risk kids in grades 1st-5th	Thousand Oaks, CA	19-May-16
Project Leader, Mike Brady, and Supervisory Wildlife Biologist, Joseph Brandt, staffed a booth at Endangered Species Weekend	Los Angeles Zoo, Burbank, CA	21-May-16
Deputy Project Leader, Ken Convery, Condor Coordinator, Steve Kirkland, and Supervisory Wildlife Biologist, Joseph Brandt, staffed a booth at Endangered Species Weekend	Los Angeles Zoo, Burbank, CA	22-May-16
Wildlife Biologist, Eddie Owens, SBZ Conservation Research Associate, Devon Pryor, and Volunteer Gerwe participated in STEM event at Fillmore Middle School	Fillmore Middle School, Fillmore, CA	6/17/2016
Project Leader, Mike Brady, and Supervisory Wildlife Biologist, Joseph Brandt, screened The Condor's Shadow for Pasadena Audubon Young Birders	Eaton Canyon Nature Center, Pasadena, CA	8/17/2016
Project Leader, Mike Brady, staffed a booth at Santa Barbara Zoo's International Vulture Awareness Day event with assistance from Pasadena Audubon Young Birders	Santa Barbara Zoo, Santa Barbara, CA	9/4/2016
Supervisory Wildlife Biologist, Joseph Brandt, screened The Condor's Shadow at Placerita Canyon Nature Center	Placerita Canyon Nature Center, Newhall, CA	9/18/2016
Wildlife Biologist, Eddie Owens, gave a presentation for the Veterans Home of California	Veterans Home of California, Ventura, CA	10/18/2016
Project Leader, Mike Brady, and Supervisory Wildlife Biologist, Joseph Brandt, attended Condor Country mobile game release event	Santa Barbara Zoo, Santa Barbara, CA	10/25/2016
Supervisory Wildlife Biologist, Joseph Brandt, screened The Condor's Shadow for 2016 Birdfest	Santa Monica National Recreation Area, Calabasas, CA	11/12/2016

4.0 Discussion

Monitoring Resource Use

The initial results of the five CTT geofencing GPS transmitter deployments were promising; it is anticipated that more GPS units of this type will be deployed in the future to help reduce conflicts with windfarms and to advance the ability to monitor condors and avoid potentially dangerous situations for the population. Deploying these units would be an extension of the current detection and curtailment system that exists for the Alta East Wind Facility as well as covering other facilities currently in operation. Transmitters with geofencing abilities would further aid onsite monitors at wind facilities who currently rely on VHF telemetry and visual observations to detect when condors come into proximity with turbines. While still only a temporary measure that relies on attaching transmitters to condors, deploying more of these transmitters has the added advantage of benefitting current research that will advance our understanding of condor movements specifically related to the threat of turbines, and generally in understanding condor movements and range expansion.

Lead Monitoring and Mitigation

Trapping success improved in 2016 compared to the previous year. The field team increased the length of time spent trying to trap the population by starting the first trapping period a month early. The field team tested a location to build an additional trap site in the Tehachapi Mountains but failed to have condors feed at this location. This may be related to a seasonal pattern of use, or because there is an abundance of food in the area and the flock was not sufficiently attracted to the location. Additional locations will be tested in 2017.

There is also a need to better understand the benefits of lead treatment. In recent published studies (Finkelstein et al. 2012, Kelly et al. 2015) and in ongoing research related to condor population viability (Appendix I), the treatment of condors for lead exposures has created uncertainty about natural condor survivorship at current rates of exposure. It is assumed that condor survival benefits from this treatment, but the extent is unknown, because there has never been a comparable period of time or portion of the population that has gone without treatment. Finkelstein et al. (2012) estimates the current practice of biannual blood lead monitoring may only capture roughly 10% of a condor's annual exposure history, and shows that condors are being exposed far more frequently than these blood tests indicate. There are also anecdotal examples, including condor #846, one of the wild fledged chicks of 2016, where condors were not able to be treated for very high blood lead exposures (>300ug/dL) and survived. By only treating condors showing severe clinical signs of lead toxicosis, the field team could more accurately assess the impacts of lead on condor survivorship and the benefits of lead treatment as a recovery action. These benefits can then

be compared to other recovery actions to develop more effective strategies to increase the wild condor population.

Detecting Mortalities

Two of the condors in 2016 died from electrocution after a mid-span power line collision (condors #683 & #759). Both of these collisions took place in the Tehachapi Mountains. This area is a recently recolonized portion of the historic condor range and has the highest level of condor activity for the Southern California population (Figure 3.1.2). The condor program has long been aware that powerlines are a hazard for condors and has developed a variety of means to reduce this threat. All captive bred condors go through a power pole aversion training prior to their release in the wild. In 2014, SCE also constructed two mock power poles at Hopper Mountain NWR and Bitter Creek NWR to provide this training to wild fledged condors that did not receive the training because they were not captive bred. SCE also refitted a number of power poles in the Bear Valley springs community with longer cross arms (80 inches, greater than wrist to wrist distance) to reduce the chances of electrocution.

In Big Sur, California Pacific Gas and Electric (PGE) replaced lines where there were mid-span collisions with underground lines or used tree wire to insulate the line and prevent the risk of electrocution. PGE has also begun to preemptively replace uninsulated lines with tree wire in areas where condors are known to frequent along the Big Sur coastline. The two mid-span collision deaths in the Tehachapi Mountains were in an area covered by SCE. They worked with the Service to take corrective action for power lines involved in the two condors deaths. In this case they are retrofitting the uninsulated line with an insulated cover. Though never used previously, this approach rather than replacing line with tree wire, allowed for a more cost effective and much quicker response.

These deaths also prompted the creation of an Avian Power Line Interaction Committee (APLIC) working group for the California condor. This group includes representatives from SCE, PGE, and many other power utilities which operate in area where condors inhabit. This working group will allow for the development and communication of best practices for avoiding condor power line mortalities.

Transfers and Releases

The infestation of the soft bodied tick [*Argas ricei*] identified the need to regularly inspect captive facilities for ectoparasites and to take measures to prevent infestations. Cleaning the flight pen perches each year and periodically replacing perches would help limit the possibility of infestations. Using perches made from artificial material, such as PVC or plastic, may reduce cracks and crevices where ectoparsites can persist. However, manmade materials may be difficult to find or expensive if trying to find perches that look similar to natural features that condors perch on.

The tick infestation also illuminated the need for quarantine space in field locations where condors potentially infected with a contagious disease can be isolated from other captive condors and

the wild population. Pre-release condors are given a health exam before being transferred from the captive breeding facilities to release sites, but if a contagious medical condition develops while the condors are at the field site, most sites currently have a limited ability to isolate the infected condor(s) from the rest of the captive population and any wild condor that visits the flight pen. Currently, the Hopper Mountain NWR flight pen has a space where condors can be held in partial isolation, but the Bitter Creek NWR flight pen lacks a similar holding space. Short term isolation can be accomplished by using a kennel, but this is would be limited to 24 to 36 hours.

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Appendix I: Contributions to Ongoing Research

Data collected over the course of 2015 will contribute to ongoing research within the Service, various universities, and other federal agencies. Examples of this ongoing research include:

California condor flight response in a variable meteorological and topographic environment
Years: 2014-2018

Study Objective: The objective of this study is to record movements of California condors to understand how their flight behavior (especially altitude above ground level) responds to variation in topography and weather. Previous work with other species suggests that flight altitude is strongly influenced by these parameters and the type of subsidized lift the bird is using. Information on condor flight behavior will be used to (a) predict risk to birds from existing and proposed individual turbines within existing condor range; and (b) predict risk to birds from existing and proposed turbines within the projected (and expanded) future range of condors (c) identify wind and/or topographic variables that may be preferentially used by condors.

Principal Researchers: Todd Katzner and Sharon Poessel from USGS Forest and Rangeland Ecosystem Science Center; Johnathan Hall and Melissa Braham from WVU.

Sponsor: California condor subaccount under the Renewable Energy Action Team Mitigation Account Memorandum of Agreement between the Renewable Energy Action Team Agencies and the National Fish and Wildlife Foundation. Funding is the result of contributions made by Alta Windpower Development, LLC as part of the avoidance, minimization, and mitigation program for the California condor (Gymnogyps californianus) that was identified in the Bureau of Land Management's final environmental impact statement (Bureau 2013) and the biological opinion (U.S. Fish and Wildlife Service [Service 2013a]) for the Alta East wind energy project.

Anticipated Completion: 2018

Species Tracking Optimization: Pilot Test of an Improved Capture and Delivery of California Condor Location Information
Years: 2013-2016

Study Objective: Alternatives for monitoring wildlife populations now exist that can significantly improve wildlife monitoring and management. Projects have the potential to track and alert wildlife mortality in near real time, track sick or injured wildlife, implement location-aware alerts (termed geofencing), and enable users to access these data though traditional desktop computing and mobile environments (e.g. smartphones). This proposal is investigating new and emerging technologies that will improve condor science and management.

Principal Researchers: David Douglas, Robert Waltermire, Tim Kern, and Chris Emmerich from USGS; Gil Bohrer, Rolf Weinzerl, and Sarah Davidson from Movebank.org; Richard Kearney, Pat Lineback, Joseph Brandt, and Laura Mendenhall from USFWS; Andrew McGann from Cellular Tracking Technologies, LLC.

Sponsor: U.S. Fish and Wildlife Service, U.S. Geological Survey, Movebank.org

Funding Source: Science Support Partnership Fund

Results to Date: Development of a new GPS data model; manufacture of a custom GSM unit; progress on establishing a condor daily map using data from FISMA-compliant repository. Report published January 2016: Improve Wildlife Species Tracking—Implementing an Enhanced Global Positioning System Data Management System for California Condors (https://pubs.usgs.gov/of/2016/1030/ofr20161030.pdf)

Anticipated Completion: January 2016

Genetic map and whole genome sequences of California condors
Years: 2006-present

Study Objective: Utilize robust genetic and genomic approaches, construct a complete genome-based database of genetic variation in California condors, and make findings available for population management and recovery. Anticipated findings include: detailed analysis of kinship among founder California condors, detailed characterization of variation at the single nucleotide polymorphism (SNP) level, assessment of retention of genetic variation in the species pedigree, identification of the mutation causing chondrodystrophy, identification of carriers of chondrodystrophy allele.

Principal Researchers: Oliver A. Ryder from San Diego Zoo Global, Stephan C. Schuster from Nanyang Technological University, Singapore, Webb Miller from Pennsylvania State University, Center for Comparative Genomics and Bioinformatics, Michael Romanov from University of Kent, Canterbury School of Biosciences.

Sponsor: U.S. Fish and Wildlife Service California Condor Recovery Program, San Diego Zoo Global.

Funding Source: San Diego Zoo Global, Seaver Institute, John and Beverley Stauffer Foundation, other private foundations.

Results to Date: A genetic map for California condors based on comparison to chicken and zebra finch genomes has been published. A microsatellite-based linkage map is in development. Sequencing of 30 California condor genomes utilizing Illumina technology has been proposed and funding is pending. This study would identify all extant genetic variation at the nucleotide

level and affords the opportunity to identify the mutation associated with heritable chondrodystrophy.

Anticipated Completion: If current funding proposals are approved, the reference genome and initial descriptions of species variation would be completed within one year. More detailed analyses of demography and evolutionary population genetics would follow. Priority will be given to reporting recovery-relevant findings.

An assessment of the biological impact of contaminants and management actions that influence the long-term persistence of the California condor
Years: 2011-2016

Study Objectives: Synthesize existing data and collect new data on the risks of contaminant exposure to California condors. We will also identify the suitability of existing and proposed future habitat with respect to changes in contaminant exposure, human demographics, and climate. Quantify baseline measures of individual condor performance (e.g., survival, reproductive success) and how these rates are influenced by the effects of contaminants (e.g., lead, organochlorines, microtrash) and future habitat suitability from changes in human demographics, climate. Develop demographic modeling approaches for each condor population in California that allows estimation of how contaminants, global climate change, future habitat suitability, and management efforts will impact population recovery.

Principal Researchers: Donald R. Smith and Myra Finkelstein from University of California, Santa Cruz. Daniel F. Doak from University of Colorado, Boulder, Vickie Bakker from Montana State University.

Sponsors: Department of Environmental Toxicology University of California, Santa Cruz; U.S. Fish & Wildlife Service, Hopper Mountain National Wildlife Refuge Complex, National Park Service, Pinnacles National Monument; US Geological Survey, Forest and Rangeland Ecosystem Science Center; U.S. Fish & Wildlife Service Water Pollution Control Laboratory CA Dept. of Fish and Game, Office of Spill Prevention and Response; University of Wyoming, USFWS Ventura Ecological Service Office

Funding Sources: Montrose Settlement Restoration Funds, USFWS Environmental Contaminants Program On-Refuge Investigations Sub-Activity

Anticipated Completion: 2016

Eggshell thinning and depressed hatching success of California condors reintroduced to Central California.
Years: 2006-2017

Study Objective: Compare condor hatching success and eggshell thickness between reintroduced populations of California condors in Central and Southern California. Evaluate the cause of egg failure in wild laid eggs and assess the potential sources of organochlorine contamination and determine its impact of the condor population in Central California.

Principal Researchers: Joe Burnett and Kelly Sorenson from the Ventana Wildlife Society, Joseph Brandt from U.S. Fish & Wildlife Service Hopper Mountain National Wildlife Refuge Complex, Bob Risebrough from the Bodega Bay Institute.

Sponsors: Ventana Wildlife Society, U.S. Fish & Wildlife Service Hopper Mountain National Wildlife Refuge Complex, The Bodega Bay Institute, Los Angeles Zoo and Botanical Gardens, Santa Barbara Zoo.

Funding Source: Ventana Wildlife Society and USFWS Hopper Mountain NWRC

Results to date: Burnett et al. 2009 (presentation); Burnett, L. Joseph, Kelly J. Sorenson, Joseph Brandt, Estelle A. Sandhaus, Deborah Ciani, Michael Clark, Chandra David, Jenny Schmidt, Susie Kasielke, and Robert W. Risebrough. 2013. Eggshell Thinning and Depressed Hatching Success of California Condors Reintroduced to Central California. The Condor 115 (3), 477-491

Anticipated Completion: 2017

California condor Nest Guarding Project
Years: 2007- present

Study objective: Analysis of nest success in Southern California's reintroduced population of California condors along with the trends of breeding effort and nest success within this population in response to changes in foraging, demographics, and management strategy (tentative plan).

Principal Researchers: Estelle Sandhaus from the Santa Barbara Zoo and Joseph Brandt from the U.S. Fish & Wildlife Service Hopper Mountain National Wildlife Refuge Complex.

Sponsors: Santa Barbara Zoo; U.S. Fish & Wildlife Service Hopper Mountain NWRC; Los Angeles Zoo.

Funding Source: U.S. Fish & Wildlife Service Hopper Mountain NWRC and Sana Barbara Zoo.

Results to date: 6% Nesting Success (2001-2006) increased to 60% nesting Success (2006-2011), Brandt et al. 2008 (presentation), Brandt et al. 2010 (poster), Sandhaus et al. (2012) Wynn & Stringfield 2011.

Appendix II:

CELLULAR TRACKING
TECHNOLOGIES

Terra-Gen Power, LLC. – California Condor Warning System
Firmware testing and validation document

Introduction

Cellular Tracking Technologies, LLC. was contracted by Terra-Gen Power, LLC. to develop a custom warning system, including all server infrastructure and telemetry units. The goals of this project are:

1. Development of a customized Firmware and server infrastructure, programmed to provide the necessary alerts when these devices near the designated hazardous locations.
2. Outfitting the California Condor population in this region with the new tracking devices, enabled with the Warning System Service.
3. Providing ongoing technical support, server, Firmware and device service/refurbishment in the event that the devices need to be repaired or replaced.
4. Assisting the agencies entrusted with managing the California Condor populations with timely telemetry data, and alerts in the event that these birds require assistance/intervention.

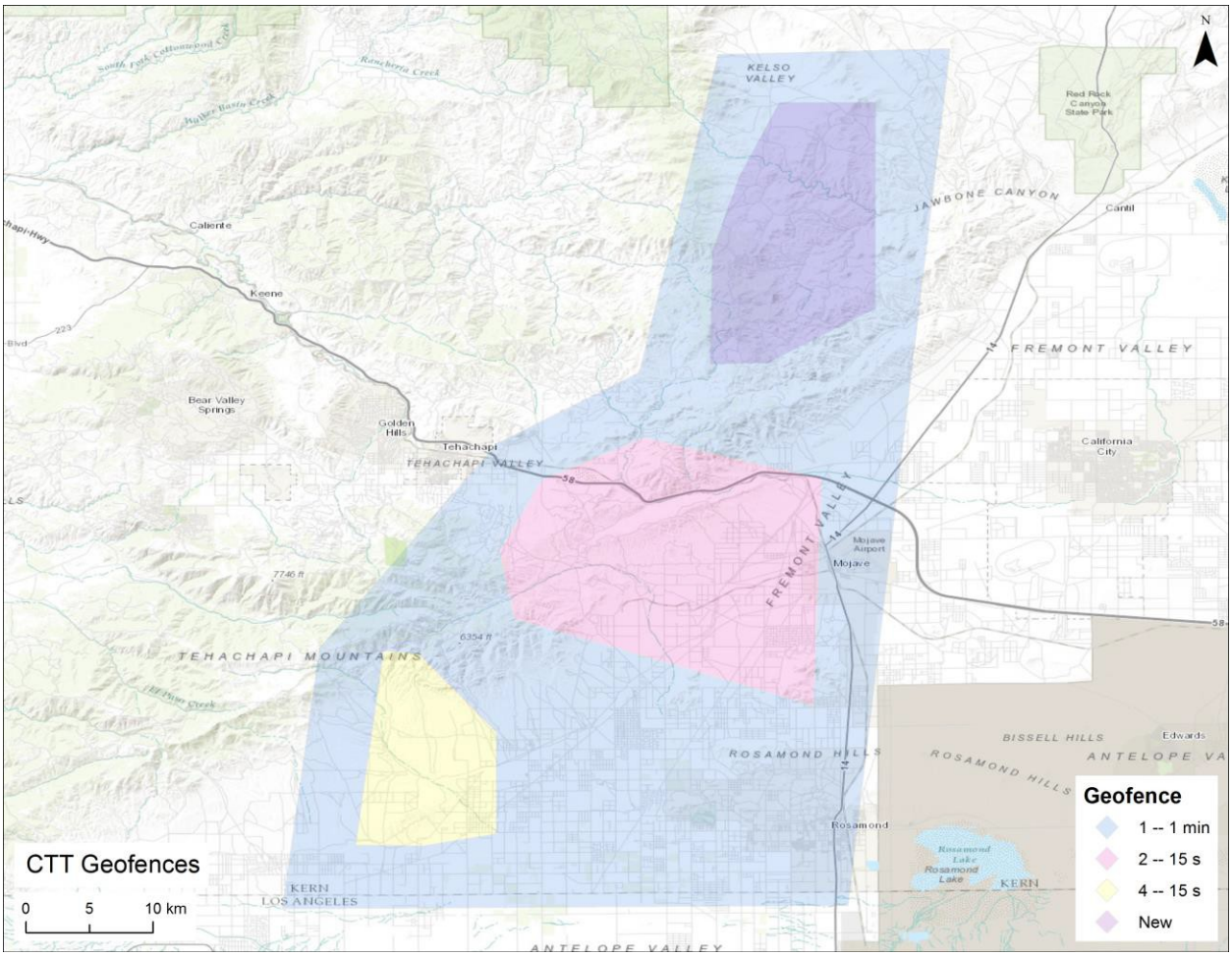
A total of 5 condor telemetry devices were shipped to USFWS on 5/10/2016 and were meant to test this system as it was developed. The development phase went through 5-6 revisions at our office including long-term testing and field units went through several rounds of testing to determine the capability of the units to stream high volumes of data in various conditions, solar recharge under high load, and run several variations of the actual firmware for this project. We also tested server side capabilities during these tests for the alert system. The basic firmware needed to be able to:

1. Collect GPS fixes outside the geofences at 10-minute intervals from 30 minutes prior to sunrise until 30 minutes after sunset
2. Transmit daily at a prescribed time of day and on geofence triggers
3. Outer Geofence, triggers the unit switches to 1-minute intervals
4. Three Inner Geofences trigger the unit to switch to 15-second intervals.
5. If unit remains inside an Inner Geofence, it will transmit subsequent batches of data at 5 minute intervals, up to 5 times
6. When a unit enters a geofence, it will transmit and indicated that it exited the geofence and push a notification if enabled.

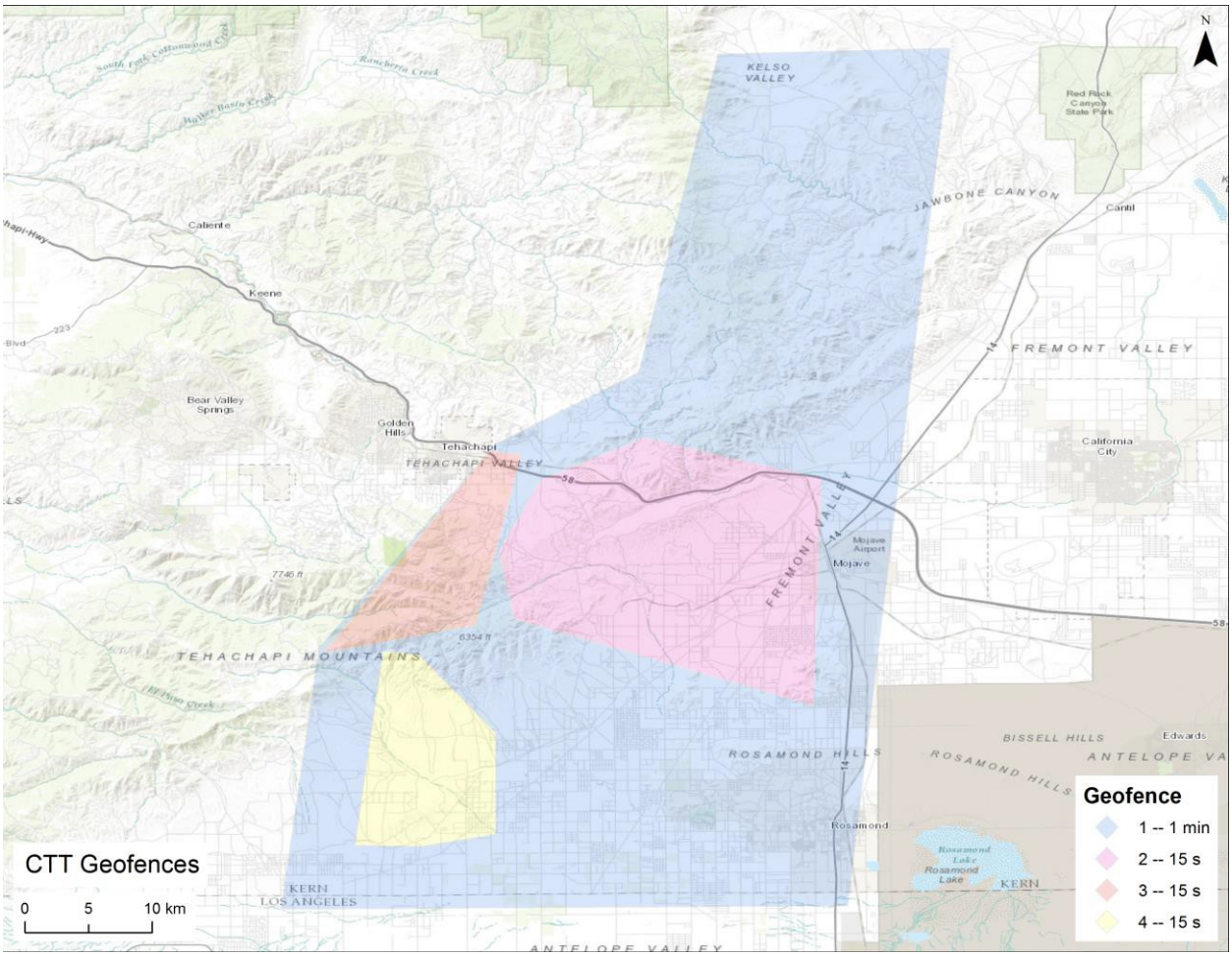
The next several pages outline these units interacting with the geofence areas to assess if the final firmware successfully switched duty cycles and operated as intended. Because of the quantity of data sent it was not feasible to display all the data collected specifically for this assessment.

1021 Route 47 South, Rio Grande, NJ 08242 USA : 866-582-8707 : www.celltracktech.com

Geofence- Original. This map shows the geofence agreed upon for the custom firmware. The purple, middle pink and yellow geofence collect data at 15 second intervals. The blue geofence collects data at 60 second intervals, and outside the geofences the unit collects data at 10 minute intervals. Upon entering any of the geofences the unit does a GSM transmission which pushes data and a notification. Appendix 1. Has more detail for the final duty cycles programmed.

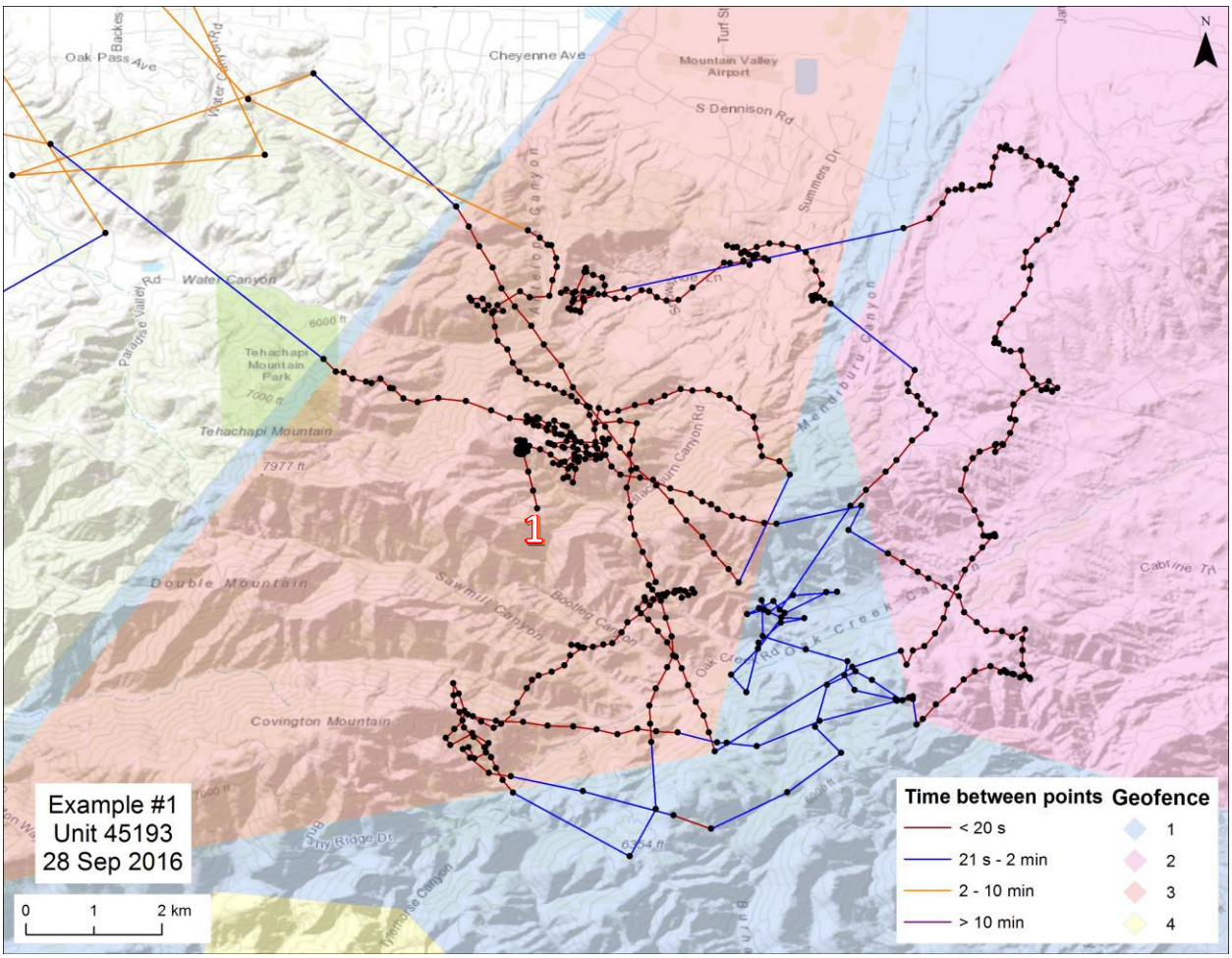


Geofence- Test Detail. This map shows the modified geofence. The orange area was added and the north geofence removed. This was done to generate more test data from where we observed the condors spending more time.

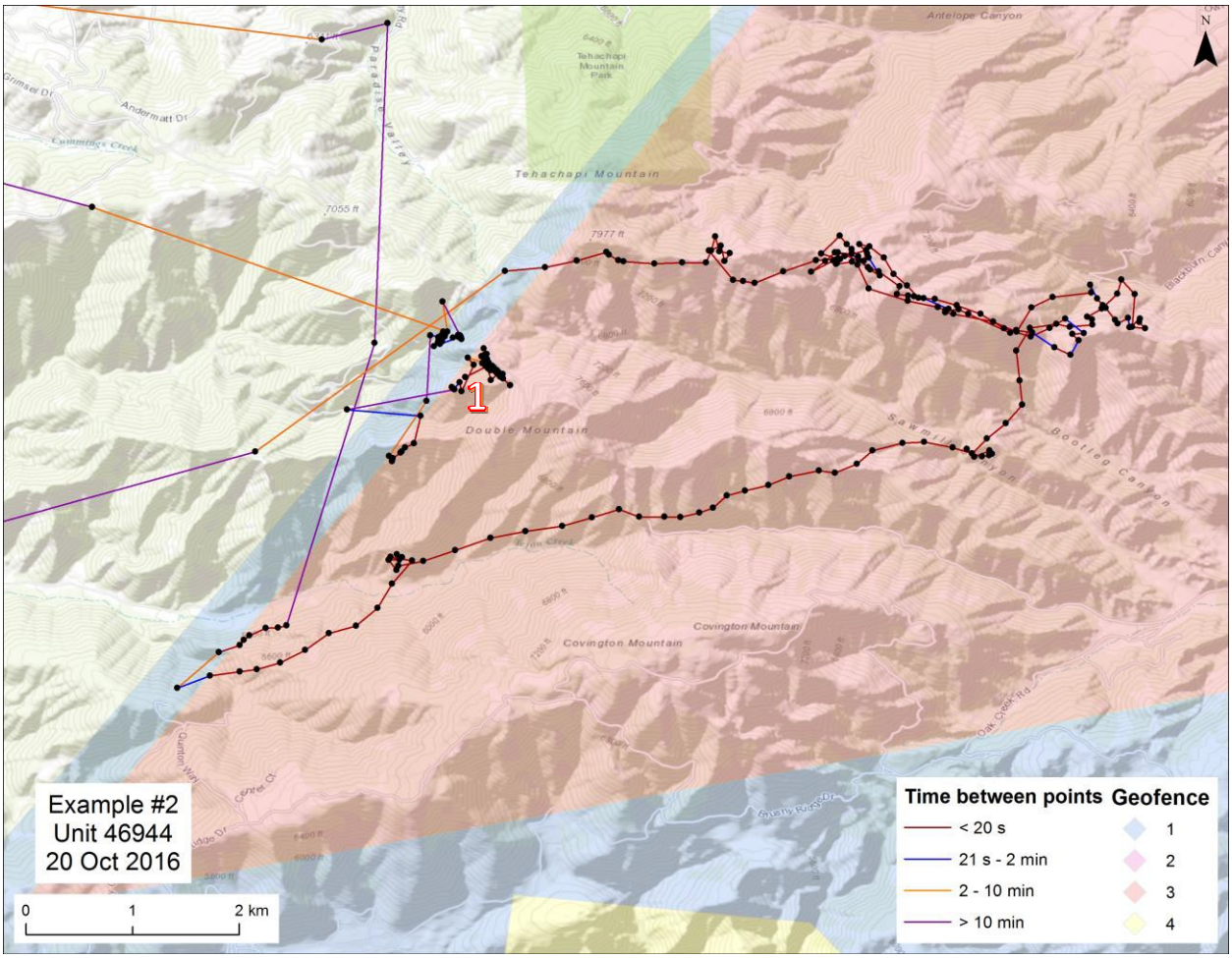


Example 1. First notice the geofence areas. Outside the geofence is 10 minute mode. Inside the blue is 60 seconds. Inside the yellow, orange, and pink is 15 seconds. Note the scale referenced in legend is the actual time between fixes within the geofence. Although the majority of fixes are at the fix interval programmed, the calculated takes into account other factors like GSM connections and time to switch within the geofence boundaries.

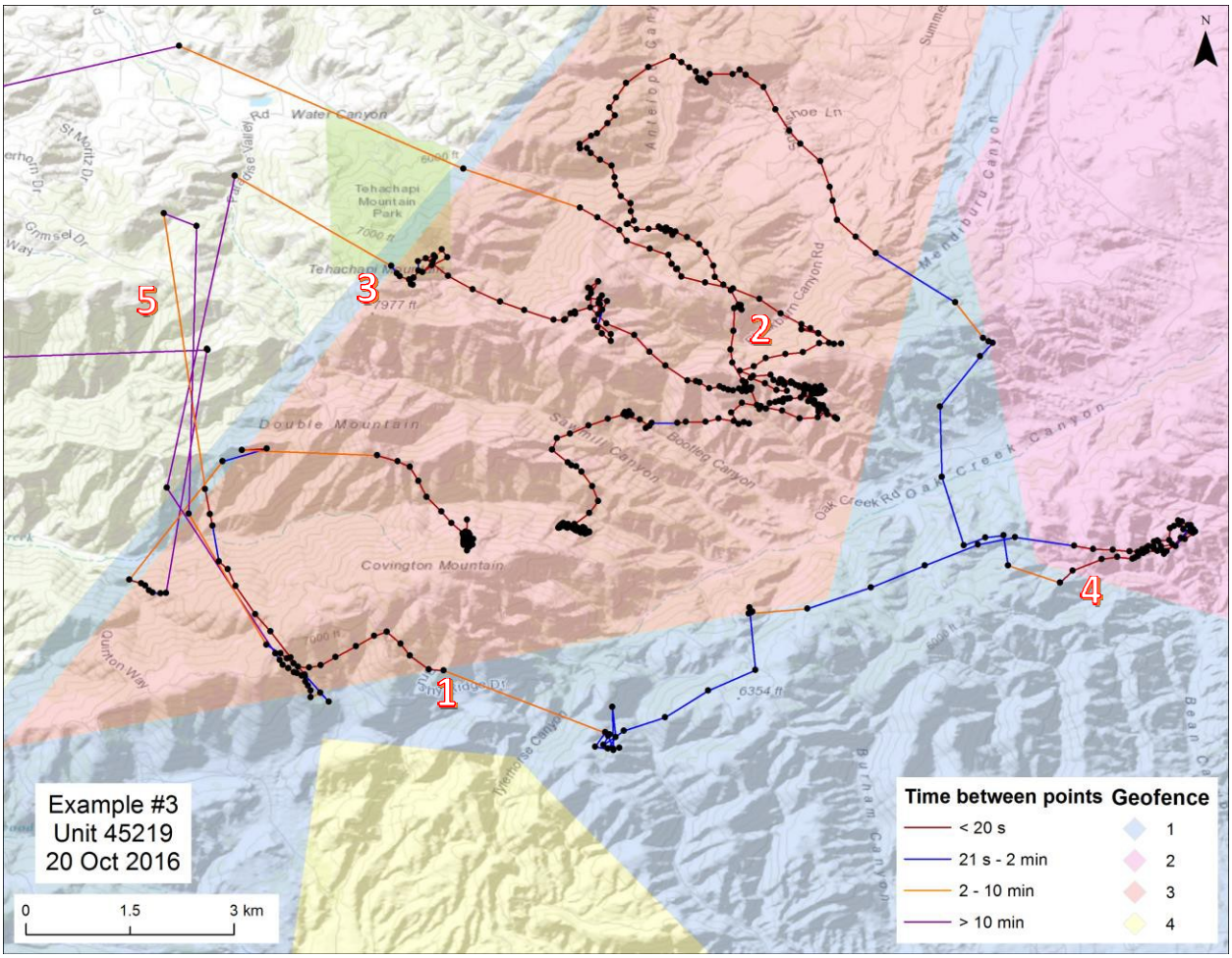
This data is from Unit 45193 on 28 September 2016. Data in this clip starts after a long time inside of the orange geofence. Look for the unconnected dots in center of orange geofence on upper reaches of Blackburn Canyon (1 below). This unit is in 15 second mode until it crosses into Blue and then immediately outside the geofence over Tehachapi Mountain Park, where it sends, then goes back into 10min mode. The condor then circles around and enters the geofence again along orange line top left. It senses it is in the orange geofence on its normal 10 minute fix. It immediately sends then goes into 15 second mode until it enters the blue geofence. As soon as it crosses into blue it triggers another GSM connection. When the GSM connection terminates it is again in the orange, so it goes back into 15s mode. It continues until it goes into the blue at which time it does a GSM connection and then goes into 60 second mode. This condor goes back and forth several times between 60second blue and 15 second orange and pink areas, each time note it senses the change and switches between modes, and each time it enters a geofence the unit will transmit data and send a notification. This continues until it again exits blue geofence, transmits a final time and switches to 10min mode.



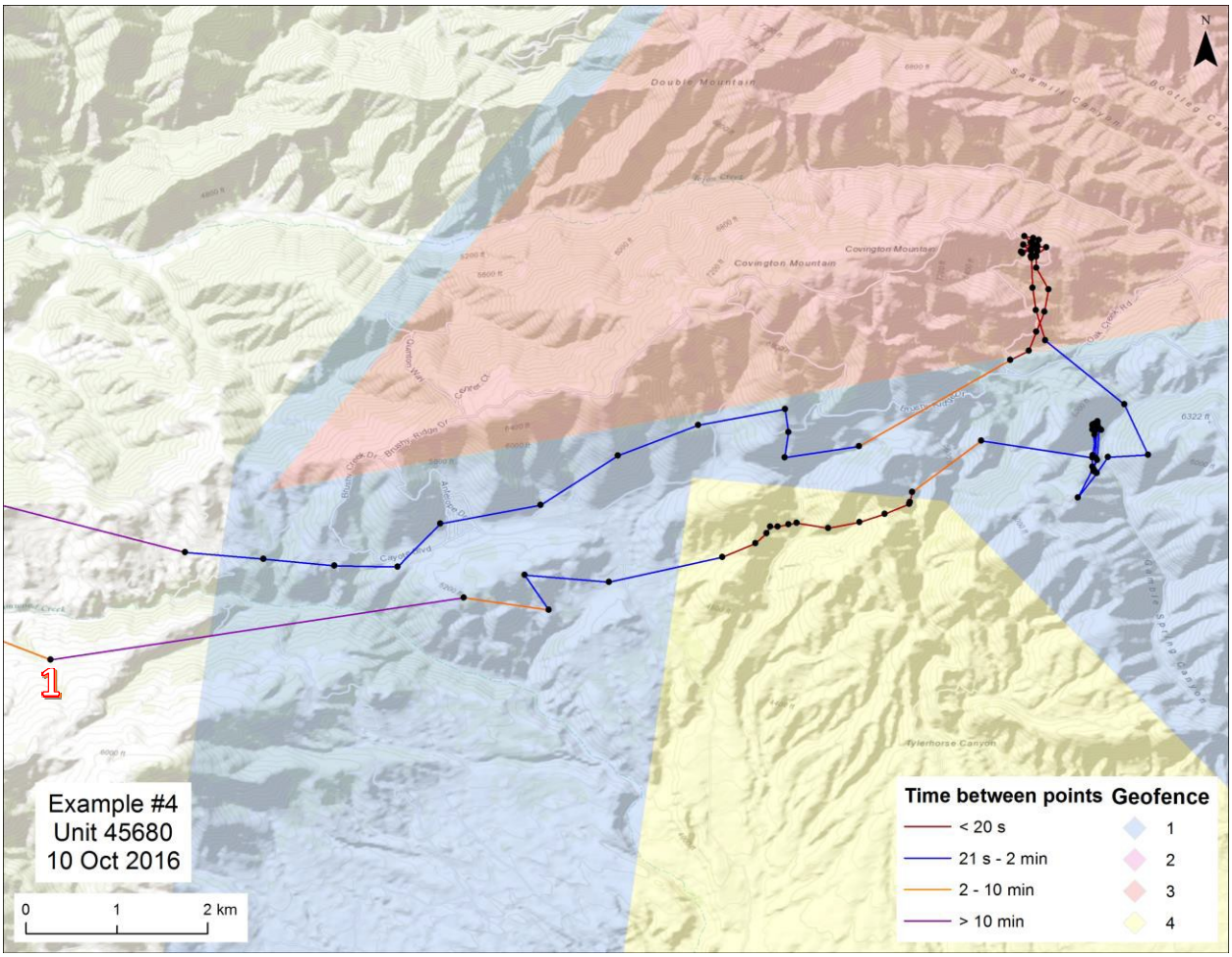
Example 2. On October 20 2016, condor 46944 was inside the orange geofence near Double Mountain. It crossed into the blue geofence, did a GSM connection and left the geofence briefly before crossing back in to orange, each time it entered a geofence it transmitted briefly. It then crosses into blue and just outside of Geofence for several fixes. It makes a big loop outside the geofences and comes back into the bottom part of the orange geofence. It stays in the orange and in 5 second mode for quite a while before crossing into blue and then out of the geofence where it switched to 10min. Note, each time 6944 entered a geofence it transmits data/pushes a notification.



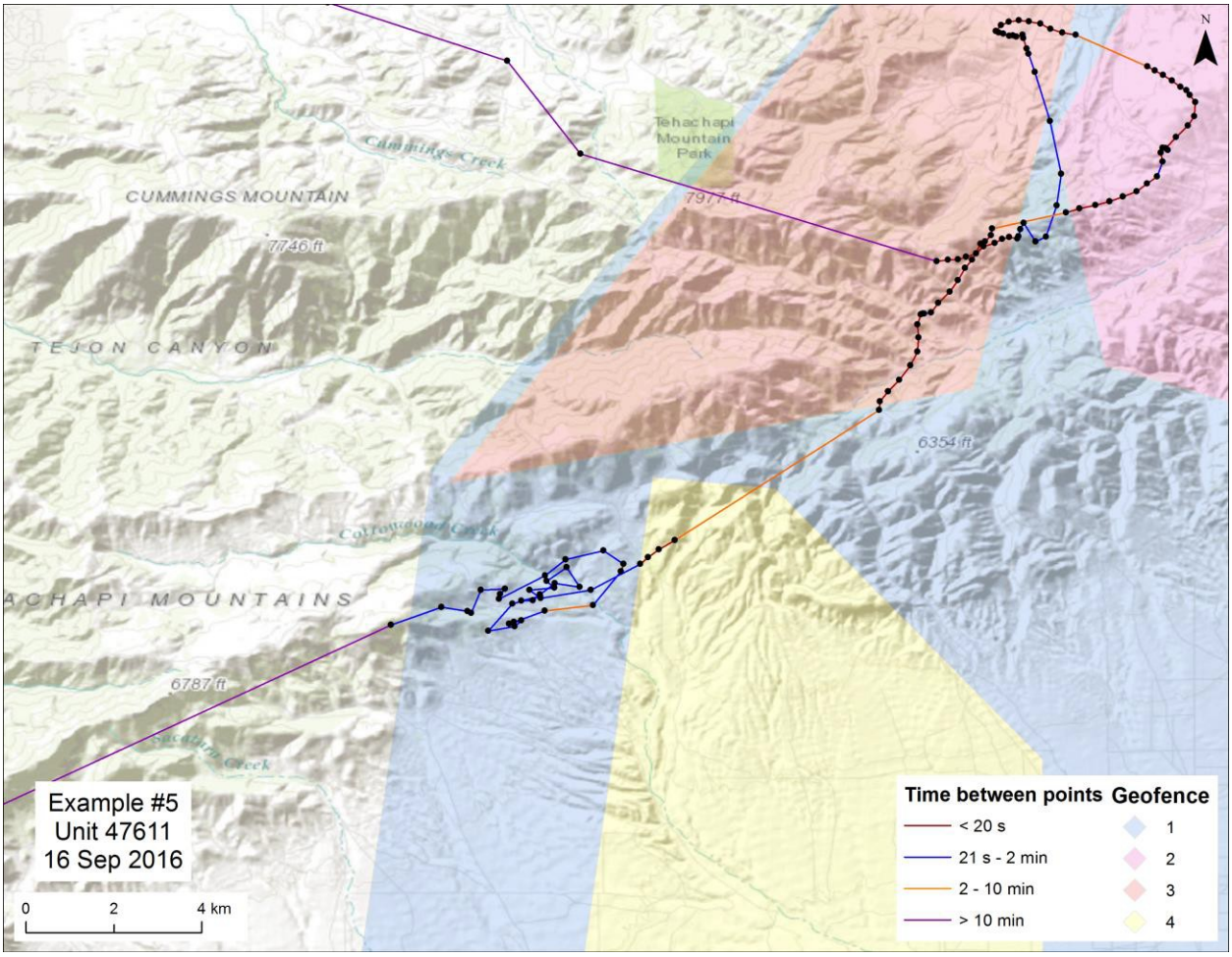
Example 3. Condor 45219 on 20 October 2016 illustrates well the different geofence areas and the data collection in each. For this example we want to explain what is happening on a case by case basis, each with a number on the figure below. Case number 1 shows a GSM connection. When entering the blue geofence, a GSM connection is triggered, and at the termination of GSM connection it starts collecting 60 second data below and to the right. Case 2 shows the bulk of the data collection in this figure, 5 second data. #3 shows the unit coming out of the geofence and going back into 10 minute mode. #4 shows the unit going from 60 second mode back into the interior pink 15 second geofence and then back to the 60 second duty cycle. #5 shows the 10 minute duty cycle outside the geofences.



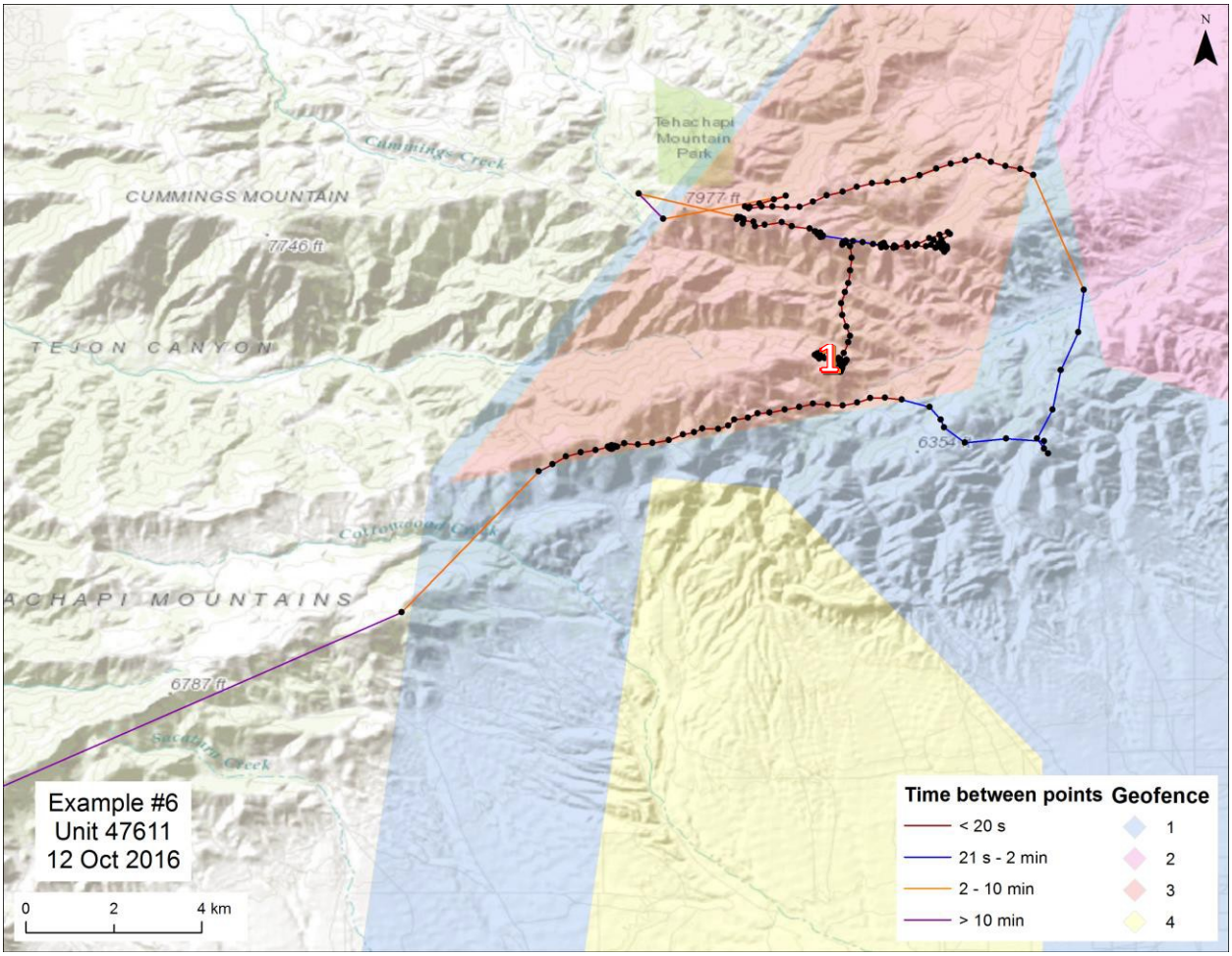
Example 4. This is a short track of condor 45680 on 10 October. This condor enters the geofence on the bottom left at #1 below. When it turns on at its scheduled 10min fix it detects it entered the geofence, transmits data and then immediately goes into 60 second mode. When it crosses into yellow, it briefly transmits data, then goes into 15 second mode before entering blue, transmitting again and then switching back into 60 second mode. It continues until entering orange geofence at which time it goes into 15 second mode till it crosses back into blue and connects to GSM again. Upon termination of GSM send, it is in the blue geofence and it goes back into 60 second mode until it exits blue, transmits the final time and returns to 10 minute mode.



Example 5. This is data from Condor 47611 on 16 September 2016 and shows the unit going between several of the geofences. This condor enters the geofence from the top left and crosses into the blue and then orange geofence. The unit operating in 10min mode outside of the geofence enters orange area before it turns on to take its normal 10 min fix (counted from after fix before entering geofence) it detects it's in the geofence, does a GSM transmission, then changes data collection to 15 seconds. It then goes into the blue geofence, transmits briefly, and changes within the duty cycle parameters (orange = 15s) to 60 sec. It stays in this mode until it again enters the orange. The duty cycle change is apparent, and that 15s mode continues until it enters the thin blue slice. At this point the program tell the unit to send again. Upon GSM termination it detects it's in the pink geofence and again switches to 15s mode until it enters blue again at which point it sends. Again the same thing happens through orange geofence till it hits blue and transmits. When GSM terminates bird was in the yellow geofence and starts collecting 15s. It exits and transmits again before going into 1min mode in the blue at which point it stays in that mode until it exits the geofence area, transmits again and then goes back to 10min mode.



Example 6. In this last example condor 47611 was in the center of the orange 15 second geofence near #1 below. It flew out and back in again through 2 geofence lines, triggering a GSM connection each time. It was then in the orange geofence collecting data at 15 seconds before crossing into the blue 60 second geofence, triggering a GSM connection before collecting data at 60 seconds. About 15 minutes later it crossed back into the orange geofence where it went back into 15 second mode before crossing back into the blue geofence, performing GSM connection, and then leaving geofence where it transmitted for the last time.



Appendix III: Flyer provided to residents where condor habituation is a concern.

CALIFORNIA CONDORS OBSERVED NEARBY

An unforeseen hurdle in the reintroduction of California condors is undesirable behaviors related to condors coming into close proximity with human structures and humans. Residential areas and other development (e.g. power poles or antennae arrays) have caused serious injury to condors. Condors can ingest small items around homes and feed them to their chicks; this can cause starvation, stunted growth, and death. Condors that come in close proximity to humans are also at risk of becoming "habituated" resulting in subsequent removal from the wild. In addition to the risks to condors, there is also a high potential for property damage due to condors' curious nature and sharp, powerful beaks.

Condors can engage in these behaviors for a variety of reasons, including attraction to nearby food or water sources or use of structures in close proximity to roosting habitat. The landscape in your area contains habitat conducive to condor foraging and roosting. Condors have historically used this area and have recolonized the area since their release back into the wild.

Please assist us in keeping condors and residents' property out of harm's way.

IF YOU SEE A CONDOR:

- **Record wing tag # and color whenever possible**
- **Do not approach or feed condors**
- **Contact the USFWS California Condor Recovery Program at (805) 644-5185**
-

California condors are an endangered species and are protected by state and federal law. HOWEVER, that does not mean that residents are helpless in trying to keep condors from perching on their homes and causing damage. It simply means that no one is permitted to harm or kill California condors.

Please see backside of flyer for information on condor deterrents and actions.

EFFECTIVE CONDOR DETERRENTS AND ACTIONS:

- **Scarecrow motion-activated animal deterrent (most effective method available) http://www.contech-inc.com/products/home-and-garden-products/animal-repellents/scarecrow-motion-activated-animal-deterrent**
- **Removing attractants (e.g. open trash and recyclable containers, wires, seat cushions, drinkable water sources)**
- **Constructing barriers to vulnerable property that is not able to be moved (e.g. barriers to AC unit wires, metal conduit around exposed wires, protective caps around insulation on outside water spouts)**
- **Immediate response by homeowners in scaring visiting condors away (e.g. spraying water, owning outdoor dogs, yelling/clapping/loud noises)**

UNTESTED DETERRENTS THAT MAY BE EFFECTIVE:

- **Electric track/electric strip tape (http://www.birdbgone.com/products/electric-track.html ; http://www.birdbarrier.com/products/bird-shock-flex-track/ ; http://www.nixalite.com/shocktape.aspx)**
- **Avian Control Bird Repellent Spray (http://solveyourbirdproblems.com/)**
- **Rollers for deck railings and ledges (http://coyoteroller.com/)**
- **Avian anti-perching spikes (http://www.nixalite.com/Nixalitemodels.aspx#Premium_Model_S)**
- **Artificial effigies (http://www.hankenimports.com/artificial-animals/93-15-inch-artificial-heads-up-vulture.html)**
- **Gull sweep/daddi long legs (http://www.gullsweep.com/index.html ; http://www.birdbusters.com/pigeon_control_repellent.html)**

*** The following list does not imply endorsement of any of these products by the USFWS. It is simply a list of options.**

U.S. Fish & Wildlife Service

California Condor Recovery Program

2493-A Portola Rd.

Ventura, CA 93003

(805) 644-5185