

Pinnacles National Park California Condor Reestablishment Program Annual Report 2021



Pinnacles National Park Report
Submitted to US Fish and Wildlife Service
Endangered Species Recovery Permit TE157291-2

Prepared by:

Alacia Welch, Condor Program Manager

Rose Fielding, Condor Field Crew Leader

Daniel Ryan, Invasive Wildlife Biologist/Non-Lead Ammunition Specialist

National Park Service

Pinnacles National Park

5000 East Entrance Road

Paicines, CA 95043

Submitted to USFWS January 31, 2022

ALACIA
WELCH

Digitally signed by

ALACIA WELCH

Date: 2022.01.31

11:19:02 -08'00'

Alacia Welch, Condor Program Manager

Cover photo: *Condor 589 landing on rock at Pinnacles National Park.*
NPS Photo by Gavin Emmons.

Please cite this publication as:

Welch, A., et al. 2022. Pinnacles National Park California Condor Reestablishment Program – Annual Report 2021. Pinnacles National Park, National Park Service, Paicines, California.

Table of Contents

ACKNOWLEDGEMENTS.....	1
INTRODUCTION.....	2
METHODS.....	2
Population Monitoring.....	2
Survival Monitoring.....	3
Trapping	4
Nest Monitoring and Reproduction.....	5
Baiting	6
Remote Monitoring.....	6
Non-proffered Food	6
Monitoring Captive Condors.....	6
Missing Birds	7
Management.....	7
Lead Sampling	8
Veterinary care	8
Vaccinations	8
Hazing.....	9
Personnel	9
Collaborative Research	9
Outreach	9
RESULTS.....	11
Population Monitoring.....	11
Survival Monitoring.....	11
Trapping	14
Nest Monitoring and Reproduction.....	14
Baiting	17
Remote Monitoring.....	17
Non-proffered Food	17
Captive-reared Releases	17

Missing Birds	17
Management.....	18
Lead Sampling	18
Veterinary Care	18
Vaccination.....	20
Hazing.....	20
Personnel	21
Collaborative Research	21
Population Viability Analysis (PVA).....	21
Protect Condors Using New, Cost-Effective Methods	21
Chelation Treatment Impacts on Short-term Survival.....	22
Rodenticide Exposure	22
Condor Range and Movements Research	22
Outreach	22
NPS Education and Interpretation by Condor Program Staff	23
Focused Non-lead Ammunition Outreach	23
RECOMMENDATIONS	24
Monitoring	24
Management.....	25
Research.....	25
Outreach	25
Recovery Planning and Multi-agency Coordination	26
Appendix A – Public Interest Highlights.....	27
Appendix B – Condor Mortality of Central California Condors, 2001-2021	28
Appendix C – Radiograph and Chelation Summary of Pinnacles-Managed Condors, 2021.....	33
Appendix D – Scientific Publications with Pinnacles Co-authorships.....	35

ACKNOWLEDGEMENTS

We are thankful to the many collaborators and partners who support our work to restore the iconic California condor. We gratefully recognize Ventana Wildlife Society, not only as the founder of the Pinnacles National Park condor release site, but as our primary partner in the management of condors in central California. We also thank our agency partners at US Fish and Wildlife Service, California Department of Fish and Wildlife, Bureau of Land Management, and US Forest Service for their support. We truly appreciate the wonderful care provided by veterinarians and staff at Oakland Zoo, Los Angeles Zoo and the Avian and Exotic Clinic of the Monterey Peninsula. We appreciate our partners at Institute for Wildlife Studies, The Peregrine Fund, Oregon Zoo, and Ventana Wildlife Society for collaborating on nonlead outreach. We gratefully acknowledge all who support condor research, including UC Santa Cruz, Montana State University, Colorado State University, US Geological Survey, and NPS Biological Resources Division. We greatly appreciate all divisions at Pinnacles for supporting our operations throughout the year. We also thank Conservation Legacy and American Conservation Experience for partnering with us to provide internship opportunities for aspiring naturalists. The release of captive-reared condors would not be possible without the exhaustive efforts of the Los Angeles Zoo, San Diego Zoo, Oregon Zoo, and The Peregrine Fund. We give special thanks to the Amah Mutsun Tribal Band for ceremonial prayers. Capturing condors would not be possible without the organic dairy farmers that generously provide carcasses to use as bait. We also thank LightHawk for their time flying condors between sites and searching for missing condors. Finally, we cannot thank our volunteers and interns enough for their amazing dedication and willingness to adapt to rapidly changing guidance as we navigated a pandemic.

Volunteers

Rakesh Agarwal, Mike Baird, Joseph Belli, Ashley Bouchahine, Dan Brogden, Denise Lopez, Jen Nagel, Sean and Sarah Parnell, Bob Quaid, Jeff Robinson, Mike Zeiss, and Darryl Zimmerman

Interns

Dan Brogden, Stacy Lammers, Kaitlin Lopez, Sarah Marquez, and Danaé Mouton

NPS Staff

Alacia Welch – Program Manager

Rose Fielding – Field Crew Leader

Erin Lehnert – Field Crew Leader (started in December)

Dan Ryan – Invasive Wildlife Biologist/Non-Lead Ammunition Specialist

Gavin Emmons – Raptor/Condor Biologist

INTRODUCTION

California condors are one of the rarest bird species in the world and biologists have been committed to their recovery for over 50 years. The Condor Reestablishment Program at Pinnacles National Park (PNP or “Pinnacles”) has several objectives with the ultimate goal of species recovery in the wild:

- monitoring central California condor population trends by documenting foraging, movements, nesting, and reproduction
- detecting mortalities and recovering condor carcasses to determine cause of death
- mitigating threats to condors
- increasing public awareness of threats to condors
- conducting cooperative research to aid condor recovery

Together with Ventana Wildlife Society (VWS), PNP manages a flock of 91 condors in central California. During 2021, PNP monitored all birds using the central California area, as well as PNP-managed condors that traveled beyond their typical range. PNP-managed condors and VWS-managed condors make up a single flock, overlap in range, feed together, and are captured at release sites managed by both organizations. This report focuses on PNP Condor Program management of birds released from the park but also includes some VWS-managed condor data, courtesy of VWS. Items of particular interest from the year are highlighted in Appendix A.

Many measures implemented in response to the COVID-19 pandemic continued in 2021. All field and office activities were modified to reduce transmission of COVID between crew members. Staff wore personal protective equipment (PPE) for all activities when multiple people were in close proximity, including face coverings or KN95 masks in addition to other PPE. With these measures in place, the PNP Condor Program successfully mitigated the risks of transmitting COVID-19 between staff while also balancing the requirements of managing critically endangered California condors.

METHODS

Population Monitoring

Condors are monitored year-round to document reproduction, mortality, and movements. Condor health, foraging, interactions, and breeding behavior are monitored through visual observations. Biologists use standard equipment to radio-track and locate condors and a

detailed equipment list is available in: *Pinnacles National Park California Condor Reestablishment – Annual Report 2013. Pinnacles National Park, National Park Service, Paicines, California. Pp. 20.*

Survival Monitoring

Pinnacles biologists monitor most condors using radio transmitters and GPS transceivers, or “GPS tags” (Figure 1). Radio transmitters are detected in the field with an antenna and handheld receiver while GPS tag data is reviewed in an office. Argos satellite GPS data are downloaded from Woods Hole Group and mapped in ESRI ArcMap version 10.6. Pinnacles also deploys GSM (cellular technology) GPS tags manufactured by Microwave Telemetry (MT) and Cellular Tracking Technologies (CTT). Data from MT and CTT GSM tags are received when a tagged condor flies within range of a cellular tower during a set time frame each day. Location data from all types of GPS tags are available to PNP staff through Movebank’s online interface and an online database called CACO Central. Biologists use ArcGIS and Google Earth to map and view all condor location data daily. Pinnacles uses a greater proportion of Argos satellite tags compared to GSM tags due to poor cellular coverage in the central California condor range.



Figure 1, Condor 840 with ATS radio transmitter visible on right wing and CTT GPS tag on left wing. NPS Photo by Gavin Emmons.

Radio tracking within and around PNP is conducted five to seven days per week. Biologists track at higher elevations to increase probability of detecting signals. Monitoring outside of the park is conducted along public roads in San Benito County, portions of western Fresno County, northern San Luis Obispo County, and eastern to southern Monterey County. All field data is recorded in Microsoft Access databases. Additionally, summary data of daily monitoring activities are entered into a secure online database called CACO Central that can be shared with research and agency cooperators.

Biologists closely monitor any condor behaving abnormally and any bird with a GPS tag that does not move in over 48 hours to determine if the individual is injured or sick. When a mortality signal (triggered by a radio transmitter that is immobile for at least four to ten hours, depending on manufacturer) is detected, biologists immediately attempt to locate the transmitter to confirm a dropped tag or a sick or deceased condor. This activity takes priority above most others to maximize the chance of treating a sick or injured bird or retrieving a carcass before it decomposes significantly. Pinnacles biologists follow condor carcass collection procedures developed by US Fish and Wildlife Service (USFWS).

Trapping

Pinnacles staff capture condors to measure blood lead levels, replace transmitters, and collect blood and feather samples for ongoing research studies. Trapping condors is critical to maintain vinyl identification tags and functioning radio transmitters and GPS tags on as many individuals as possible.

Before handling condors, biologists receive extensive training in handling protocols, sample collection methods, and processing birds from highly experienced LA Zookeepers and PNP staff already listed on PNP's USFWS recovery permit as approved handlers. PPE during handling includes eye protection, long-sleeved shirts and pants, closed-toe boots, and leather and nitrile gloves (Figure 2). Due to the ongoing threat of COVID-19, crew members wear face coverings, KN95, or N95 masks in addition to regular PPE.

All data related to each condor handling is recorded in a Microsoft Access database and entered in CACO Central.



Figure 2, Crew member, Erin Lehnert, holding Condor 828 with new transmitter and vinyl tag. NPS Photo by Rose Fielding.

Nest Monitoring and Reproduction

Pinnacles and VWS manage nests based on geographic location and ease of monitoring as opposed to who manages the adult condors. In general, nests east of the Salinas Valley are managed by PNP while VWS manages those to the west.

Biologists monitor active nest sites from observation points located 300-800 meters from the nest depending on topography. They look for egg incubation, hatching, nestling health, behavioral interactions, adult-nestling feeding events, and fledging of young. Where feasible, biologists



Figure 3, Crew member, Rose Fielding, descends to a nest while Condor 340 opens his wings behind her. NPS Photo by Gavin Emmons.

enter active nests following standard procedures for nestling health checks, conducted at 45-60 and 120 days of age (Figure 3). Access to nests on private property, nest location, parent and nestling behavior or health, and staff capacity may result in changes to planned nest entries to ensure safety for the field crew as well as the condors.

During nest entries, PPE includes all appropriate climbing equipment, eye protection, respirators, and leather and nitrile gloves. Biologists and/or a veterinarian check a nestling's blood lead level, general health, and administer a West Nile Virus vaccination. If a nestling has high lead exposure, it may be evacuated from the nest for emergency care or monitored more closely. Biologists search nest substrates for eggshell fragments and trash, which are removed when found. Annual nest entry trainings are conducted at PNP and additional technical ropes trainings occur year-round to maintain staff experience with relevant technical skills.

Biologists install remote video cameras in suitable nests when possible. Factors determining suitability include nest location, level of risk to access the nest, whether the nest interior can be viewed from a distant observation point, landowner permission, and site topography. Biologists follow an installation design and method developed by the USFWS Condor Program. After

locating a nest site, they enter the nest for an egg fertility check and install a video camera. They set up a solar panel and battery within a hundred meters of the nest and connect to the video camera secured inside or next to the nest. A microwave antenna is also powered by the solar system and transmits the video signal to a receiving antenna with a direct line to a computer running video recording software. This software allows live viewing as well as the ability to review recordings up to five days old. Nest video cameras greatly increase the number of hours of nest observations, enhance the quality of observations, and reduce the amount of time field biologists spend hiking to remote nests. The cameras allow biologists to observe nestling health, nestling-parent interactions and other important events that would otherwise not be observed.

Baiting

Biologists primarily use calf carcasses acquired from organic dairies as food for captive and free-flying condors. Carcasses are placed approximately twice per week at one or two established bait stations in the park. Other carcass types may also be placed after they are radiographed to ensure they contain no foreign or metallic objects, such as spent ammunition. Bait stations are in an area of the park closed to the public with one at the captive pen and a second on a hilltop. Safety protocols for baiting traps and stations require proper PPE, four-wheel drive training, and placement of carcasses by at least two people. Carcasses are placed at night to minimize interactions with condors and association with humans as food suppliers.

Remote Monitoring

Remote video cameras stationed at the captive pen and Hilltop bait site record during daylight hours, allowing biologists to perform physical checks on individual birds, observe condor interactions, and document feeding patterns. Memory cards from motion-triggered remote cameras are replaced weekly and the photographs are reviewed for presence of birds and predators. Photos and video recordings allow biologists to track the general condition of condors and document those without functioning transmitters.

Non-proffered Food

Non-proffered food is any carcass not placed for condors at pre-established bait sites by PNP or VWS staff. When condors are observed feeding on non-proffered food, biologists identify the carcass species if possible. Observing condors feeding on private land from public roads is often limited and biologists are rarely able to identify carcass species. Landowners are contacted about a carcass on their property only when there is a specific concern.

Monitoring Captive Condors

Condors are held at PNP's captive pen as needed for flock management. Biologists monitor condor health and interactions while in captivity (Figure 4). Power poles outfitted with wire laid



Figure 4, PNP condor pen with six captive condors perched inside and one free-flying condor perched on top. NPS Photo by Gavin Emmons.

Missing Birds

When a condor goes undetected via visual observation, radio signals, camera/video images, and GPS data for over a week, monitoring efforts increase by extending the radio-tracking search area and using aerial telemetry flights through partner organizations or contractors. Following USFWS guidance, missing birds not detected for 12 months are considered dead and are removed from the population total. Other factors, such as breeding status or suggestive information like detection of a mortality signal, may allow certain missing birds to be classified as dead prior to 12 months.

Management

The main threat to condors in central California is lead exposure from spent ammunition fragments in scavenged carcasses. Other risk factors include, but are not limited to, electrocution from perching on power poles or flying into power lines, drowning in open water tanks, microtrash consumption, West Nile Virus, and direct human interactions. Pinnacles biologists manage condors to reduce the impacts of these risks.

Lead Sampling

From 2008-2012, both PNP and VWS attempted to capture all birds twice per year for a research study evaluating condor lead levels. When the study concluded, trapping objectives changed to catching all condors at least once per year. In 2020, trapping efforts were reduced even further due to COVID-19 protocols and the loss of the VWS pen in Big Sur from the Dolan Fire. In 2021, PNP returned to the goal of trapping all PNP-managed condors annually and VWS condors as directed by their staff.

Trapping condors allows for tag and transmitter maintenance as well as managing risk factors that affect condor survival. Biologists take blood samples to determine blood lead levels each time a bird is captured from the wild. LeadCare Analyzers, suitable for field use, are used to obtain immediate results that determine whether a condor requires treatment for high blood lead levels. The threshold used to initiate chelation treatment is a blood lead value of 35 µg/dL or greater. Condors with elevated blood lead levels on a LeadCare II Analyzer are radiographed in the park's Condor Care Unit (CCU), at zoos, or clinics to help inform treatment needs. Birds with possible metallic densities in their gastrointestinal systems, or those with blood lead levels >65 µg/dL, are transported to the Oakland or LA Zoos for treatment. Condors with clear radiographs and blood lead levels between 35-65 µg/dL are treated at PNP when there is sufficient staff capacity to care for birds daily, otherwise they are transferred to zoos for care. In addition, condors with clear radiographs and blood lead levels between 25 and 35 µg/dL may be monitored for two weeks in the PNP captive pen for an internal lead depuration study.

For VWS-managed condors, treatment of lead exposure is initiated if clinical signs are observed in the bird prior to or during handling. Blood samples are not analyzed in the field, unless requested by VWS staff, but are shipped to a lab for analysis. Pinnacles biologists have approval from NPS Biological Resources Division (BRD) staff on their Institutional Animal Care and Use Committee (IACUC) permit to allow VWS treatment protocols to be applied when VWS-managed condors are trapped in the park.

Veterinary care

Pinnacles biologists are permitted to conduct basic first aid for superficial wounds discovered during handling. Any treatment requiring veterinary care is conducted by or under the guidance of a licensed veterinarian in the field, at a clinic, or at a zoo.

Vaccinations

Captured condors receive West Nile Virus vaccinations and boosters on a schedule provided by veterinarians. In 2021, the schedule remained the same as recent years, with a goal of vaccinating 100% of the flock on an annual basis and giving nestlings a minimum of two shots

spaced at least 30 days apart while still in the nest. This schedule was followed for all captured birds and for nestlings where nest entries were possible.

Hazing

Hazing may be needed when condors endanger themselves by approaching humans or landing on human infrastructure. Hazing methods vary depending on location and include clapping and running, clapping wood blocks together, spraying water, using air horns, and throwing pebbles near a condor.

Personnel

Implementing a long-term endangered species recovery program requires consistent staff capacity with highly trained, experienced biologists. The current program structure includes a program manager, two field crew leaders, an intern fellow, and two interns, all working full-time and year-round. An additional wildlife biologist works with the program full-time for six months per year and PNP's invasive animal biologist works throughout the year with half his time dedicated to non-lead outreach. In 2021, one of the field crew leader positions was vacant January- November.

Volunteers provide vital program support and receive extensive training prior to assisting in the field. Volunteers are asked to make a year-long commitment to the program for a minimum of two days per month. Volunteers assist in radio tracking, field observations, and a wide variety of logistical tasks that support management of the species.

Collaborative Research

In 2021, PNP continued to work closely with researchers at Montana State University (MSU) on a population viability and management analysis and the University of California at Santa Cruz (UCSC) to measure condor responses to environmental risk factors. Pinnacles also partnered with US Geological Survey (USGS) to study potential impacts of rodenticides on condors and provided data to Colorado State University (CSU) for a research study assessing habitat risks.

Outreach

The PNP Condor Program defines outreach as any activity that provides an opportunity for greater understanding of a particular resource or issue. Activities include, but are not limited to: promoting awareness, presenting information, and building partnerships through education. Outreach to surrounding communities and those affected by conservation actions on public lands provide an opportunity for greater trust and cooperation between PNP and local residents. Building a foundation of trust and cooperation can lead to partnerships, with the goal to steward natural resources together.

Outreach fosters communication and understanding of the needs and concerns beyond the park boundary and creates opportunities to realize aspects of natural resource conservation that have not been previously considered. These opportunities assist immediate and long-term efforts, whether they are related to condor recovery, the use of non-lead ammunition, or any community conservation effort.

As lead exposure in wild condors continues to be the primary obstacle to recovery, PNP Condor Program staff prioritize outreach with broader, multi-regional NPS staff, other land-management agencies, local landowners, ranchers, hunters, and the general public about the impacts of spent lead ammunition to scavenging wildlife (Figure 5). Pinnacles dedicates half the time of one biologist to conduct outreach and work



Figure 5, An example of a nonlead outreach booth. NPS photo by Daniel Ryan.

closely with the Institute for Wildlife Studies (IWS), VWS, The Peregrine Fund, Oregon Zoo, Great Basin Institute, and other partners to collaborate on outreach efforts. Additionally, during routine fieldwork, Condor Program employees, interns and volunteers speak with park visitors and local residents. Outreach is conducted in the local community, statewide, and at larger scales in coordination with other partners and NPS Regional and National staff to address the complexity of this issue, from local perceptions to nationwide non-lead ammunition availability.

Hunting and ranching operations are essential to condor recovery. These operations depend on clean water and healthy habitats to sustain livestock and game species. Condors benefit from related water resources, as well as the availability of nesting and foraging habitat. Carcasses or remains left on the land are an important food source for condors. The success of condor recovery relies on developing trust-based relationships with the hunting and ranching communities, resulting in fostered ownership of wildlife health.

Pinnacles' outreach message is focused on how condors benefit from hunting and ranching operations when non-lead ammunition is used. Pinnacles staff discuss available alternatives to lead ammunition with hunters and ranchers, as well as how to achieve the best performance from non-lead ammunition. Additionally, they communicate with other land management agency staff the benefits of reducing wildlife lead exposure from external and internal actions, and how to change internal practices. Staff also highlight the need for continued hunting and ranching with park visitors and the general public, as well as how those traditions play an important role in wildlife conservation.

RESULTS

Population Monitoring

In January 2021, PNP managed 32 of the 91 condors in central California, approximately 35% of the flock. Over the year, there were nine deaths, two captive-reared birds were released, and two condors fledged. The total number of PNP-managed condors at the end of 2021 was 27, marking the third year in a row with a net loss.

At the end of 2021, 91 condors occupied the central California region, or no net loss (Figure 6). Combined with condors managed by VWS, there were 11 nesting attempts, with eight of those including at least one PNP condor. Six nests fledged young with two managed by PNP and four by VWS.

As of December 2021, the ratio of adult males to females was skewed toward males, with 69% of the central California population male and 31% female. Adults are defined as those hatched in 2016 or earlier. This skewed sex ratio continues to be a concern because it impacts annual productivity and could be a long-term problem. Further research into mortality rates and projected future sex ratios is needed.

Survival Monitoring

Throughout the year, PNP monitored radio- and GPS-tagged condors almost daily. Condors without functioning transmitters were observed opportunistically. This year, there were 4,039 visual observations of wild condors by PNP biologists in the field and 3,479 observations seen on remote video and still cameras.

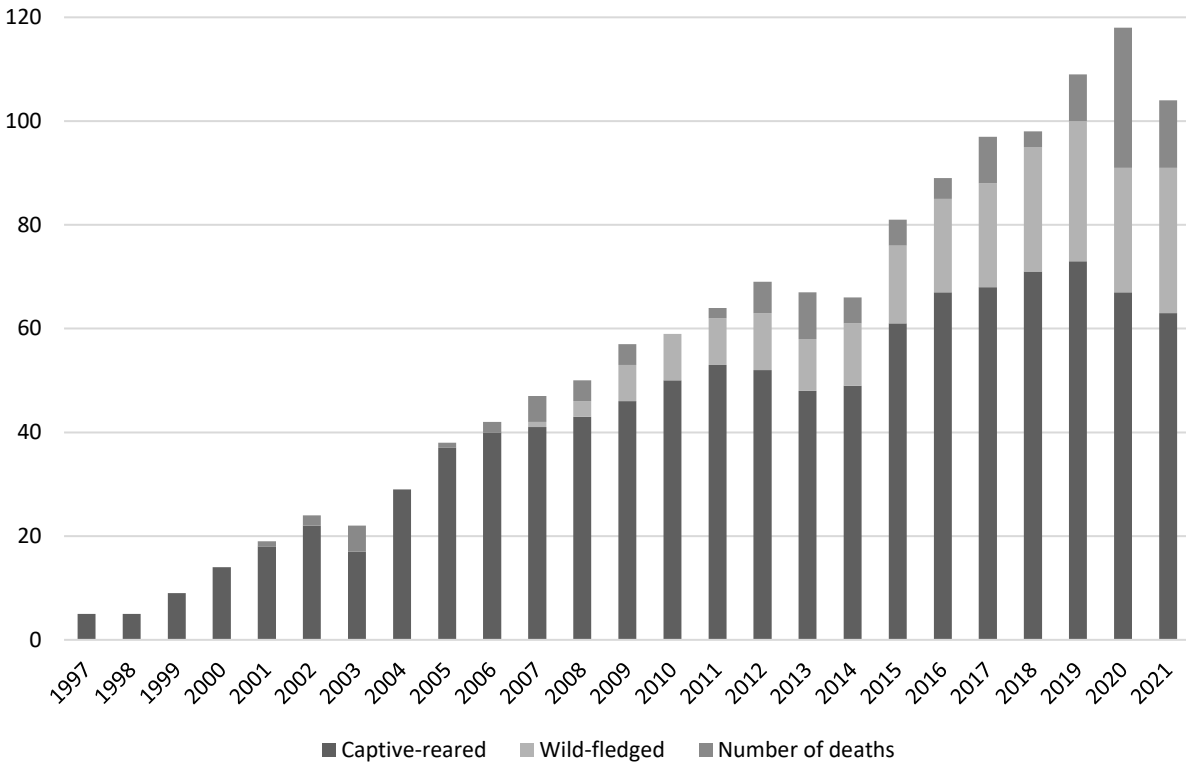


Figure 6, *Summary of wild-fledged condors, captive-reared releases, and annual number of deaths in central California from 1997-2021. Chart presents total number of condors in the wild (both wild-fledged and captive-reared) currently managed by PNP and VWS in the central California area, in addition to the number of condor deaths each year. Note that condor nestling deaths are not included. VWS data provided by J. Burnett.*

Staff used GPS tags to monitor nearly 90% of PNP-managed birds and these data often directed where staff focused efforts for a given day. Hundreds of thousands of GPS locations were downloaded from GPS tags on 30 PNP-managed condors throughout the year. Condors released by both VWS and PNP use the landscape in all directions surrounding the park as indicated by the green outline in Figure 7. This outline represents the condor range of all central CA condors with GPS tags in 2020. Because condors are social, monitoring them using GPS tags adds great efficiency to locating all released condors, including those without functioning radio transmitters or GPS tags.

In 2021, three condors ventured outside the 2020 range (Figure 7). Condor 828 flew from PNP north of Livermore toward Oakland in the East Bay Area, which may be the farthest north a condor was documented since reintroduction efforts began. Additionally, condors 943 and 986 flew over the Santa Cruz Mountains, north of Pescadero toward Half Moon Bay.

Movements of three condors that flew outside of the historic range boundary in 2021

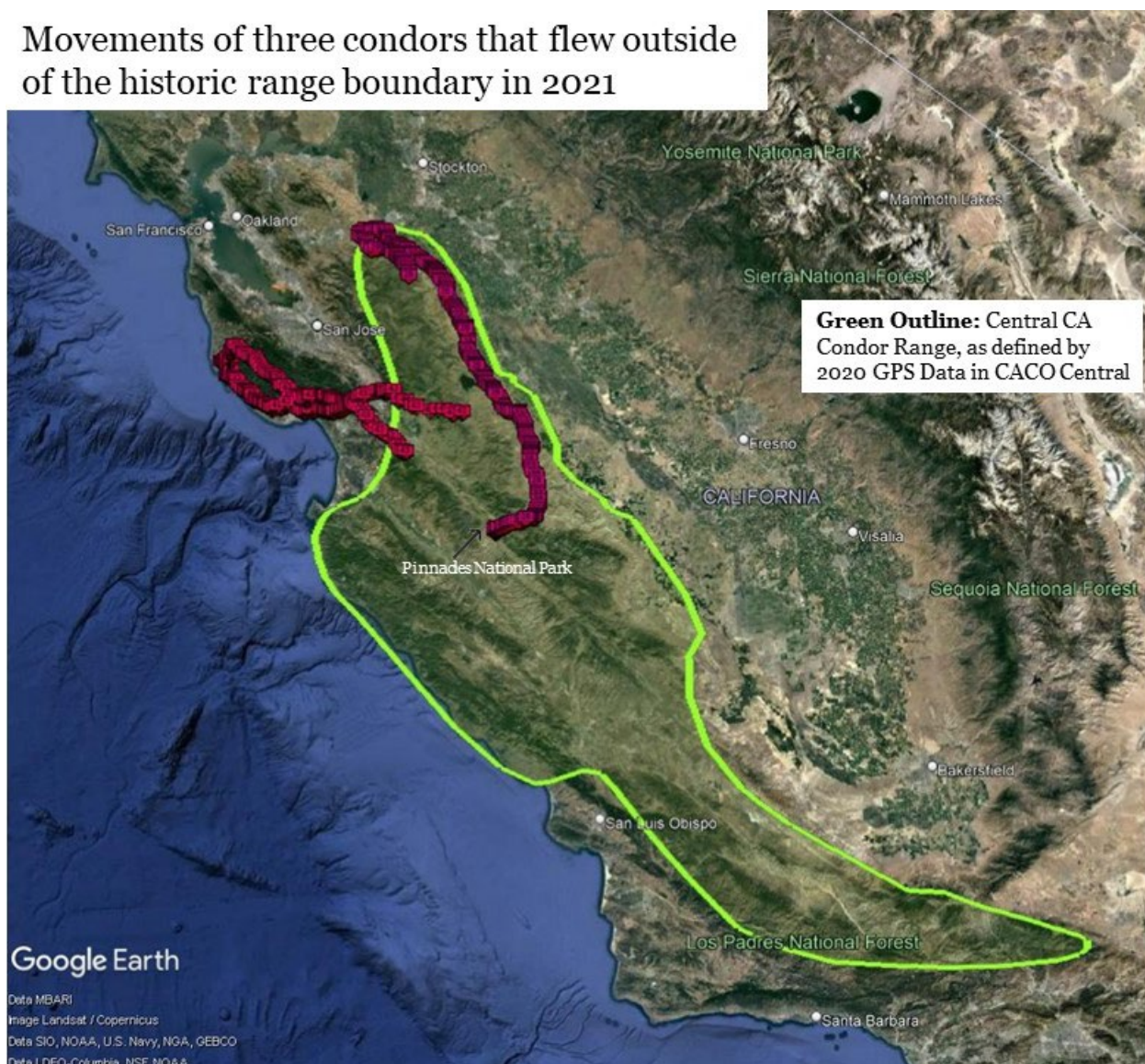


Figure 7, Flight map of condors 828, 943, and 986 with 2020 range outlined in green.

Mortality

In 2021, nine PNP-managed condors died, representing 33% of the PNP flock, the second-highest annual rate of mortality since the program began in 2003. These deaths bring the total loss of PNP-managed condors to 52 birds (Appendix B). Of the nine deaths, two condors died in captivity while undergoing treatment for acute lead toxicosis and the remaining seven were retrieved and submitted to the USFWS Forensics Lab for necropsies. A cause of death was determined for six of the seven condors that were recovered, and all were due to lead toxicosis. The final bird was found in an advanced state of decomposition and the cause of death could not be determined. One necropsy report from a condor that died in 2020 remains pending at the time of publication.

Trapping

Pinnacles returned to pre-pandemic levels of trapping effort in 2021. With the VWS pen in Big Sur out of use due to the Dolan Fire in 2020, PNP was effectively the only site operating in central California to capture condors in the region. Pinnacles staff captured 45 individual condors (not including condors handled in nests or caught in the wild) and 25 of those were PNP-managed. They spent 135 days trapping and captured 58 condors (Table 1).

Year	Total handling days ^a	Total captures ^b	Total individuals captured ^c	Person Days ^d
2017	20	45	45	150
2018	11	31	23	158
2019	27	96	50	171
2020	11	22	20	47
2021	27	58	45	135

Table 1. Five-year review of trapping effort and captures of PNP and VWS-managed condors at PNP captive pen.

^a Days that biologists initially handled any condors trapped at PNP. These include condors caught for health checks, transmitter replacements, or as non-targets. Nestling handlings at nests are not included.

^b Number of condors trapped including multiple captures of the same individual in given year.

^c Number of individual condors trapped during given year at PNP.

^d Number of days a staff member could have trapped a condor if a target condor went into the trap.

Nest Monitoring and Reproduction

In 2021, there were 11 nesting pairs or trios in central California and six fledged young, although one was unconfirmed visually at the end of the year (Table 2). Pinnacles managed five of the nesting pairs and VWS managed six. Of the PNP-managed nests, three were in the park and two were on private land in San Benito County. The two on private land were inferred by GPS tag movement patterns of one parent. Neither were confirmed visually, and, in each case, the other parent was never verified. Of five nesting attempts, two pairs successfully fledged young. The other three failed before hatch and the cause of two failures were unknown. The third egg failure was overdue to hatch, and the parents stopped incubating the egg.

Manager	Nesting Male	Nesting Female	Egg ID	Estimated Lay Date	# Nest Entries	Wild Egg Fate	Nestling Studbook	Nest Outcome
VWS	574	538	CC1021	2/4	0	Hatched	1104	Fledge
PNP	589	569	CC121	2/13	2	Hatched	1078	Fledge
VWS	663	438	CC221	2/14	0	Hatched	1077	Fledge
VWS	204	646	CC321	2/16	0	Hatched	1089	Fledge
VWS	652	550	CC421	2/21	0	Hatched	1095	Fledge
PNP	UNK	626	CC921	2/23	0	Did not hatch	--	Fail
VWS	477	190	CC521	2/26	0	Did not hatch	--	Fail
PNP	431	UNK	CC621	2/26	0	Did not hatch	--	Fail
PNP	340	236	CC721	3/8	1	Hatched	1096	Fledge
PNP	692	726	CC821	3/18	0	Did not hatch	--	Fail
VWS	566/711	725	CC1121	4/13	0	Did not hatch	--	Fail

Table 2, 2021 central California nesting summary in order by estimated lay date. VWS data provided by J. Burnett.

Pinnacles Condor Nesting Details

Pinnacles manages accessible condor nests to gain an understanding of the risks that may be present during nesting and to mitigate those risks. Management activities may include checking egg fertility, replacing infertile eggs with viable ones, performing nestling health checks, providing care or treatment to nestlings, removing microtrash within nest cavities, and installing nest cameras. Nesting results should be



Figure 8, Condor 1078 after fledging. NPS Photo by Erin Lehnert

interpreted with this in mind. In addition, each year the number of breeding-age condors varies in the central California flock, which impacts the number of nesting attempts each year.

In 2021, biologists conducted nest entries at two nests inside the park boundary. Both nests were entered to perform 45-day health checks on the nestlings. Biologists entered one nest a second time to perform a 120-day nestling health check and attach a radio transmitter. The 120-day nest entry at the other nest was canceled due to the ability of the nestling to move across a great area and likely evade capture. Both nestlings successfully fledged (Figure 8).



Figure 9, Condors 589 and 569 inspect their newly hatched nestling, 1078. Still frame from remote video camera in nest. NPS Photo.

Pinnacles used a remote video camera to monitor one nest this year, which provided important insights into nestling behavior and development. For the first time since installing nest cameras at PNP, the egg hatching was fully captured on video (Figure 9).

Central California Condor Nesting Trends Over Time

While the population total in central California plateaued in recent years (Figure 6), the number of annual nesting attempts varied (Figure 10). Overall a slight increase in egg production was observed, but the average number of fledglings remained at five per year since 2014.

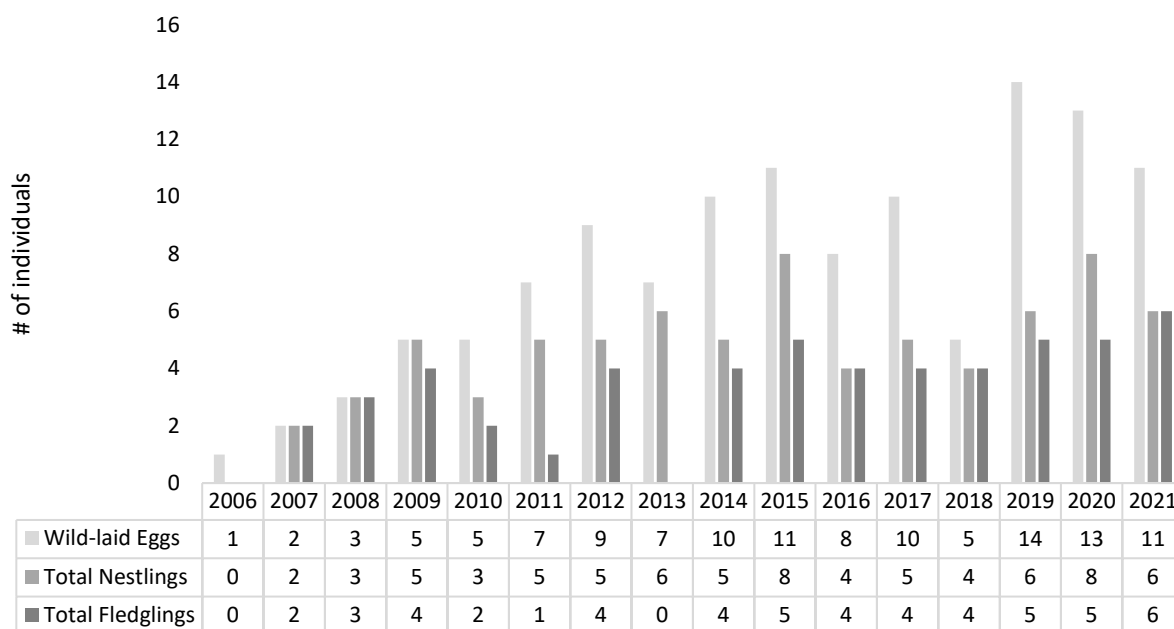


Figure 10, Multi-year central California condor nests: 2006-2021. VWS data provided by J. Burnett.

Microtrash

Since 2009, 65 nest entries included a search for microtrash. The nests managed by PNP in 2021 contained 2 plastic bottle caps, approximately 13 small pieces of blue plastic, a metal hinge, and a piece of thin rubber which staff removed during two nest entries. In all, trash removed from nests over the years included bottle caps and items made of plastic, rubber, cloth, and metal. Items weighed between .07 and 26.9 grams.

Baiting

In 2021, biologists placed 95 calves procured from organic dairies near Modesto, CA to bait the captive pen during trapping, feed captive condors, and attract condors to a video-monitored bait site. Other bait items from a variety of sources included six rabbits, four pigs, one goat, one fawn, and one lamb. During trapping seasons, carcasses were placed exclusively at the pen to increase trapping success.

Remote Monitoring

To supplement radio and GPS monitoring, staff collected and reviewed tens of thousands of remote motion-triggered photos and thousands of hours of video recordings. These remote cameras documented 3,479 sightings of individual free-flying condors throughout the year.

Non-proffered Food

In 2021, biologists and members of the public reported observations of nine non-proffered feeding events that resulted in 49 observations of 33 individual condors feeding on carcasses other than those provided at the PNP or VWS bait sites. Many feeding events in the wild go unrecorded due to limited access to private land and the dispersed nature of animals across the landscape.

Captive-reared Releases

In February 2021, PNP released two captive-reared juveniles into the wild. The juveniles arrived at the park in November 2020 from the World Center for Birds of Prey. Both juveniles succeeded in navigating the transition out of captivity and survived their first year in the wild.

Missing Birds

Condor 547 was missing since October 2020 and declared dead one year later. According to standard protocols, this condor was added to the mortality total of 2020 (Figure 6).

Management

Lead Sampling

Blood lead sampling continued to be a priority for the entire central California condor population. Figure 11 summarizes the initial lab lead values for all captured central California condors, including nestlings, those caught in traps, and those netted on the ground since 2007. In 2021, biologists collected 61 samples from 48 condors and, of those, 29 were PNP-managed.

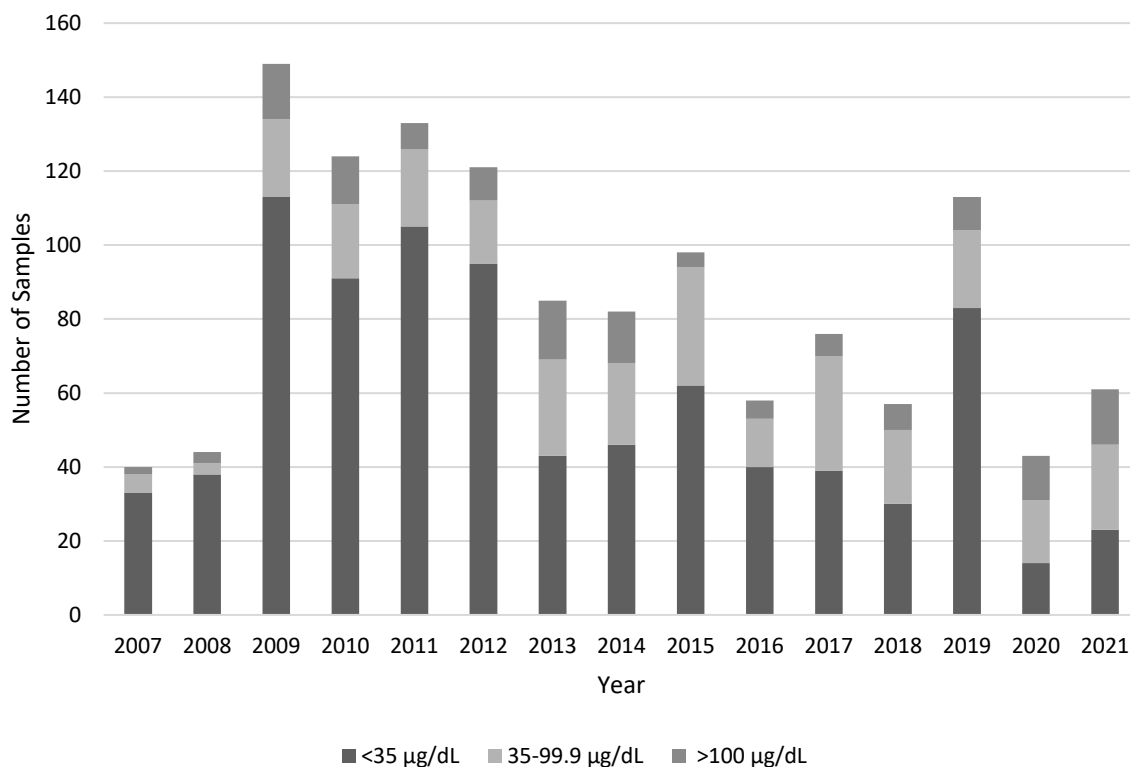


Figure 11, Blood level lab test outcomes in µg/dL for all central California condors: 2007-2021. VWS data courtesy of J. Burnett.

Veterinary Care

Radiographs and Chelation Treatments

In 2021, 15 PNP-managed condors required chelation treatment (Appendix C). Three condors with elevated blood lead values were radiographed at PNP. Two were chelated on site before release, while the third was held for observation for two weeks and released. Oakland Zoo staff radiographed and chelated 10 PNP-managed condors with elevated blood lead levels, and all were re-released. LA Zoo received two PNP-managed condors in advanced stages of lead toxicosis that required intensive treatment, and both died in captivity. They also radiographed and chelated one additional condor from PNP that was released back into the wild.



Figure 12, Radiograph of Condor 1034 showing large copper bullet and multiple small metallic fragments (circled in enlarged inset) in the ventriculus. Image courtesy of Oakland Zoo.

One unusual case from 2021 related to condor 1034 ingesting an entire spent copper bullet. He was captured at PNP with an elevated blood lead level and transferred to the Oakland Zoo for chelation treatment. During the intake examination, radiographs revealed a large bullet in the ventriculus that appeared to be the shape of a spent copper bullet in addition to

multiple smaller metallic densities (Figure 12). Condor 1034 underwent two rounds of chelation to reduce his blood lead level. During that time, zoo staff provided casting material and limited food to encourage him to cast the bullet and cast or pass the smaller metal fragments. They collected and radiographed all feces and castings and found multiple small metal fragments, but not the copper bullet. They transferred 1034 to the LA Zoo for surgery to remove the bullet, but he cast it out before surgery occurred. Pinnacles staff brought 1034 back to Pinnacles and released him. Throughout his time in captivity, he did not exhibit clinical effects attributed to copper exposure. This was the first documented case of a condor ingesting an entire spent copper bullet.

Surgeries

No surgeries were performed on PNP-managed condors in 2021.

Special Responses: Aluminum Cans

In 2021, two condors, 943 and 889, were seen with aluminum cans wedged around their lower beaks. Remote cameras alerted VWS and PNP field crews to the plight of each condor and observations over time suggested both birds could drink water, but not feed. With successful capture, both survived what could have been a fatal experience. These close calls highlighted the importance of cleaning up trash on the landscape.



Figure 14, Condor 943 with lower beak wedged into partial can. NPS Photo.



Figure 13, Condor 889 with lower beak wedged into a whole can. NPS Photo.

Pinnacles condor 943 was trapped in April after being seen with the top half of a can over his lower beak for 18 days (Figure 13). He was taken to the Monterey Avian & Exotic Clinic for examination and can removal. He had a small wound on his lower jaw that was treated, but otherwise appeared unharmed. However, a blood test revealed a high blood lead level and he was treated at the Oakland Zoo for four weeks before release back into the wild.

VWS condor 889 was seen in late July with a whole aluminum can stuck on her lower beak (Figure 14). A PNP biologist trapped her at PNP eight days later and removed the can. She had an indentation at the edge of her beak, but no laceration. She only weighed 6.8 kg (15 pounds), so was held for observation for a week, deemed fit and healthy, and released.

Vaccination

In 2021, West Nile Virus vaccinations were administered to 26 PNP condors.

Hazing

In 2021, no condors were hazed by staff for being in locations deemed unsafe or dangerous.

Personnel

In 2021, one of the crew leader positions was vacant for eleven months. However, an additional intern was hired to cover field operation needs and volunteers continued to provide vital support. In total, 13 volunteers contributed a total of 1,643 hours. Additionally, 5 interns contributed 4,733 hours.

Collaborative Research

Working collaboratively with USFWS, VWS, universities, and other researchers is a high priority for PNP and helps accomplish recovery goals. Multiple studies are underway to better understand threats to condors and how management can reduce their impacts.

Population Viability Analysis (PVA)

Montana State University and UC Santa Cruz researchers developed a PVA model with data and input from PNP, USFWS, and VWS for all condors in California. Initial results with data through 2013 were published in 2016 by Bakker, et al (Appendix D). In 2021, researchers updated the analysis on survival and reproductive rates through August 2018. Data indicated that condor survival and reproductive rates were similar to prior analysis, but the current analysis suggested a sex bias in mortality wherein juvenile females had a lower survival rate than juvenile males. Current work includes incorporating data through 2021 and expanding analysis to include condors in Arizona and Utah. Results from this research will inform management decisions for release sites, captive rearing facilities and overall recovery strategies.

Protect Condors Using New, Cost-Effective Methods

Pinnacles is partnering with UCSC to analyze lead concentrations and isotopic compositions in condor tissues and fragments to predict lead exposure risk as well as inform management actions. Pinnacles and VWS staff collect blood and feather samples that UCSC researchers analyze. Lead concentrations and isotopic compositions in sequential feather segments from individual birds provide data on the degree, frequency, and severity of lead exposures in condors. Recent analyses identified the lead poisoning sources for several condors, including a condor which ingested a copper bullet at the time of lead poisoning. Additional analyses examined the relationships between lead exposure and risk of power line collision.

These data will be considered with chelation history of individual birds. When feasible, PNP biologists measure and mark at least one growing primary feather at the time of capture. Any previously marked feathers are sampled when opportunity allows. The results will be published in a peer-reviewed journal upon completion. Due to the high value of data from feathers, PNP staff will continue to mark and collect samples for future research.

Chelation Treatment Impacts on Short-term Survival

In 2019, PNP and VWS, in collaboration with MSU and UCSC, began a three-year study comparing survival of condors with and without treatment to asymptomatic lead exposure. All PNP-managed condors continue to be radiographed and chelated if field blood lead values are 35 µg/dL or greater. All VWS-managed condors are radiographed and chelated when they display symptoms of lead exposure. Blood samples are taken for all PNP and VWS condors and submitted for laboratory analysis. These data will be tied to the treated and not-treated groups to better understand the effectiveness of chelation on survival rates between the two groups. Due to trapping and treatment protocol changes as a result of the pandemic starting in 2020, this research study may be extended an additional 1-2 years.

Rodenticide Exposure

Preliminary results from condor liver samples analyzed in recent years indicated that some condors were exposed to rodenticides and highlighted the need to continue research that began in 2014 on Prairie Falcons at PNP. Collaboration between the NPS Washington Office, PNP, and USGS continued through 2020. Garth Herring presented initial findings at the Raptor Research Foundation Conference in 2021 with a presentation titled *Collateral Damage: Anticoagulant Rodenticides Pose Threats to California Condor Recovery Efforts* and a peer-reviewed publication of results is expected in 2022.

Condor Range and Movements Research

Pinnacles research collaboration with CSU continued into 2020. Researchers estimated annual core and home range areas of condors that wore GPS tags between 2006 and 2017. They identified individual characteristics, management factors, population changes, and environmental variables associated with home ranges. Through this analysis, they built a tool to predict condor range expansion in California and identified likely areas of conflict with potential wind energy development. Results of this work will help inform agencies of areas in which to mitigate potential threats to condor survival and areas in which to focus outreach and education. Data analysis was completed in 2020 and a peer-reviewed journal publication is expected in 2022.

Outreach

A large component of PNP's Condor Recovery Program is educational outreach and interpretation. As the only condor release site currently within a National Park, visitation gives staff an opportunity to reach thousands of people from all over the world. Providing the public with information about the natural resources in the park and the surrounding landscape is an essential pathway to inspire environmental stewardship and enthusiasm and is one of the responsibilities of a national park.

NPS Education and Interpretation by Condor Program Staff

In 2021, PNP Condor Program staff conducted education and interpretation in the park and in the surrounding communities. While in the field, biologists and trained volunteers answered questions and provided visitors with both formal and informal interpretation about condors. This year condor staff and volunteers spoke with 1,909 park visitors within the park and 71 individuals while outside the park.

Outreach about lead as an environmental contaminant is recognized as one of the most important actions that can positively impact condor recovery. Pinnacles staff employed various strategies to educate diverse groups on the impacts of lead on condors, other wildlife, and human safety, as well as the benefits of removing lead from the landscape.

Focused Non-lead Ammunition Outreach

This year PNP continued conducting outreach related to the use of non-lead ammunition and lead poisoning in scavenging wildlife due to inadvertent ingestion of spent ammunition in animal remains left in the field. One PNP biologist with half his time dedicated to non-lead outreach built on efforts from past years while initiating new projects. Pinnacles continued to collaborate with partners working in non-lead outreach around the country, which was critical due to capacity reductions and limitations associated with the COVID-19 pandemic.

Pinnacles, with its many partners, is committed to building on its 16-year effort to help hunters and ranchers switch to non-lead ammunition options through education and nurturing positive relationships. All partners in non-lead outreach made great progress and, although much work remains, there are positive trends in acceptance and use of non-lead ammunition. In 2020 and 2021, ammunition and firearm purchases increased dramatically from previous years, resulting in shortages of all types of ammunition. These shortages made assessments of product demand and choice extremely difficult. However, manufacturers continued to develop and market more non-lead options. Every major ammunition manufacturer offered at least one non-lead round and some new manufacturers exclusively developed non-lead loads.

In California, hunters and gun owners expressed frustration over the combination of legal requirements related to using non-lead ammunition and face to face transfers of all ammunition, as well as an extended national shortage of ammunition. These challenges led PNP nonlead outreach efforts to focus on non-lead ammunition availability rather than bullet performance. Ventana Wildlife Society provided a critical service to central California hunters and ranchers with their free non-lead ammunition program, which for some was their only source of ammunition for the year.

While many outreach events were cancelled, others in the state remained virtual this year with hunting expositions, hunting club meetings, shooting demonstrations, and ranchers' workshops opting for webinars or online conference formats. Despite these restrictions, PNP staff reached thousands of individuals directly in northern and central California. In many cases, attendance may have been higher given the accessibility of virtual meetings. As in-person restrictions continued, outreach content was optimized for the online environment with plans for an ongoing presence in this format as many groups consider a hybrid model in the future.



Figure 15, NPS employee and volunteer traverse wooded terrain during bison reduction project at Grand Canyon NP. NPS Photo by Daniel Ryan.

Recognizing that the NPS and other land management agencies also play a significant role in exposing wildlife to lead through culling operations, invasive species management, and dispatch of sick or injured wildlife, outreach efforts in 2021 continued to target agency wildlife management. Trainings across the country on non-lead ammunition and wildlife dispatch worked to align NPS units with service-wide guidance. The emphasis on assisting parks with culling operations utilizing skilled volunteers resulted in a successful partnership at Grand Canyon National Park with their North Rim bison population reduction program (Figure 15). Non-Lead ammunition was required for removal operations, so the PNP outreach biologist and non-lead specialist from Oregon Zoo held virtual trainings to teach volunteers about the positive impacts of using non-lead ammunition, ensuring that everyone had the knowledge for a successful hunt.

RECOMMENDATIONS

Monitoring

Maintaining staff capacity and efficient monitoring creates a safe and sustainable program, including outreach and research components that are tied to condor management and population recovery. The increase in number of condors with GPS tags over time has improved

monitoring efficiency by reducing the number of missing birds that were difficult to locate and by guiding daily field monitoring efforts. Keeping 80-90% of PNP-managed condors with GPS tags remains among the highest program priorities to maintain monitoring efficiency.

Management

The primary obstacle to condor recovery continues to be lead contamination of food sources on the landscape. Condors will continue to use public and private lands from PNP to the coast and beyond given the availability of excellent foraging, roosting, and nesting habitat. Addressing the lead risk across these lands is an ongoing necessity, as is providing the best care possible to condors suffering from lead exposure. Additionally, a greater understanding of the efficacy of chelation treatment will aid all condor release sites to determine the conditions when it is most useful or detrimental.

Research

Each research project conducted to date has informed management decisions that affect the recovery of the species. Pinnacles' biologists continue to work closely with researchers and prioritize the collection of samples and data that support scientific research. With limited research funding, condor recovery partners should continue to work cooperatively with USFWS leadership and discuss highest priority needs, research proposals, joint funding opportunities, data sharing, and opportunities to collaborate.

Outreach

Developing strong partnerships will continue to be an important step in successful outreach efforts. Fostering inclusion and cooperation while addressing the issue of lead exposure will foster better understanding and appreciation among interest groups. Multiple organizations and agencies work together to coordinate their efforts to reach the greatest number of people each year and to provide accurate information to interested hunters. Outreach efforts, considered paramount for condor recovery, are still limited by insufficient funding and, therefore, staff capacity.

In 2022, the ongoing uncertainties of the global pandemic will bring new challenges to non-lead outreach. Pinnacles staff in collaboration with other nonlead outreach groups will aim to adapt standard outreach methods used pre-pandemic to this new reality and develop novel approaches. Virtual and digital materials continue to play a larger, possibly permanent role, and the development and publication of these materials will require new skillsets. Ammunition availability will continue to be an important issue that requires increased emphasis until supplies rebound. Pinnacles staff will continue working with new and established partners to broaden the scope of outreach and increase accessibility to accurate information and

resources. Condor release sites and all recovery partners should continue to coordinate and fund successful outreach.

Recovery Planning and Multi-agency Coordination

Condor field team meetings, typically held annually and coordinated by USFWS, bring together a diversity of perspectives from experts in the field, captive breeding programs, management agencies, veterinarians, and others. Facilitated research coordination in concert with, or in addition to, field team meetings have enabled partners to prioritize needs, consider joint funding proposals, and provide future direction. Developing a framework for management decisions based on the current population viability analysis will help inform changes to management at release sites and direct well-informed decisions that are based on the best available science.

Appendix A – Public Interest Highlights

2021 marked the 19th year of the California Condor Recovery Program at Pinnacles National Park. Notable highlights and programmatic accomplishments include:

- For the first time in program history, there were three active condor nests within the park boundary simultaneously. Although one of the nests failed, it was also the first time two condors fledged from nests in the park in the same year.
- Established pair 340 and 236 successfully nested two years in a row when 1027 fledged in 2020 and 1096 fledged in 2021. They remain an important part of their species' recovery story.
- Two condors, on separate occasions, got their lower beaks stuck in the top openings of aluminum cans, affecting their ability to eat and drink. Pinnacles staff successfully captured both birds, removed the cans, and re-released them into the wild. Both individuals continue to live with no perceived ill effects.
- Condor 828 made history when she ventured north into Contra Costa County, east of Mt. Diablo, in September. She may be the first condor documented that far north in over a century.
- Condors 943 and 986 flew over the Santa Cruz Mountains as far as Loma Mar County Park in San Mateo County. The last time a condor was documented in the mountains north of Santa Cruz was in 2014.
- Although the pandemic continued to limit in-person non-lead outreach, virtual events showed a positive trend among California hunters in use and satisfaction with non-lead ammunition. While ammunition availability was extremely low nationwide, the number of non-lead ammunition types developed and marketed increased this year.
- In December, the PNP Condor Program was fully staffed for the first time in nearly two years. Having a program manager, two crew leaders, and three intern positions greatly improved overall effectiveness and well-being while managing an endangered species.

Appendix B – Condor Mortality of Central California Condors, 2001-2021

Summary table of all known condor deaths, in order by death date, in central California since release programs by VWS and PNP began.

Estimated date of death is used instead of date found and reflects first day of possible death date range, if applicable. For chicks with no carcass recovery, estimated nest fail date is used. VWS data provided by J. Burnett, Big Sur Condor Program Coordinator and Senior Biologist. All dates and causes of death verified and corrected in 2021.

Condor SB ID	Sex	Estimated Date of Death	Manager	Cause of Death	County Recovered
230	M	5/9/2001	VWS	Electrocution: Bird electrocuted on line (mid-span)	Monterey
233	F	5/17/2002	VWS	Missing (last detected 5/15/2002)	NA
212	F	11/30/2002	VWS	Electrocution: Bird electrocuted on line (mid-span)	San Luis Obispo
254	M	2/19/2003	VWS	Electrocution: Bird electrocuted on line (mid-span)	Monterey
260	M	5/20/2003	VWS	Malnutrition	Monterey
170	M	6/15/2003	VWS	Lead Toxicosis	Ventura (Died at LA Zoo)
179	M	10/15/2003	VWS	Missing (since wildfire at Hopper NWR)	NA
256	F	10/17/2003	VWS	Undetermined: Bird recovered in desiccated state	Monterey
164	M	9/30/2005	VWS	Unknown: Bird recovered in desiccated state	Ventura
376	M	7/1/2006	VWS	Electrocution: Bird electrocuted on line (mid-span)	Monterey
363	M	7/14/2006	VWS	Malnutrition	Monterey (died at Avian&Exotic Clinic)
417	F	5/12/2007	PINN	Trauma to neck, possible predator	San Benito
301	M	5/15/2007	VWS	Electrocution: Bird electrocuted on line (mid-span)	Monterey
307	F	5/16/2007	PINN	Unknown - possible snake envenomation	Monterey
356	F	10/3/2007	VWS	Unknown: found dead near release site in desiccated state	Monterey

429	F	11/1/2007	VWS	Missing (last detected after fledging)	NA
278	M	6/25/2008	VWS	Missing (since wildfire at Hopper NWR)	NA
377	F	6/26/2008	VWS	Missing (since wildfire at Hopper NWR)	NA
336	F	9/7/2008	PINN	Lead Toxicosis	Monterey (Died at LA Zoo)
475	M	12/20/2008	VWS	Trauma (possible collision)	Monterey
286	M	5/11/2009	VWS	Lead Toxicosis	Monterey (Died at LA Zoo)
503	F	7/6/2009	VWS	Trash Ingestion	Monterey
422	F	7/12/2009	PINN	Unknown	Fresno
303	F	10/23/2009	VWS	Lead Toxicosis	San Benito
621	M	4/29/2011	VWS	Trauma, chick died in nest	Monterey
624	U	5/29/2011	VWS	Trauma, chick died in nest	Monterey
294	F	6/29/2011	VWS	Undetermined: bird recovered in desiccated state	Fresno
499	F	11/17/2011	VWS	Aspiration	San Benito
478	M	4/22/2012	PINN	Lead Toxicosis	San Benito (Died at LA Zoo)
588	M	7/27/2012	PINN	Unknown	San Benito
298	F	10/23/2012	VWS	Lead Toxicosis	Monterey
644	M	11/10/2012	VWS	Exposure: hypothermia	Monterey
318	M	11/30/2012	VWS	Lead Toxicosis	San Benito (Died at LA Zoo)
598	F	12/8/2012	PINN	Unknown	San Benito (Died at LA Zoo)
312	F	4/10/2013	PINN	Lead Toxicosis	San Benito
681	U	4/14/2013	PINN	Unknown, chick - nothing in nest to recover, no necropsy report	NA
345	M	5/29/2013	PINN	Lead Toxicosis	San Benito
686	U	6/1/2013	VWS	Undetermined, chick recovered in desiccated state, died in nest	Monterey
335	M	6/5/2013	PINN	Lead Toxicosis	San Benito
306	F	6/9/2013	PINN	Electrocution (possible indirect lead exposure)	Monterey
715	U	6/21/2013	VWS	Missing (disappeared shortly after hatch)	NA
332	M	7/3/2013	PINN	Lead Toxicosis	Fresno
194	F	7/5/2013	VWS	Missing (last detected 7/10/2013)	NA
708	U	7/12/2013	VWS	Trauma, chick died in nest	Monterey
313	M	8/8/2013	PINN	Lead Toxicosis	San Benito

714	U	8/28/2013	VWS	Trauma, chick died in nest	Monterey
693	U	9/8/2013	PINN	Unknown, chick - no collection based on remote nest location	NA
501	F	10/1/2013	VWS	Missing (last detected 9/25/2013)	NA
451	M	12/7/2013	PINN	Lead Toxicosis	San Benito
739	U	4/28/2014	VWS	Unknown, chick disappeared before fledged	NA
400	F	4/29/2014	PINN	Lead Toxicosis	San Benito (Died at LA Zoo)
401	M	41805	PINN	Lead Toxicosis (proximate) perforation of the ventriculus (immediate)	San Benito (Died at LA Zoo)
444	F	8/26/2014	VWS	Lead Toxicosis	San Benito
753	M	10/1/2014	VWS	Missing (disappeared shortly after fledging)	NA
411	M	12/6/2014	PINN	Undetermined: bird recovered in desiccated state	San Benito
664	F	12/31/2014	VWS	Lead Toxicosis	San Benito
788	U	4/25/2015	VWS	Unknown, chick - nothing in nest to recover, no necropsy report	NA
798	U	5/1/2015	VWS	Unknown, chick - nothing in nest to recover, no necropsy report	NA
713	M	5/15/2015	PINN	Missing (last detected 5/15/2015)	NA
782	F	5/31/2015	PINN	Unknown, chick - nothing in nest to recover, no necropsy report	NA
242	M	7/30/2015	VWS	Lead Toxicosis	Monterey
769	F	8/29/2015	VWS	Trauma from powerline collision	Monterey
615	M	11/17/2015	VWS	Trauma - Predation	Monterey
481	F	4/22/2016	PINN	Missing (last detected 4/21/2016)	NA
742	F	5/1/2016	PINN	Septicemia	San Benito (Died at LA Zoo)
251	M	7/11/2016	VWS	Lead Toxicosis	Monterey
838	U	12/1/2016	VWS	Trauma, fledgling euthanized due to injuries	Monterey
514	M	3/17/2017	PINN	Anticoagulant toxicity	Fresno
534	F	4/17/2017	PINN	Missing (last detected 4/16/2017)	NA
583	F	6/28/2017	VWS	Missing (last detected 6/27/2017)	NA
703	M	7/6/2017	VWS	Lead Toxicosis	San Benito
460	F	7/7/2017	PINN	Egg binding	Monterey
597	F	7/19/2017	VWS	Drowning	San Luis Obispo
760	F	7/19/2017	VWS	Drowning	San Luis Obispo
525	F	8/1/2017	PINN	Lead Toxicosis	Monterey
787	F	12/24/2017	VWS	Drowning	Monterey

614	F	1/19/2018	PINN	Lead Toxicosis	San Benito
687	F	5/22/2018	PINN	Missing (last detected 5/21/2018)	NA
706	M	6/11/2018	VWS	Lead Toxicosis	Monterey
684	F	1/30/2019	PINN	Missing (last detected 1/29/2019)	NA
351	M	4/27/2019	PINN	Electrocution: Bird electrocuted on line (mid-span)	Monterey
835	F	6/7/2019	PINN	Lead Toxicosis	Monterey
744	F	6/22/2019	PINN	Lead Toxicosis	San Benito
418	F	7/1/2019	PINN	Lead Toxicosis	San Benito
795	F	10/8/2019	PINN	Lead Toxicosis	San Benito
799	F	11/27/2019	VWS	Lead Toxicosis	Monterey
842	F	12/22/2019	VWS	Lead Toxicosis	San Benito
559	M	12/30/2019	VWS	Lead Toxicosis	San Benito (Died at LA Zoo)
463	M	1/5/2020	PINN	Lead Toxicosis	San Benito (Died at LA Zoo)
199	M	1/16/2020	VWS	Lead Toxicosis	Monterey
222	F	1/22/2020	VWS	Missing (last detected 1/21/2020)	NA
991	U	4/3/2020	VWS	Missing (last detected 4/2/2020)	NA
405	M	4/25/2020	PINN	Lead Toxicosis	Monterey
906	F	5/14/2020	VWS	Electrocution: Bird electrocuted on line (mid-span)	San Luis Obispo
231	F	5/21/2020	VWS	Missing (last detected 5/20/2020)	NA
878	F	6/28/2020	PINN	Necropsy report pending	Fresno
310	F	7/26/2020	PINN	Missing, mortality signal detected, unrecovered	NA
785	M	8/10/2020	PINN	Undetermined	San Benito
167	M	8/21/2020	VWS	Missing (since Dolan Fire in Big Sur)	NA
375	F	8/21/2020	VWS	Missing (since Dolan Fire in Big Sur)	NA
448	M	8/21/2020	PINN	Missing (since Dolan Fire in Big Sur)	NA
678	F	8/21/2020	VWS	Missing (since Dolan Fire in Big Sur)	NA
773	M	8/21/2020	VWS	Missing (since Dolan Fire in Big Sur)	NA
789	M	8/21/2020	VWS	Missing (since Dolan Fire in Big Sur)	NA
875	F	8/21/2020	VWS	Missing (since Dolan Fire in Big Sur)	NA
992	F	8/21/2020	VWS	Missing (since Dolan Fire in Big Sur)	NA
1004	F	8/21/2020	VWS	Missing (since Dolan Fire in Big Sur)	NA
1022	U	8/21/2020	VWS	Missing (since Dolan Fire in Big Sur)	NA
1029	U	8/21/2020	VWS	Missing (since Dolan Fire in Big Sur)	NA
874	F	8/28/2020	PINN	Lead Toxicosis	Monterey
823	F	9/12/2020	VWS	Lead Toxicosis	San Benito (Died at LA Zoo)
909	M	10/2/2020	PINN	Undetermined, only wings recovered	San Benito

543	F	10/9/2020	PINN	Lead Toxicosis	Monterey
567	M	10/11/2020	VWS	Lead Toxicosis	Monterey (Died at LA Zoo)
547	F	10/29/2020	PINN	Missing (last detected 10/28/2020)	NA
1030	U	11/2/2020	VWS	Missing (disappeared shortly after fledging)	NA
564	M	11/7/2020	PINN	Lead Toxicosis	San Benito (Died at LA Zoo)
688	M	1/6/2021	PINN	Lead Toxicosis	Stanislaus
901	M	1/17/2021	VWS	Euthanized due to burns from Dolan Fire	San Benito (Died at LA Zoo)
824	M	1/24/2021	VWS	Lead Toxicosis	San Benito
877	M	2/2/2021	PINN	Lead Toxicosis	San Benito (Died at LA Zoo)
606	M	3/4/2021	PINN	Lead Toxicosis	San Benito
431	M	5/3/2021	PINN	Lead Toxicosis, euthanized	San Benito (Died at LA Zoo)
728	F	5/9/2021	PINN	Lead Toxicosis (proximate cause), drowning (immediate cause)	Monterey
704	M	5/19/2021	PINN	Lead Toxicosis	San Benito
725	F	6/6/2021	PINN	Lead Toxicosis	Monterey
438	F	7/1/2021	PINN	Undetermined, advanced decomposition	San Benito
974	M	7/6/2021	VWS	Disease, infection air sacculitis	San Luis Obispo
311	F	7/24/2021	VWS	Lead Toxicosis	Monterey
961	F	9/4/2021	PINN	Lead Toxicosis	San Benito

Appendix C – Radiograph and Chelation Summary of Pinnacles-Managed Condors, 2021

Summary table of radiographs, chelations, detections of metallic densities, and outcomes of PNP-managed condors at PNP, Oakland Zoo, and LA Zoo in 2021.

Condor	Location	Purpose	Metallic Density	Outcome	Chelated
317	Oakland Zoo	Lead Exposure	No	No metallic densities. Chelated and released.	Yes
330	Oakland Zoo	Lead Exposure	No	No metallic densities. Chelated and released.	Yes
340	Oakland Zoo	Lead Exposure	Yes	One metallic density. Chelated, density cleared, and released.	Yes
431	LA Zoo	Lead Exposure	Yes	Multiple metallic densities. Chelated, but did not survive.	Yes
602	PNP	Lead Exposure	No	No metallic densities. Chelated and released.	Yes
692	LA Zoo	Lead Exposure	No	No metallic densities. Chelated and released.	Yes
800	PNP	Lead Exposure	No	No metallic densities. Chelated and released.	Yes
868	Oakland Zoo	Lead Exposure	No	No metallic densities. Chelated and released.	Yes
877	LA Zoo	Lead Exposure	Yes	Multiple metallic densities. Chelated, crop flushed, but did not survive.	Yes
912	Oakland Zoo	Lead Exposure	Yes	Multiple metallic densities. Chelated, densities cleared, and released.	Yes
943	Oakland Zoo	Lead Exposure	Yes	One metallic density. Chelated, densities cleared, and released.	Yes
996	Oakland Zoo	Lead Exposure	No	No metallic densities. Chelated and released.	Yes
1006	Oakland Zoo	Lead Exposure	No	No metallic densities. Chelated and released.	Yes
1021	Oakland Zoo	Lead Exposure	No	No metallic densities. Chelated and released.	Yes

1021	PNP	Lead Exposure	No	No metallic densities. Released.	No
1021	Oakland Zoo	Lead Exposure	No	No metallic densities. Chelated and released.	Yes
1034	Oakland Zoo & LA Zoo	Lead Exposure	Yes	Large metallic density (possible copper bullet) and multiple small fragments. Chelated, densities cleared, and released.	Yes

Appendix D – Scientific Publications with Pinnacles Co-authorships

Bakker, V.J., Smith, D.R., Copeland, H., Brandt, J., Wolstenholme, R., Burnett, J.,...Kirkland, S. (2016). Effects of Lead Exposure, Flock Behavior, and Management Actions on the Survival of California Condors (*Gymnogyps californianus*). *EcoHealth*.

D’Elia, J., Brandt, J., Burnett, L.J., Haig, S.M., Hollenbeck, J., Kirkland, S., Marcot, B.G., Punzalan, A., West, C.J., Williams-Claussen, T. and Wolstenholme, R. (2019). Applying circuit theory and landscape linkage maps to reintroduction planning for California Condors. *PLoS ONE*

Finkelstein, M.E., George, D., Scherbinski, S., Gwiazda, R., Johnson, M., Burnett, J.,...Brandt, J. (2010). Feather Lead Concentrations and Ratios Reveal Lead Exposure History of California Condors (*Gymnogyps californianus*). *Environmental Science & Technology*.

Finkelstein, M.E., Doak, D.F., George, D., Burnett, J., Brandt, J., Church, M., Grantham, J., & Smith, D.R. (2012). Lead Poisoning and the Deceptive Recovery of the Critically Endangered California Condor. *Proceedings of the National Academy of Sciences of the United States of America*.

Finkelstein, M.E., Kuspa, Z.E., Welch, A., Eng, C., Clark, M., Burnett, J., & Smith, D.R. (2014). Linking Cases of Illegal Shootings of the Endangered California Condor Using Stable Lead Isotope Analysis. *Environmental Research*.

Glucs, Z.E., Smith, D.R., Tubbs, C.W., Bakker, V.J., Wolstenholme, R.W., Dudus, K.,... Finkelstein, M.E. (2020). Foraging behavior, contaminant exposure risk, and the stress response in wild California condors (*Gymnogyps californianus*). *Environmental Research*.

Glucs, Z.E., Smith, D.R., Tubbs, C.W., Scherbinski, J.J., Welch, A., Burnett, J.,...Clark, M. (2018). Glucocorticoid Measurement in Plasma, Urates, and Feathers From California Condors (*Gymnogyps californianus*) in Response to a Human-Induced Stressor. *PLOS One*.

Herring, G., Eagles-Smith, C.A., Bedrosian, B., Craighead, D., Domenech, R., Langner, H.W.,...Parish, C.N. (2018). Critically Assessing the Utility of Portable Lead Analyzers for Wildlife Conservation. *Wildlife Society Bulletin*.

Kelly, T.R., Grantham, J., George, D., Welch, A.,...Johnson, C.K. (2014). Spatiotemporal Patterns and Risk Factors for Lead Exposure in Endangered California Condors during 15 Years of Reintroduction. *Conservation Biology*.

Kelly, T.R., Rideout, B.A., Grantham, J., Brandt, J., Burnett, J., Sorenson, K.J.,...George, D. (2015). Two Decades of Cumulative Impacts to Survivorship of Endangered California Condors in California. *Biological Conservation*.

Kurle, C.M., Finkelstein, M.E., Smith, K.R., George, D., Ciani, D., Koch, P.L., & Smith, D.R. (2012). Discrimination Factors for Stable Isotopes of Carbon and Nitrogen in Blood and Feathers from Chicks and Juveniles of the California Condor. *The Condor*.

Kurle, C.M., Bakker, V.J., Copeland, H., Burnett, J., Scherbinski, J.J., Brandt, J., & Finkelstein, M.E. (2016). Terrestrial Scavenging or Marine Mammals: Cross-Ecosystem Contaminant Transfer and Potential Risks to Endangered California Condors (*Gymnogyps californianus*). *Environmental Science & Technology*.

Rideout, B.A., Stalis, I., Papendick, R., Pessier, A., Puschner, B., Finkelstein, M.E.,...Smith, D.R. (2012). Patterns of Mortality in Free-Ranging California Condors (*Gymnogyps californianus*). *Journal of Wildlife Diseases*.

Rivers, J.R., Johnson, J.M., Haig, S.M., Schwarz, J., Burnett, J., Brandt, J.,...George, D. (2014). An Analysis of Monthly Home Range Size in the Critically Endangered California Condor (*Gymnogyps californianus*). *Bird Conservation International*.

Wengert, G.M., I.D. Medel and M.W. Gabriel (2020). Threats from Toxicants at Illegal Cannabis Cultivation Sites on Public and Adjacent Private Lands to Reintroduced California Condors in California. *Final report to National Park Service, Agreement # P17AC01674*