

Gould's Wild Turkey **(*Meleagris gallopavo mexicana*)** **Delisting Investigation Report**

Prepared by:

John Bulger and Casey Cardinal
Wildlife Management Division
New Mexico Department of Game and Fish
Santa Fe, NM

Purpose

The purpose of this Delisting Investigation Report is to evaluate whether there is sufficient evidence that Gould's wild turkey (*Meleagris gallopavo mexicana*) no longer requires statutory protection as a threatened species in New Mexico and that the objective and related information needs proposed in the Department's Recovery Plan have been satisfied to the extent that the subspecies can be safely removed from the state list of threatened and endangered species.

Introduction

Gould's wild turkey was listed by the New Mexico Department of Game and Fish¹ as a state threatened species in 1974 (NMDGF 2020), pursuant to Section § 17-2-41 of the New Mexico Wildlife Conservation Act (WCA; NMSA 17-2-37 to 17-2-46). In 2017, the New Mexico State Game Commission approved the Department's Gould's Wild Turkey Recovery Plan (Recovery Plan hereafter; Cardinal & Bulger 2017). The Recovery Plan identified criteria and data needs that would allow the Department to better assess Gould's wild turkey² prospects for population maintenance or growth in the foreseeable future throughout all or a significant portion of its range in New Mexico (NMSA 17-2-38).

This report was developed under authority of the WCA, which authorizes NMDGF to conduct delisting investigations of wildlife species indigenous to the state based upon new evidence and/or substantial public interest and support for an evaluation of the status of the species. In light of new information gathered since 2017, we evaluate herein the current conservation status of Gould's turkey in New Mexico in relation to goals, objectives, and performance measures established in the Recovery Plan. The report will be used by the NMDGF Director to make a recommendation to the State Game Commission to delist or not delist the species under the WCA. Following public hearings and a public comment period, the State Game Commission will make the final decision on delisting.

As required by the WCA, notice of the investigation was provided to agencies, organizations, and the public at large through electronic mailings, internet announcements, and press releases in November 2021. A public repository was subsequently established for comments and to document the investigation process. Additionally, one qualified individual from each of the six four-year state universities was invited

¹ Hereafter referred to as "the Department" or "NMDGF".

² Hereafter referred to as Gould's turkey.

to serve on a peer review panel. Peer reviews of the Delisting Investigation Report were submitted to NMDGF by: Drs. Martha Desmond, New Mexico State University; Benjamin Duval, New Mexico Institute of Mining and Technology; William Norris, Western New Mexico University; Kyle Shaney, New Mexico Highlands University; and Blair Wolf, University of New Mexico. No comments were received from Eastern New Mexico University.

Background

Gould's Turkey Distribution and Natural History

Wild turkey (*Meleagris gallopavo*) populations occur in all 48 states of the continental United States, north into southern Canada, and south into Mexico as far as Colima. There are five subspecies of *M. gallopavo*, of which Gould's (*M. g. mexicana*) is the southernmost. The historic and current range of Gould's turkey extends from Guanajuato, Mexico, northward along the slopes of the Sierra Madre Occidental and Madrean Sky Island ranges into extreme southwestern New Mexico and southeastern Arizona (Baur et al. 2019). Within New Mexico, Gould's turkeys inhabit the Peloncillo/Guadalupe Mountains (hereafter referred to conjointly as the Peloncillo Mountains) on the west side of the Animas Valley, and the Animas and San Luis Mountains on the east side of the Animas Valley (NMDGF 2020). The occupied range in New Mexico is contiguous with suitable habitats in Sonora and Chihuahua, Mexico.

The biology and natural history of wild turkeys are described in detail in several literature compilations (Dickson 1992, Healy & Powell 1999, McRoberts et al. 2020), and were summarized for Gould's turkey in the Department's Recovery Plan (Cardinal & Bulger 2017). As directly pertinent to the Delisting Investigation, aspects of Gould's turkey ecology and natural history are included in the relevant sections of this report.

Historical Perspective

NMDGF listed Gould's turkey as threatened in New Mexico in 1974 due to its limited range within the state (Peloncillo and Animas Mountains)³ and presumed small population sizes. Subsequent actions undertaken or funded by the Department included:

- 1982-1992: A series of studies undertaken by New Mexico State University professor Sanford Schemnitz and four graduate students (hereafter generically referred to as "the 1982-1992 NMSU studies": Schemnitz and Zeedyk 1982, Potter 1984, Willging 1987, Figert 1989, Schemnitz and Potter 1984, Schemnitz et al. 1990, York 1991, Schemnitz 1992, York and Schemnitz 1993, Zornes 1993, Zornes and Schemnitz 1993, Schemnitz and Zornes 1995). The 1982-1992 NMSU studies were primarily observational in nature and focused on diet, range, and habitat use of Gould's turkeys in the Peloncillo Mountains. The population size during that interval was described as numbering fewer than 50 adults⁴, and was speculated to be growing in size.
- 1996-1998: Surveys of Gould's turkey distribution in the Peloncillo and Animas Mountains (Zeedyk 1996, 1997, 1998).

³ Suitable habitat for Gould's Turkey in New Mexico, both historically and currently, occurs only in the Peloncillo and Animas Mountains.

⁴ In this report, "adults" refers to full-size individuals in the winter/early spring pre-breeding population. Turkeys are capable of reproducing at 1 year of age.

- 2006-present: Annual population surveys conducted by NMDGF and the National Wild Turkey Federation beginning in 2006 (Lerich and Cardinal, in review).
- 2014-2016: Translocation of 60 Gould's turkeys from Arizona to augment the Peloncillo Mountains population as follows: 19 in 2014, 26 in 2015, and 15 in 2016 (Lerich and Cardinal, in review).
- 2017: Gould's Turkey Recovery Plan approved by the New Mexico State Game Commission in 2017 (Cardinal and Bulger 2017).
- 2018 – ongoing: NMDGF GPS telemetry study of range and habitat use, movements, survival, and population size.

Recovery Plan Development

The Gould's Wild Turkey Recovery Plan specified an objective and several actionable performance measures that, if accomplished, might allow for a re-evaluation of the species' status in the state and eventual delisting. These were as follows:

Recovery Plan Goal: Ensure the long-term persistence of Gould's turkey within its historical range in New Mexico.

Objective: Maintain a total population of at least 175 Gould's turkeys in the Peloncillo Mountains either through natural processes alone or in combination with periodic strategic augmentation.⁵

Objective Parameters: Objective parameters are performance measures that are designed to assist in achieving the objective of the Recovery Plan:

- Develop population survey and monitoring methods and protocols to better characterize population distribution and trends.
- Identify and map the full extent of suitable or potentially suitable Gould's turkey habitat in the Peloncillo Mountains.
- Evaluate unoccupied portions of the suitable range for their potential to support a translocated flock if natural colonization seems unlikely.
- Evaluate and map limiting habitat components, such as roost sites, water sources, and brood-rearing habitat.
- Identify and manage, as feasible, current threats to limiting habitat components.
- Where feasible and warranted, identify, prioritize, and implement specific habitat enhancement projects.

NMDGF recovery plans are developed using the best information available at that time. Apart from consulting the broader literature on wild turkeys in general, in writing the Recovery Plan for Gould's turkey in New Mexico we relied primarily on information gathered in the 1982-1992 NMSU studies and the subsequent 2006-2016 population surveys. While the field studies and surveys conducted prior to 2017 comprised the best available information for development of the Recovery Plan, we were aware of the limitations of the data and related interpretations and recommendations. The NMSU studies, in particular, relied primarily on adventitious observations collected over a largely inaccessible study area

⁵ The Animas Mountains were not included because we do not have access to Gould's turkey habitat within the mountain range.

and/or locations from a small number of turkeys outfitted with VHF telemetry backpacks (n = 6 females and 4 males that lived longer than 5 months).

Therefore, as recommended in the Recovery Plan, in 2018 we initiated a GPS radio-telemetry investigation of Gould's turkey habitat and range use, movements, survival, and population size in the Peloncillo Mountains. This study (discussed in detail below) is key to supporting the present Delisting Investigation, and provides multiple lines of evidence which, in the aggregate, suggest that demographic and environmental parameters critical to maintaining and supporting the population are sufficiently robust to ensure population persistence for the foreseeable future.

NMDGF GPS Telemetry Study

This study has been underway since May 2018⁶ and is ongoing. Turkeys are captured and fitted with GPS/Iridium backpack transmitters that are programmed to record the location of each bird once each night (roosting) and three times during daylight hours every other day (mid-morning, noon, mid-afternoon). GPS locations are uploaded to Iridium satellites and subsequently downloaded weekly. The transmitters also have sensors to alert us to bird mortality within 10 hours of the event. Although our sample size fluctuates, we usually have at least 25 turkeys equipped with backpacks, slightly more females than males. We attempt to capture and mark approximately equal numbers of birds from three widely separated sites to control for biases that may arise from use of a single trapping location. The currently deployed transmitters will continue to operate for approximately four years, and we will attach additional transmitters to more turkeys in the future as needed to fill information gaps. Results obtained to date are reported below.

Range and Range Use

Figure 1 shows all GPS locations for all turkeys backpacked to date. The data set comprises more than 53,500 GPS turkey locations, provided over time by 69 different turkeys (30 males, 39 females) between May 2018 and November 2021. The salient results are these:

1. The documented occupied range of Gould's turkeys inhabiting the Peloncillo Mountains extends north/south over a length of at least 87 km, including at least 53 km north of the U.S./Mexico border to the Rough Creek/Big Creek watershed and 34 km south into Sonora in the Cajon Bonito watershed and the Sierra Pan Duro.
2. The turkeys use specific areas within the overall range (hereafter "core use areas"). In Figure 1, the core use areas are named Rough Creek, Horse Camp, Skeleton Canyon⁷, Cascabel, Animas Creek, Foster Draw, Cloverdale, and Guadalupe Canyon. Dunagan Crossing is also a known core use area, but none of our backpacked birds have resided at the site yet. (Mexico is discussed separately later in the document).
3. Large portions of the mountain range appear not to be used at all by Gould's turkeys or are used only for travel to get from one core use area to another.

⁶ The first GPS backpacks were attached during May 2018, but data from a sample size of >20 turkeys are primarily from the period February 2019 – October 2021.

⁷ Core use area includes Skeleton, Pine, and Dutchman canyons and surrounding uplands.

4. The turkeys are highly mobile, and individual birds regularly move between core use areas.⁸ There generally are turkeys present in all these areas year-round, but flock composition changes over time. Consequently, core use areas are not occupied by discrete resident flocks. Examples of individual turkey range use are shown in Figure 2 for birds captured and backpacked at Cloverdale (Fig. 2a), Cascabel (Fig. 2b), and Foster Draw (Fig. 2c).
5. 63.0% of the GPS locations were on private land, and 34.4% on the Coronado National Forest.

GPS telemetry studies have given us a much more complete picture of the distribution and range use of turkeys occupying the Peloncillo Mountains than what was known at the time the Recovery Plan was written. In particular, these studies have expanded our understanding of range use to include several additional core use areas, and have documented Gould's turkey habitat continuity and use well into Mexico. In the 1982-1992 NMSU studies, the Gould's turkey range in the Peloncillos was thought to extend from Skeleton Canyon southward to Cloverdale, with some modest but indeterminate use of Horse Camp, Guadalupe Canyon, and Rough Creek. Turkey use of Foster Draw and Animas Creek was unreported at that time, as was use of the Cajon Bonito and adjacent mountains in Mexico.

In the Gould's turkey Recovery Plan, we discussed evaluating "unoccupied portions of the suitable range". Having now better defined (i) the size and extent of the occupied range, and (ii) the extent to which turkeys move freely about the landscape, including brief forays into little used areas and regular movements between core use areas, we no longer believe that there exists any suitable habitat that is unoccupied because turkeys have yet to discover it.

Habitat Use/Selection

Figure 3 shows turkey locations relative to SW GAP land cover types⁹. Mexico is excluded from the map because we don't have a comparable digital vegetation layer. In the Peloncillos, Gould's turkeys primarily use two land cover types: Apacherian-Chihuahuan Piedmont Semi-Desert Grassland/Steppe¹⁰ (66.4%), and Madrean Encinal¹¹ (23.4%). It is apparent from Figure 3 that the GAP land cover types are too broad to adequately describe turkey habitat use or selection. In general, Gould's turkeys in the Peloncillo Mountains occupy the ecotone where the grasslands of the Animas Valley transition to Madrean Encinal savannas and open woodlands. This transition zone is a mosaic of rolling mid-elevation foothills comprised of oak and/or juniper savanna, punctuated at regular intervals by drainages that support many of the oaks (*Quercus* spp.)¹² or cottonwoods (*Populus deltoides* var. *fremontii*) that are used for roosting; drainages are also used for foraging and often support oaks and other Encinal vegetation farther downslope than do upland areas. Denser woodland habitat types (typically pinyon/juniper) are for the most part avoided by the turkeys and are used only to travel through between core use areas (Figure 3). Pure grasslands with no trees that provide escape cover are similarly avoided. Gould's turkeys will forage

⁸ Although we can only report on movements of individual turkeys equipped with backpacks, we note that turkeys (particularly hens) usually travel and forage in flocks.

⁹ Southwest Regional GAP Analysis Project <http://earth.gis.usu.edu/swgap/>

¹⁰ The Piedmont Grassland/Steppe is a broad land cover type. On the eastern slope of the Peloncillos it is characterized by stands of diverse perennial grasses; the western slope of the range tends to be a grass/shrub mix.

¹¹ *Encinal* is a Spanish designation for evergreen woodlands composed primarily of oaks or of some combination of oak/pinyon/juniper. These are more open woodlands and savannas, with canopy cover generally ranging from 5-25%; denser stands on north-facing slopes may approach 50% overstory canopy cover (Brown 1994, USDA 2018).

¹² Emory oak (*Q. emoryi*) and gray oak (*Q. grisea*) are used for roosting and, along with Toumey oak (*Q. toumeyii*) and silver-leaf oak *Q. hypoleucoides*), produce mast crops that are important food items for Gould's turkey.

many kilometers outward from roost sites provided there are at least small trees in the landscape. The lack of trees across the broad Animas Valley likely limits movement of turkeys between the Peloncillo and Animas ranges.

Turkey diets vary seasonally by availability of forage. Approximately 50 plant species were identified in York's (1991) analysis of Gould's turkey feces in the Peloncillo Mountains. Mast-producing trees and shrubs are particularly important food sources. These include alligator juniper (*Juniperus deppeana*), pointleaf manzanita (*Arctostaphylos pungens*), sumac (*Rhus* spp.), four oak species, border pinyon (*Pinus cembroides* var. *discolor*), and canyon grape (*Vitis arizonica*). Gould's turkeys also eat a variety of grass seeds, the primary grasses being pinyon ricegrass (*Piptochaetium fimbriatum*), sideoats grama (*Bouteloua curtipendula*), Orcutt's threeawn (*Aristida schiedeana* var. *orcuttiana*), and barnyard grass (*Echinochloa* spp.). Insects are an important food source for poults and are also readily consumed by adult turkeys. Although the pinyon-juniper woodlands include major mast-producing resources, Gould's turkeys in our study for the most part foraged only at the edges of this vegetation association. Only 2.3% of all GPS locations occurred in the Madrean Pinyon-Juniper Woodland land cover type (Figure 3).

Roosting

Except when brooding pre-flight chicks, Gould's turkeys roost at night in large trees with relatively open crowns that contain branches of sufficient size to support a 5-15 kg bird. Roost sites are usually located adjacent to an open area that functions as a takeoff and landing site used for flying into and out of the roost trees. Although a single large tree can accommodate several dozen birds, most roost sites are comprised of two or more trees in close proximity to one another. Gould's turkey roosting flock sizes vary by season and sex, and are largest during winter (January-early April) when more than 100 birds may aggregate at a single roost site.

The 1982-1992 NMSU studies documented 39 roost sites used by Gould's turkeys in the Peloncillo Mountains (Figure 4; Zornes 1993). Of these, 32 were within groves of Chihuahua pine (*Pinus leiophylla* var. *chihuahuana*). Due to the small number of roost sites reported in those studies, the preponderance of Chihuahua pine roosts in the sample, and the relative scarcity of Chihuahua pine in the Peloncillos¹³, it was proposed that roost sites were a limiting feature of Gould's turkey habitat in the study area (Schemnitz 1992) -- limiting in the sense that the restricted distribution of Chihuahua pines rendered areas of otherwise suitable foraging habitat inaccessible to the turkeys.

Figure 4 shows all locations where GPS-backpacked turkeys have roosted during our telemetry study. To date, we have documented turkeys using approximately 250 roost sites that sustained ≥ 3 turkey roost nights and an additional 450 that had < 3 use nights throughout the range of Gould's turkey in the Peloncillo Mountains. The designations "high", "medium", and "low" in Figure 4 refer to relative frequency of use for the ≥ 3 roost nights category. The vast majority ($> 90\%$) of tree species used for roosting are either oaks (*Q. emoryi* and *Q. grisea*) or cottonwoods, with remaining $< 10\%$ being in the aggregate Arizona sycamore (*Platanus wrightii*), Chihuahua pine, Arizona walnut (*Juglans major*), or alligator juniper. Use of GPS transmitters has provided us with an unbiased record of Gould's turkey roosting habits in the Peloncillos. Whether this technological advantage alone accounts for the

¹³ Chihuahua pine occurs almost exclusively in drainages at mid- to high elevations in the Peloncillos. In their vegetation mapping, the 1982-1992 NMSU studies identified only 19 locations where groves of Chihuahua pine were present (Schemnitz 1992).

differences between our results and those of the 1982-1992 NMSU studies or whether the birds have shifted their roosting habits is uncertain.

In view of our better understanding of roost site distribution and availability in the Peloncillo Mountains, we have found no evidence that roost sites restrict use of otherwise suitable habitat for Gould's turkeys. The birds walk distances of 10-15 km in a single day when moving between core use areas, and even in the course of daily foraging they travel on average 4-5 km (Gross et al. 2015). It is therefore unlikely that the distribution and number of suitable (as defined by the turkeys themselves) roost sites limits their ability to forage broadly through the general occupied range. While there are some hard edges to the occupiable range that are defined in part by lack of roosts (e.g., most of Animas Valley, large areas of mesquite and desert scrub, areas north of Rough Creek/Big Creek), these are simply natural vegetation types that don't produce big trees due to soil type, moisture and other factors.

Nesting and Brood Rearing

Nesting:

Turkeys nest on the ground, typically selecting sites with moderately dense overhead cover and at least some degree of horizontal cover (Lehman et al. 2008, Fuller et al. 2013). Prior to our study only two Gould's turkey nests had been described for the Peloncillos (Zornes 1993). We have to date discovered 31 additional nests.¹⁴ Nests have been placed against tree trunks (oaks and junipers), beneath beargrass clumps (*Nolina* spp.), in tall grasses of open wetland or grassland, beneath chaparral vegetation, atop cliff-like rock outcroppings, and a variety of other situations. At the nest scale, appropriate habitat is ubiquitous. In terms of broad land cover types most nesting has occurred in savanna habitats associated with grassland-steppe and Madrean Encinal (Figure 5), but nests have also been situated in woodland, chaparral, and wetland land cover types (Table 1). There is no indication at any scale that nesting habitat is limiting.

Table 1. Number of nests found per SW GAP land cover type.

Grassland & Steppe	Madrean Encinal	Madrean Juniper Savanna	Madrean Pinyon/Juniper Woodland	Riparian Woodland
12	13	3	2	1

As is typical of wild turkeys in general (Healy and Powell 1999), nesting rates and nesting success have been variable over the three breeding seasons comprising our study (Table 2). Nesting rates in our sample of backpacked hens have ranged from 100% in 2019 to 13% in 2021 during severe drought. The percentage of backpacked hens that produced chicks (successfully hatched >1 egg) has ranged from 100% in 2018, to 9% in 2021. By way of comparison, Collier et al. (2019) reported the following for Gould's turkeys in Arizona during the 2017 nesting season: nesting rate of 23 backpacked hens was 65% (15/23), and 10 of 23 backpacked hens (43%) produced chicks (hatched).

¹⁴ Nesting chronology over three years of study is as follows: initiation of incubation of first clutch (n= 26) May 11 -- June 11; second clutch (n=5) June 7 – June 27. The incubation period is 28 ± 1 days.

Table 2. Nesting and hatching rates of hens fitted with GIS backpacks in this study.

Year	# Backpacked Hens	# Hens that Nested (%)	# Nesting Attempts (# Renests)	# Nests Hatched	% of Backpacked Hens that Produced Chicks
2019	12	12 (100)	15 (3)	12	100%
2020	16	11 (69)	13 (2)	6	38%
2021	23	3 (13)	3 (0)	2	9%

Brood Rearing:

Gould's turkey chicks (poults) are flightless until approximately 14 days post-hatching, a critical life history stage during which most poult mortality occurs (Schemnitz et al. 1990, Chamberlain et al. 2020). Arthropods and herbaceous vegetation form the bulk of the newly hatched poults' diet (Healy 1985). Females brood chicks on the ground during this two-week period, after which brood hens and poults rejoin flocks and roost in trees with other turkeys.

Data on brood rearing from our study are somewhat limited, due largely to the relative lack of nesting in 2021. Figure 5 shows GPS locations used by brood hens (n = 20) during the first 14 days after hatching. At coarser scales there was again a strong association with the grassland-steppe and Madrean Encinal landcover types, although young broods also used various woodland, scrub, and chaparral communities as well (Table 3).

Table 3. Early brood rearing GPS locations (n = 707) by SW GAP land cover type. Relative frequency.

Grassland & Steppe	Madrean Encinal	Riparian Woodland	Madrean Pinyon/Juniper Woodland	Madrean Juniper Savanna	Mixed Scrub	Mogollon Chaparral	Salt Desert Scrub	Pine-Oak Woodland
58.3%	25.5%	5.8%	4.5%	4.2%	0.8%	0.6%	0.1%	0.1%

Based on very small sample sizes, the 1982-1992 NMSU studies reported that riparian habitats appeared to be of key importance to brood rearing in the Peloncillo Mountains, and considered the low availability of riparian habitats in comparison to other vegetation types in the study area to potentially be a limiting habitat feature to Gould's turkey population growth. We are still gathering data on habitat use during the early brood rearing period, but to date see no indication that habitats appropriate to this stage of the life history are limiting in the study area. Although broad, well-vegetated drainage bottoms and wetland sites are indeed often used by hens and their young broods, rolling savanna type grasslands are also routinely and more commonly used during the brood rearing period. Using satellite imagery to reanalyze our data at a finer scale than the SW GAP land cover types presented in Table 3, we found that 22.5% of 707 total brood locations were in riparian or wetland habitats¹⁵, the remainder in upland habitats. Upland savanna/grassland sites usually include oaks and/or junipers at sparse to moderate densities, and beargrass is frequently also present. Thus, as has been reported by other wild turkey researchers (Healy and Powell 1999, Chamberlain et al. 2020), sites selected for brood rearing are, generically, open habitats

¹⁵ Wetland habitats include the Cloverdale Cienega and portions of Animas Creek; riparian habitats were delineated using the flood-prone zone adjacent to all drainages.

that support graminoids and forbs sufficiently dense to provide cover but not so dense as to impede the poults' ability to move about freely while foraging. Such areas occur broadly throughout the occupied range in the Peloncillos.

Adult Survival

Annual survival rates reported for wild turkeys of all subspecies are highly variable, ranging from 15% to 75% for 15 studies (Healy & Powell 1999). For the GPS backpacked birds in our study ($n = 63$ in this analysis), average annual survival rates for 2019-2021 were estimated to be 0.698 (95% CI = 0.569 - 0.796; Kaplan and Meier 1958), including a year of extreme drought. Mortality rates in wild turkeys are countered by evolutionary traits that contribute to high potential fecundity, including large clutches, nesting by yearling hens, and renesting after initial failure (Healy and Powell 1999, Baur et al. 2019).

Population Size

Statistically robust population estimates for wild turkeys are nearly impossible to achieve due in large part to the expansive spatial scales over which population dynamics operate (Healy and Powell 1999, Bauer et al. 2019). Moreover, high variability in annual survival, migration rates, and reproductive success can result in annual fluctuations of up to 50% of the long-term mean population size (Mosby 1967). In consequence, wildlife management agencies usually adopt one or more index measures in an attempt to allow for trend assessment. Various methods are reviewed by Locke (2007).

Our Recovery Plan objective was to maintain a total population of at least 175 Gould's turkeys in the Peloncillo Mountains either through natural processes alone or in combination with periodic strategic augmentation. This numeric target was based in part on assuming a female biased sex ratio (F:M ratio = ca. 60:40), as is found in most turkey populations¹⁶ (Healy and Powell 1999): a population of 175 adults would be expected to contain approximately 100 reproductive females, which we suspected would be sufficient for long-term population persistence barring catastrophic events. At that time, we were not certain that the total Peloncillos Gould's turkey population numbered more than about 100 birds, and to achieve our objective we suspected it might be necessary to either improve habitat conditions in some areas and/or proceed with another translocation to augment the existing population. Schemnitz and Potter (1984) had previously estimated if all potential habitat was improved and occupied, the Peloncillo Mountains could support up to 150 turkeys.

From 2006-2018, NMDGF undertook annual spring surveys of turkeys in the Peloncillos using fixed routes at dawn, a method where observers intersected turkeys after they came off the roost. Results of these surveys were highly variable from year to year and were unreliable for the purpose of confidently discerning population trends (summarized in Lerich and Cardinal, in review). Despite our uncertainty in the relationship between number observed and number present, we suspect that the 2014-2016 translocation of birds from New Mexico contributed to population growth in the short-term: survey counts from 2006-2013 never exceeded 46 birds; counts obtained from 2014-2018 ranged from 55-97 birds.

Beginning in 2019, we implemented a new survey method to improve our counting technique in the Peloncillo Mountains. This method capitalizes on the fact that Gould's turkeys roost in large aggregations during the winter and early spring (Caveny et al. 2013). These roosting aggregations are concentrated in

¹⁶ Female bias has also since been observed in our study.

a small number of locations, and the GPS transmitters deployed on the birds allow us to know locations of roost sites being used at that time.¹⁷ We can then count birds as they fly into (evening) or out of (morning) the roost sites, covering the accessible survey area on two successive days with multiple observers making simultaneous counts. This increases the probability that we are not missing flocks and reduces the probability of counting the same birds twice. We will be evaluating turkey detectability on surveys in future years.¹⁸

Due to land ownership patterns and road or trail access, we are unable to survey turkey numbers over much of the occupied range. We can, however, achieve a good result for the Cascabel, Animas Creek, Foster Draw and Cloverdale core use areas (see Figure 1), which we refer to as the primary survey area. We can additionally count turkeys that regularly roost at Dunagan Crossing, which we treat separately from the primary survey area. A complete minimum count for the entire Gould's turkey range in the Peloncillo Mountains would require access to additional private lands.

Counts using the new survey method for winter (late January/early February) and spring (late March/early April) are given in Table 5. The lower counts obtained in Spring 2019 and Winter 2020 do not necessarily reflect a smaller population size because we were still in the process of refining the survey method at those times.

Table 5. Results of winter and spring survey counts of Gould's turkeys in the primary survey area (see text) and at Dunagan Crossing, spring 2019 through winter 2022.

Year	Primary Survey Area		Dunagan Crossing		Total Minimum Count	
	Winter Survey	Spring Survey	Winter Survey	Spring Survey	Winter Survey	Spring Survey
2019	n/a	166	n/a	14	n/a	180
2020	166	199	26	25	192	224
2021	207	230	17	16	224	246
2022	184	184	36	23	220	207

Turkey numbers presented in Table 5 reflect a minimum count for only a portion of the occupied range. Clearly the Gould's turkey population size in the Peloncillos Mountains is considerably larger than was previously known. We have documented that the primary survey area alone is capable of supporting at least 230 adult turkeys, and counts at Dunagan Crossing have ranged from 14-36 birds on our surveys. Additionally, we know from the distribution of our backpacked turkeys and from landowner information that turkeys are also present during the winter and spring count intervals in other core use areas on private lands we cannot access: Guadalupe Canyon typically holds 10-15 turkeys, and the Horse Camp

¹⁷ We visit all roost sites the birds have used within four weeks leading up to the survey.

¹⁸ We evaluated count repeatability in the primary survey area by doing three back-to-back surveys in spring of 2021, obtaining a 3-count mean and standard error of 215 ± 7.51 .

area usually supports 30-40 birds in one or two flocks. We are uncertain about turkey numbers in the Rough Creek area¹⁹.

Animas Mountains and Mexico

Animas Mountains:

Gould's turkey presence in the Animas Mountains and adjacent areas²⁰ has been documented since at least 1892 (Mearns 1907). Under contract to NMDGF, Zeedyk (1997b, 1998b) reported on turkey occupancy of these ranges in the late 1990s. The area over which he documented turkeys or turkey sign is shown in Figure 6, comprising upper Double Adobe Creek and the Deer and Indian Creek watersheds in the Animas range, as well as the Smuggler Hills, Whitewater Mountains, and the New Mexico extent of the Sierra San Luis. Based on sightings and the distribution of sign, he proposed that the Gould's turkey population size in this occupied area in 1998 was likely on the order of 100-200 birds. These mountains are in private ownership and we have not accessed them since Zeedyk's study. However, turkey habitat in the Animas Mountains remains intact and the population there has persisted, though in unknown numbers, according to the principal landowner.

Mexico:

In our current GPS telemetry study, 4 of 11 hens backpacked²¹ at the Cloverdale capture site 2018-2020 have occupied ranges that extend from New Mexico into Sonora (Figures 1, 2a). Cross-border connectivity of range use had also been established prior to our study: a male that was translocated from Arizona to the Peloncillos in January 2015 was harvested in Sonora four months later, and two of four males equipped with VHF transmitters in the 1982-1992 NMSU studies had home ranges that included habitat areas in Sonora (Zornes 1993). These observations clearly establish that Gould's turkey population demography and dynamics are not interrupted by the international border.

Available information on Gould's turkey distribution and abundance in northern Mexico is highly limited. The region is sparsely inhabited, there are far fewer recreational birders than there are in the U.S., and large areas are inaccessible by vehicle. There is good evidence, however, that Gould's turkey populations are widespread and well-established in adjacent Sonora and Chihuahua:

1. From 2009-2012, Flesch (2014, 2018) conducted breeding bird surveys in 26 Madrean Sky Island ranges in northeast Sonora and northwest Chihuahua, and documented Gould's turkey occurrence in 16 of them, including 13 ranges where turkeys had not previously been recorded.²² Prior to Flesch's fieldwork, Marshall (1957)²³ and subsequent compilers of bird records from northern Mexico (Howell and Webb 1995, Russell and Monson 1998) reported that Gould's turkey had been essentially extirpated from the Madrean Sky Islands region, and considered the northern extent of the Gould's turkey range to lie approximately 50-75 km south of the U.S. border. Flesch (2014) concluded that: *"...montane forests and woodlands, which Marshall visited shortly after or while they were being commercially logged, have matured to varying extents over*

¹⁹ Fragmentary information from landowners indicates that the Rough Creek area supports ± 20 birds.

²⁰ Including Smuggler Hills, the Whitewater Mountains, and the New Mexico portion of the Sierra San Luis.

²¹ Three additional hens backpacked at Cloverdale lived less than a week.

²² This is particularly notable because most surveys involved a single transect visited only once.

²³ Marshall (1957) reported on distribution, abundance, and habitat associations of breeding birds in the Sky Islands region based on his extensive fieldwork conducted from 1951-1955.

the last six decades, and the extensive network of logging roads present in Marshall's time is now largely in disrepair. Thus, many Sky Islands in Mexico are much less accessible today and subjected to much lower levels of exploitation by humans. As a result, species that ... are the focus of hunting by humans such as Wild Turkey seem to be more abundant and broadly distributed today than during the 1950s."

2. Madrean Discovery Expeditions (<https://madreandiscovery.org/>) maintains a flora and fauna database for the Madrean Sky Islands Ecoregion – a geographic area comprised of more than 40 small mountain ranges extending north and northwestward from the main block of the Sierra Madre Occidental. Outside of Mexico, the region includes the Peloncillo and Animas Mountains in New Mexico, and all the Gould's turkey range in Arizona. Gould's turkey observations (including Flesch's) from the Mexico portion of the Madrean Sky Islands are shown in Figure 6. The dataset is compiled from incidental observations²⁴ by biologists, resource managers, and conservationists working on other projects in the region, primarily from 2009 onward. As is evident in Figure 6, Gould's turkeys are well distributed through the Madrean Sky Island ranges of northern Sonora, including the Sierra Pan Duro and Sierra San Luis, which are contiguous with the Peloncillo and Animas mountains, respectively. Although the pertinent observations have not been captured in Madrean Discovery database, Gould's turkeys are also reported to "abound" in the portion of the Janos Biosphere Preserve (Figure 1) that overlaps the central and northern Sierra San Luis in Chihuahua (List et al. 2010).
3. Cajon Bonito drains the Sierra San Luis on the east, and the Sierra Pan Duro on the west, forming a horseshoe of mountainous terrain that is continuous northward through the Peloncillo and Animas Mountains (Figure 6). In their description of various ecological attributes of the Cajon Bonito watershed, Hunt & Anderson (2002, 2004) maintained that the Cajon is the most important corridor for biotic interchange in the Madrean Sky Islands. This watershed has to date facilitated movements of two of our backpacked turkeys.

On the basis of what we know about Gould's turkey ecology and behavior in the Peloncillo Mountains and what we can gather from information sources pertaining to the Animas Mountains and adjacent ranges in Mexico, we propose that it is likely that turkeys occupying the Peloncillos, Sierra Pan Duro, Sierra San Luis, and Animas Mountains form a single demographic population (polygon in Figure 6). We have sound evidence to support this contention from our own observations for the Peloncillo/Sierra Pan Duro ranges, and the information presented above strongly suggests population continuity as well through the Animas/San Luis ranges, and east-west across Cajon Bonito. Additionally, Gould's turkey occupation of other Madrean Sky Island ranges and the Sierra Madre adjacent to the Sierra Pan Duro/San Luis raises the possibility that meta-population dynamics may be operating at a much larger scale.²⁵

Threats to Future Viability

In developing the "threats" section of our Recovery Plan for Gould's turkey, we relied on a catalogue of potential threats that had been proposed in the 1982-1992 NMSU studies. Those included fire, lack of water, poaching, overgrazing by livestock, hybridization with domestic turkeys, and fuelwood and

²⁴ These are not focused turkey surveys.

²⁵ The close proximity of additional turkey populations adjacent to the Sierra Pan Duro/San Luis (Fig. 6) suggests a reasonable likelihood that individuals are able to migrate between somewhat disjunct populations, resulting in gene flow at a larger regional scale and in the possibility of re-occupation of a site after a local extinction event.

beargrass harvesting. Since the 1980s, changes in Forest Service resource utilization policies and private landowner management practices have successfully minimized many of these potential impacts.

Currently Mitigated Threats

Overgrazing by Cattle:

The Coronado National Forest and local landowners have adopted conservative and restorative grazing practices such that overgrazing is no longer an issue that would significantly limit turkey population growth. Guidelines for allotments on the Coronado National Forest are as follows (USDA 2018):

- Forage utilization should be based on site-specific resource conditions and management objectives, but in general should be managed at a level corresponding to light to moderate intensity (15 to 45 percent of current year's growth).
- Burned areas should be given sufficient deferment from grazing, especially during the growing season, to ensure plant recovery and vigor.
- Construction or reconstruction of livestock fencing and replacement of nonpermeable fencing where wildlife movement is restricted should be consistent with the appropriate state wildlife agency standards for safe passage of wildlife and/or species-specific fencing guidelines developed at the local or regional level.
- Grazing management practices should be designed to maintain or promote ground cover that will provide for infiltration, permeability, soil moisture storage, and soil stability appropriate for the ecological zone. Additionally, grazing management should retain ground cover sufficient for the forage and cover needs of native wildlife species.
- Within riparian areas, structures used to manage livestock should be located and used in a way that does not conflict with riparian functions and processes.
- Treatments for restoring rangelands should emphasize the use and perpetuation of native plant species.
- Grazing intensity, frequency, occurrence, and period should provide for growth and reproduction of desired plant species while maintaining or enhancing habitat for wildlife.

The Coronado National Forest also works closely with permittees in the area, particularly the Malpai Borderlands Group (MBG). The MBG was formed in 1991 by a group of ranchers in the Peloncillo area in response to the threat of future fragmentation of the landscape as well as declining productivity of the land (Curtin 2002). The group's goal is "to restore and maintain natural processes that create and protect a healthy, unfragmented landscape to support a diverse, flourishing community of human, plant, and animal life". To that end, MBG has secured conservation easements on more than 75,000 acres (30,350 ha) of private land in the Peloncillos Mountains region, and works with multiple state and federal agencies and institutions to incorporate scientifically-based best management practices. The MBG has also contracted with independent range management consultants to ensure that each of the Coronado National Forest grazing allotments is monitored and remains in good ecological condition (Rich Winkler²⁶, personal communication). Most of the allotments in New Mexico have been monitored on a three-year schedule for more than 15 years. Monitoring reports are filed with the Douglas Ranger District.

²⁶ Rich Winkler, Executive Director, Malpai Borderlands Group.

Fuelwood and Beargrass Harvesting:

Beargrass harvesting was last reported in the Peloncillo Mountains in 1998, and no permits have been issued by Coronado National Forest in recent years for either beargrass or fuelwood harvesting (Lerich and Cardinal, in review). There is no commercial timber harvesting in the Peloncillos.

Hybridization with Domestic Turkeys:

Hybridization with domestic turkeys in the Peloncillo Mountains is no longer a threat. The individual who was releasing domestic turkey poults in Guadalupe Canyon early on in the 1982-1992 NMSU studies ceased doing so 35 years ago and none of the ranchers within the New Mexico portion of the Gould's turkey range keep turkeys (R. Winkler, pers. comm.). We do not know if the potential for hybridization within this population currently exists in Sonora or Chihuahua.

Extant Potential Threats

Below we discuss lack of permanent water sources, fire, extended drought, poaching, and disease as potential threats or limitations to Gould's turkey persistence.

Lack of Permanent Water Sources:

There are no permanent lakes or streams in the Peloncillo Mountains, and few natural springs. Stock tanks and drinkers have been constructed in various locations, and cattle troughs on private ranches in some cases can provide reliable water sources for turkeys and other wildlife year-round, although it is unknown how essential they are. It is noteworthy in that regard, that turkeys produce metabolic water from digestion of carbohydrates and also derive dietary water from leaves, other succulent plant matter, invertebrates, and dew (Baur et al. 2019).

Gould's turkey is an arid country subspecies that successfully occupied its current range long before artificial water sources were available on both sides of the international boundary. Many of the wildlife drinkers that have been erected in the Peloncillos appear (GPS points and cameras) to receive little use, and the turkey population is demonstrably robust under the current distribution of water in the study area. The 1982-1992 NMSU studies mentioned in particular that a lack of free-standing water in brood rearing areas might be a limiting habitat component, but we point out that brood rearing occurs during the summer monsoon season, a time of year when water is available at multiple locations in and out of streams in all but the deepest drought years. We do not believe that provision of additional water sources at this time is necessary to ensure population persistence.

Fire:

Whereas low to moderate intensity fires can provide significant benefits to Gould's turkey habitat, severe wildfire can pose a significant threat. High intensity fires can cause soil damage, kill roost trees, temporarily destroy wet meadow habitat, and kill mast producing plants. Much of the Peloncillo Mountain range is in Fire Regime Condition Class 2 (USDA 2012), in which *"the risk of losing key ecosystem components is moderate. Fire frequencies have departed from historical frequencies by one or more return intervals, resulting in moderate changes to one or more of the following: fires size, intensity and severity, and landscape patterns."* To further reduce the probability of catastrophic fire, one of the goals of the Coronado National Forest management plan is to treat at least 35% of the vegetation in the Peloncillo Ecosystem Management Area every 10 years using wildland fire (planned and unplanned ignitions), prescribed cutting, and mastication (USDA 2018).

Comprehensive fire management planning and implementation by federal and state agencies in collaboration with private landowners in southeastern Arizona and the bootheel region of New Mexico has significantly reduced the potential for high-intensity fires in recent decades. In concert with federal and state agencies, the Malpai Borderlands Group has been successful in restoring periodic low intensity fire as a key ecosystem process (Allen 2006, Gottfried and Allen 2009, Gottfried et al. 2014). More than 100,000 acres of the Coronado National Forest and adjacent public and private lands in the Peloncillo Mountains have been burned at least once since the early-1990s either by using prescribed fire as a management tool (47,000 acres) or by allowing natural or accidental fires in pre-designated areas to burn and be managed for ecosystem restoration rather than having been immediately suppressed (Ben Brown²⁷, personal communication). In northern Sonora, conservation ranches owned and managed by the Cuenca Los Ojos Foundation adjacent to the U.S. border have been both applying and advocating for prescribed burns to restore grassland and woodland habitat integrity in the Sierra Pan Duro and adjacent lowlands (Barry 2014). Historical and current fire regimes in the Madrean Sky Island region were recently described by Villarreal et al. (2019, 2020), and provide a basis for future collaborative long-term planning and restoration efforts on both sides of the international boundary.

Extended Drought:

Although periodic drought may result in short-term population fluctuations and be a significant factor determining inter-annual forage availability and habitat use by Gould's turkeys (York et al. 2003), multi-year droughts could potentially reduce the population size considerably. In our own brief study, the low nesting rate recorded in 2021 (Table 2) coincided with a drought interval that extended well into the nesting season. However, because drought and other climate variables originate from regional or global processes, there is little wildlife and land managers can do to forestall or mitigate ultimate consequences to turkeys or other wildlife apart from evaluating the need for and potential success of a translocation of additional individuals to the affected population.

Poaching:

The potential for a small amount of opportunistic poaching exists in the Cascabel and Cloverdale areas, where there are primitive campsites that cater to hunters and recreationists. However, in comparison with other areas of New Mexico, the Peloncillos receive only light human visitation and much of the Gould's turkey range is substantially inaccessible to would-be poachers due to the presence of extensive areas of unroaded backcountry and/or private land ownership.

Disease:

Diseases can negatively impact wildlife populations, particularly in species that gather in large flocks like turkeys. Wild turkeys are susceptible to many infectious and noninfectious diseases including viral diseases, bacteria, and internal and external parasites (Davidson and Wentworth 1992, WAFWA 2019). As least 60 different parasites have been associated with wild turkeys (McRoberts et al. 2020). Although some level of disease can be found in populations, disease does not necessarily always result in population declines (Rocke and Yuill 1987). There are not currently large-scale treatments that can be applied when populations are diseased. Individuals that appear ill can be removed from the population in an attempt to reduce disease spread. Additionally, if a translocation is determined as necessary in the future to

²⁷ Ben Brown, Ph.D., former Science Coordinator, Malpai Borderlands Group, Animas, NM.

augment populations numbers, all birds will be tested for common diseases prior to being released in the Peloncillos.

Habitat Enhancement and Population Augmentation

Our 2017 Recovery Plan included the following measure as potentially required to meet our objective: *Where feasible and warranted, identify, prioritize, and implement specific habitat enhancement projects.*

At present, it is inconclusive what habitat enhancement projects might facilitate further population growth (or elevate carrying capacity). Successfully implemented habitat projects might cause the turkeys to use their range differently, but may not necessarily produce a larger population. The current Gould's turkey population is maintaining above the target objective of 175 adults without any active habitat management. It appears that current conditions (water, roosts, brood habitat, etc.) are adequate for sustaining population persistence. Therefore, at this point in time we believe there is no urgency for habitat management, and by extension, no need to augment the population with another translocation project. As we collect additional data from the GPS backpacked birds, we will continue to assess the desirability and need for targeted habitat management.

The Case for Delisting

Decisions about prospects for long-term persistence of threatened and endangered species often rely on simulation models collectively referred to as Population Viability Analysis (PVA). Meaningful PVA, however, requires years of data derived directly from the population under scrutiny on the mean and variance of critical vital rates, range size and trends, connectivity with adjacent populations, and realistic estimates of future environmental variability (Beissinger and Westphal 1998, Flather et al. 2011). Moreover, correct identification of population boundaries can have far reaching conservation and management implications (Waples and Gaggiotti 2008).

The question we ultimately are addressing in this document is: Does Gould's Turkey in New Mexico meet the statutory definition of a threatened species in New Mexico? Under the WCA, "*threatened species*" is defined as "*any species (or subspecies) that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range in New Mexico*". Gould's turkey was listed as threatened in 1974. It has never, even prior to listing, been known to be absent from the state, and in the ensuing 47 years the population has persisted, is demonstrably secure, and has likely increased in size. If the subspecies is delisted, it remains a "Protected Wildlife Species" under NMSA 17-2-3, and will continue to be monitored and managed by NMDGF for long term population viability into the future.

Conformance with the 2017 Recovery Plan

Our GPS telemetry studies 2018-present have produced information responsive to the Recovery Plan objective and objective parameters:

1. Using an improved survey method 2019-2021, we have documented that the Gould's turkey population size in the Peloncillo Mountains exceeds the Recovery Plan objective of at least 175 adults.
2. We have identified the approximate extent of the occupied range, and have now substantiated that the population extends well into Sonora/Chihuahua, Mexico. This ecological and

demographic continuity across the international border needs to be factored in when considering prospects for long-term persistence of Gould's turkey in New Mexico. There is not a discrete "Peloncillo Mountains" Gould's turkey population, but rather the Peloncillos are a geo-political management unit for a fluid segment of the total population.²⁸ In consequence, the number of Gould's turkeys present in New Mexico at any given point in time is not solely the result of internal local population dynamics or local habitat conditions.

3. Given our findings pertaining to range use and extensive turkey movements, we have no evidence that there are suitable unoccupied portions of the range that would not already have been naturally 'colonized' by the current population. Additional translocations for this purpose are unwarranted.
4. We have not found roost sites, water sources, or brood-rearing habitat to be limiting habitat components in otherwise suitable turkey range, as was suggested by the prior NMSU studies. It is conceivable that permanent artificial water sources distributed more broadly within the occupied range would alter range use, but a robust population has persisted under the current spatial and temporal configuration of free-standing water.
5. We find no evidence that there are localized anthropogenic threats operating at a scale or intensity that significantly limits Gould's turkey population growth to the extent that the current threatened status is warranted. In contrast, catastrophic fire, disease, and extended drought are inimical forces that could foreseeably impact the population in the future. However, numerical population recovery from such events via internal and external recruitment is highly probable in view of the extensive continuous range occupied by Gould's turkeys in New Mexico and the adjacent states in Mexico.
6. Given the long-term persistence of Gould's turkey in New Mexico (including 47 years post-listing) and the newly documented robust population size and distribution, identification of specific habitat enhancement projects to ensure the future security of Gould's turkey in New Mexico is at present unwarranted.

Recommendation

Delist Gould's turkey throughout its range in New Mexico in accordance with procedures detailed in the WCA, and continue to monitor and manage as a Protected Species under Chapter 17 NMSA to ensure population persistence.

²⁸ This conclusion applies as well to Gould's turkeys inhabiting the Animas/San Luis Mountains.

Literature Cited

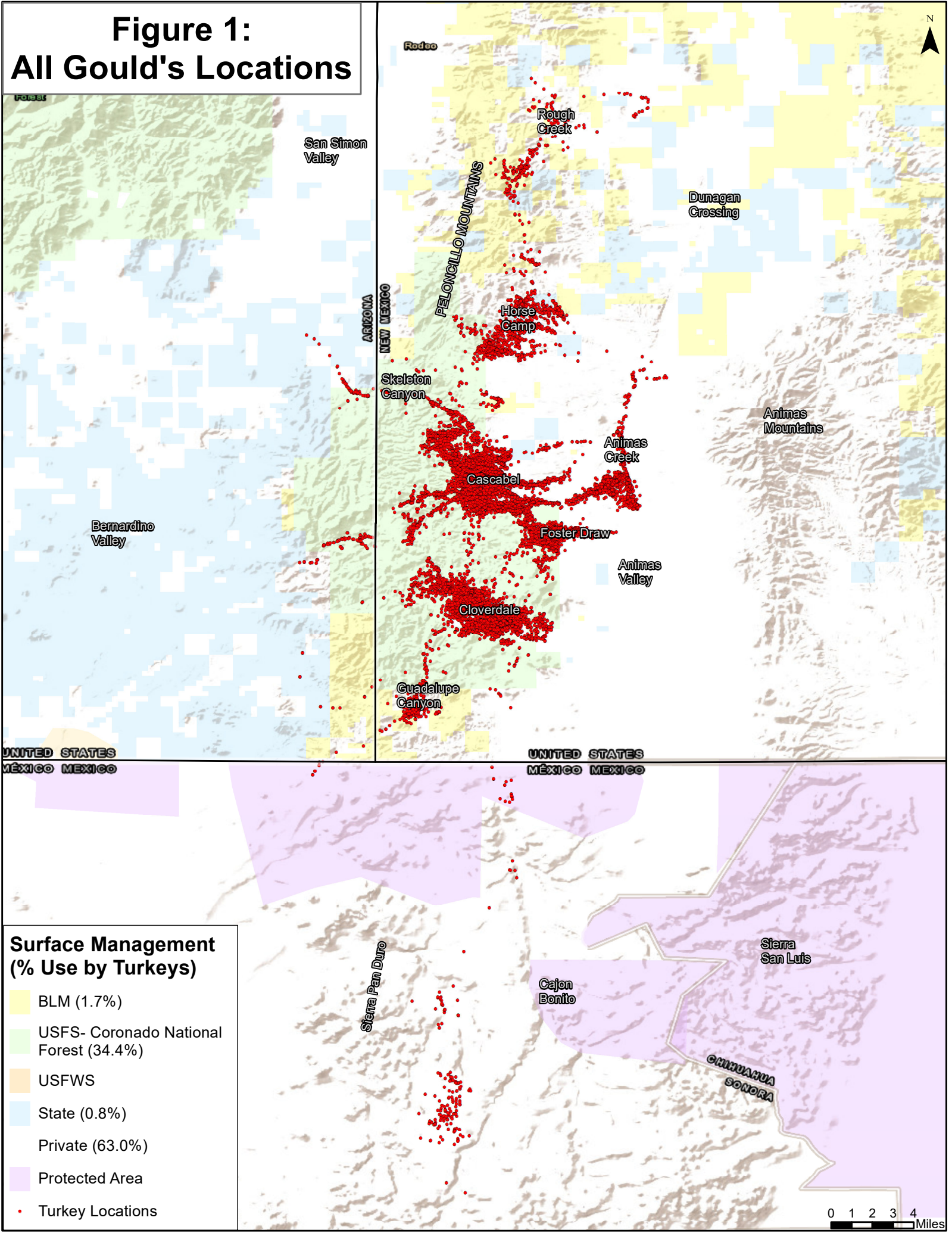
- Allen, L.S. 2006. Collaboration in the borderlands: the Malpai Borderlands Group. *Rangelands* 28(3): 17-21.
- Barry, T. 2014. Transborder drylands restoration: Vision and reality after three decades of innovative partnerships on the U.S.-Mexico border. *Surveys and Perspectives Integrating Environment and Society* 7(2): 1-8.
- Baur, E.H., S.D. Schemnitz, A. Lafon-Terrazos and L.E. Williams Jr. 2019. Turkeys in Mexico. Pages 141-161 in R. Valdez and J.A. Ortega-S (eds). *Wildlife Ecology and Management in Mexico*. Texas A&M University Press, College Station.
- Beissinger, S.R. and M.I. Westphal. 1998. On the use of demographic models of population viability in endangered species management. *Journal of Wildlife Management* 62: 821-841.
- Brown, D.E. 1994. *Biotic communities: southwestern United States and northwestern Mexico*. University of Utah Press, Salt Lake City, UT.
- Cardinal, C.J. and J.B. Bulger. 2017. Gould's Wild Turkey (*Meleagris gallopavo mexicana*) recovery plan. New Mexico Department of Game and Fish, Santa Fe.
- Caveny, R.J., S.J. Voelkel, W.T. Brademan, J.B. Hardin, M.J. Peterson, and B.A. Collier. 2011. Distribution, fidelity, and abundance of Rio Grand wild turkey roosts in the Texas coastal sand plains. *Proceedings of the Annual Conference of SEAFWA* 2011: 45-50.
- Chamberlain, M.J., B.S. Cohen, N.W. Bakner and B.A. Collier. 2020. Behavior and movement of wild turkey broods. *Journal of Wildlife Management* 84: 1-14.
- Collier, B.A., N. Fyffe, A. Smallwood, B. Oleson, N.W. Bakner, J.R. Heffelfinger and M.J. Chamberlain. 2019. Reproductive ecology of Gould's Wild Turkeys (*Meleagris gallopavo mexicana*) in Arizona. *Wilson Journal of Ornithology* 131: 667-679.
- Curtin, C.G. 2002. Integration of science and community-based conservation in the Mexico/U.S. Borderlands. *Conservation Biology* 16:880-886.
- Davidson, W. R. and E.J. Wentworth. 1992. Population influences: Diseases and parasites. in Dickson, J.G. (ed.). *The Wild Turkey: Biology and management*. Stackpole Books, Harrisburg, PA.
- Dickson, J.G. (ed.). 1992. *The Wild Turkey: Biology and management*. Stackpole Books, Harrisburg, PA.
- Figert, D.E. 1989. Status, reproduction, and habitat use of Gould's turkey in the Peloncillo Mountain, New Mexico. Thesis. New Mexico State University, Las Cruces, NM.
- Flather, C.H., G.D. Hayward, S.R. Beissinger, and P.A. Stephens. 2011. Minimum viable populations: is there a 'magic number' for conservation practitioners? *Trends in Ecology and Evolution* 26: 307-316.
- Flesch, A.D. 2014. Distribution, abundance, habitat, and biogeography of breeding birds in the Sky Islands and adjacent Sierra Madre Occidental of northwest Mexico. Final Report. Prepared for U.S. National Park Service, Wilcox AZ, and U.S. Fish and Wildlife Service, Albuquerque NM.

- Flesch, A.D. 2018. Patterns and drivers of long-term changes in breeding bird communities in a global biodiversity hotspot in Mexico. *Diversity and Distributions*, November 2018: 1-15.
- Fuller, A.K., S.M. Spohr, D.J. Harrison, and F.A. Servello. 2013. Nest survival of wild turkeys *Meleagris gallopavo silvestris* in a mixed-use landscape: influences at nest-site and patch scales. *Wildlife Biology* 19: 138-146.
- Gottfried, G.J. and L.S. Allen. 2009. A plan for landscape fire restoration in the southwestern borderlands. *Ecological Restoration* 27: 129-131.
- Gottfried, G.J., P.F. Ffolliott, D.G. Neary, and D.D. Decker. 2014. Effects of prescribed fire and a wildfire on oak savannas in the Peloncillo Mountains of the southwestern borderlands region. *Hydrology and Water Resources in Arizona and the Southwest: Proceedings*. Pages 35-40. <http://hdl.handle.net/10150/627355>.
- Gross, J.T., A.R. Little, B.A. Collier and M.J. Chamberlain. 2015. Space use, daily movements, and roosting behavior of male Wild Turkeys during spring in Louisiana and Texas. *Journal of the Southeastern Association of Fish and Wildlife Agencies* 2: 229-234.
- Healy, W.M. 1985. Turkey poult feeding activity, invertebrate abundance, and vegetation structure. *Journal of Wildlife Management* 49: 466-472.
- Healy, W.M. and S.M. Powell. 1999. Wild turkey harvest management: Biology, strategies, and techniques. U.S. Fish & Wildlife Service Biological Technical Publication BTP-R5001-1999.
- Howell, S.N. and S. Webb. 1995. A guide to the birds of Mexico and northern Central America. Oxford University Press.
- Hunt, R. and W. Anderson. 2002. A rapid biological and ecological inventory and assessment of the Cajon Bonito Watershed, Sonora, Mexico. Part 1: Natural history. *Desert Plants* 2002: 3-20.
- Hunt, R. and W. Anderson. 2004. A rapid biological and ecological inventory and assessment of the Cajon Bonito Watershed, Sonora, Mexico. Part 2: Using the variable transect. *Desert Plants* 2004: 3-18.
- Kaplan, E.L. and P. Meier. 1958. Nonparametric estimation from incomplete observations. *Journal of the American Statistical Association* 53: 457-481.
- Lehman, C.P., M.A. Rumble, L.D. Flake, and D.J. Thompson. 2008. Merriam's turkey nest survival and factors affecting nest predation by mammals. *Journal of Wildlife Management* 72: 1765-1774.
- Lehman, C.P., D.J. Thompson and M.A. Rumble. 2010. Ground roost resource selection for Merriam's Wild Turkeys. *Journal of Wildlife Management* 74: 295-299.
- Lerich, S.P. and C.J. Cardinal. In review. Historical and potential growth of Gould's Wild Turkey populations in New Mexico. *Proceedings of the National Wild Turkey Symposium* 12: XXX-YYY.
- Lerich, S. P., and B. F. Wakeling. 2011. Restoration and survival of Gould's wild turkeys in Arizona. *Proceedings of the National Wild Turkey Symposium* 10:277-281.
- List, R., J. Pacheco, E. Ponce, R. Sierra-Corona and G. Ceballos. 2010. The Janos Biosphere Preserve. *International Journal of Wilderness* 16: 35-41.

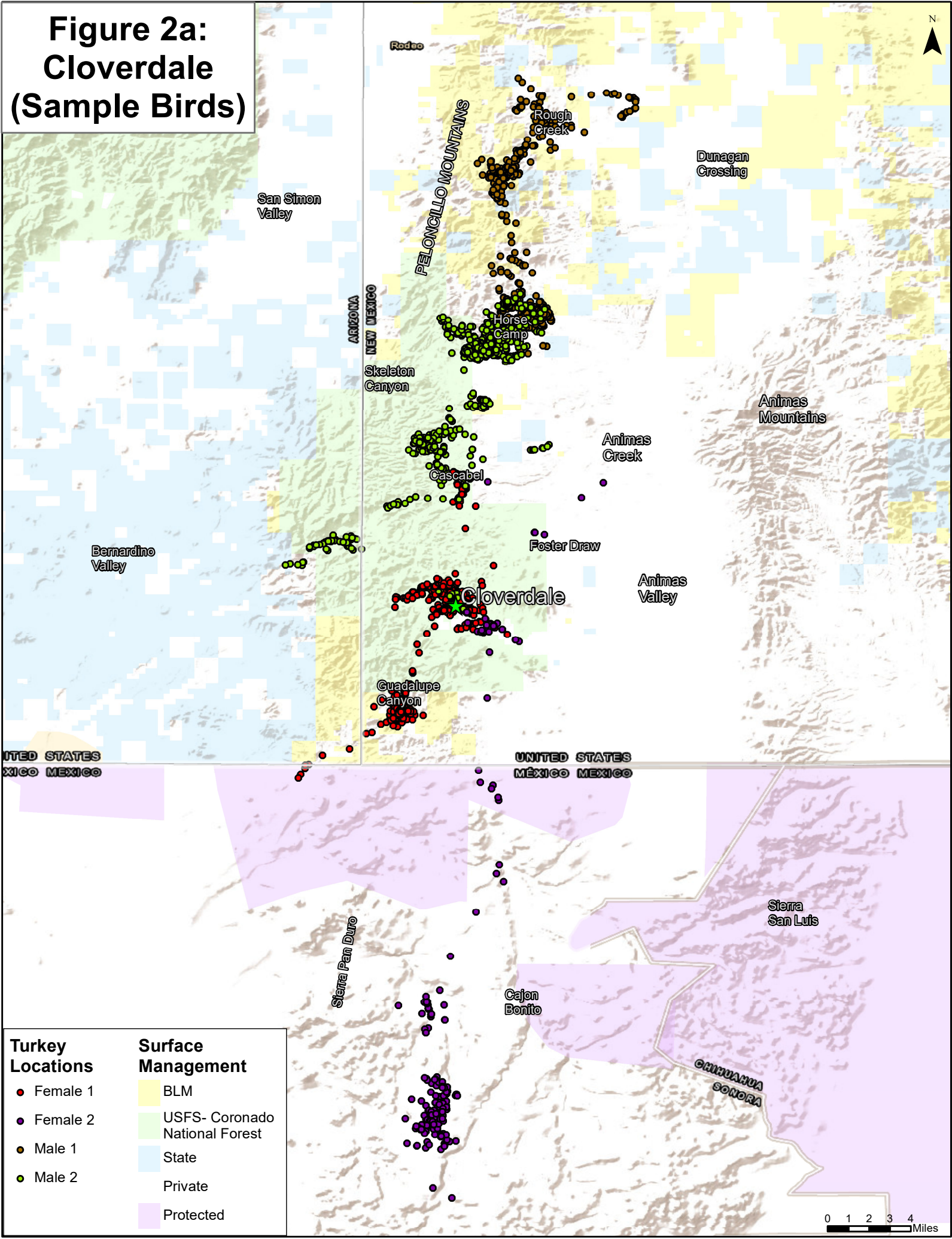
- Locke, S.L. 2007. Estimating Rio Grande wild turkey densities in Texas. PhD Dissertation, Texas A&M University, College Station, TX.
- Marshall, J.T. 1957. Birds of pine-oak woodland in southern Arizona and adjacent Mexico. *Pacific Coast Avifauna* 32.
- McRoberts, J.T., M.C. Wallace and S.W. Eaton. (2020). Wild Turkey (*Meleagris gallopavo*), version 1.0. *In* A.F. Poole (ed). *Birds of the World*. Cornell Lab of Ornithology, Ithaca, NY.
- Mearns, E.A. 1907. Mammals of the Mexican boundary of the United States. U.S. National Museum Bulletin 56.
- Mosby, H.S. 1967. Population dynamics. Pp. 113-136 *In* O.H. Hewett (ed). *The Wild Turkey and its Management*. The Wildlife Society, Washington, D.C.
- New Mexico Department of Game and Fish (NMDGF). 2020. Threatened and endangered species of New Mexico: Biennial review. NMDGF, Santa Fe, NM.
- Potter, T.D. 1984. Status and ecology of Gould's turkey in New Mexico. Thesis. New Mexico State University, Las Cruces, NM.
- Rocke, T. E., and T. M. Yuill. 1987. Microbial infections in a declining wild turkey population in Texas. *The Journal of Wildlife Management* 51: 778-782.
- Russell, S.M., and G. Monson. 1998. *The birds of Sonora*. University of Arizona Press, Tucson.
- Schemnitz, S.D. 1992. Limiting factors and management strategies for Gould's turkeys in the Peloncillo Mountains, New Mexico. Pp. 74-78 *In*: A.M. Barton and S.A. Sloane (eds.). *Chiricahua Mountains Research Symposium Proceedings*, 16-17 March 1992. Southwest Parks and Monuments Association, Tucson, AZ.
- Schemnitz, S.D. and T.D. Potter. 1984. Final Report: Status and ecology of Gould's turkey (*Meleagris gallopavo mexicana*) in the Peloncillo Mountains, Coronado National Forest, New Mexico. New Mexico Department of Game and Fish Contract 516-71-27.
- Schemnitz, S.D. and W.D. Zeedyk. 1982. Ecology and status of Gould's turkey in New Mexico. *Proceeding of the Western Wild Turkey Workshop* 1:110-125.
- Schemnitz, S.D. and M.L. Zornes. 1995. Management practices to benefit Gould's turkey in the Peloncillo Mountains, New Mexico. Pp. 461-464 *In*: L.F. DeBano. P.F. Ffolliott, A. Ortega-Rubio, G.J. Gottfried, R.H. Hamre, and C.B. Edminster (eds.). *Biodiversity and management of the Madrean Archipelago: The Sky Islands of southwestern United States and northwestern Mexico*. USDA Forest Service GTR-264, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
- Schemnitz, S.D., D.E. Figert and R.C. Willging. 1990. Ecology and management of Gould's turkeys in southwestern New Mexico. Pp. 72-83 *in* W.M. Healy and G.B. Healy (eds). *Proceedings of the Sixth National Wild Turkey Symposium*, National Wild Turkey Federation, Edgefield, SC.
- U.S. Department of Agriculture (USDA) - Forest Service. 2012. Coronado National Forest 2012 fire management plan. March 23, 2012.

- U.S. Department of Agriculture (USDA) - Forest Service. 2018. Coronado National Forest land and resource management plan. USDA-Forest Service Southwestern Region, Albuquerque, NM.
- Villarreal, M.L., S.L. Haire, J.C. Bravo and L.M. Norman. 2019. A mosaic of land tenure and ownership creates challenges and opportunities for transboundary conservation in the US-Mexico borderlands. *Case Studies in the Environment* 3: 1-10.
- Villarreal, M.L., J.M. Inguez, A.D. Flesch, J.S. Sanderlin, C.C. Montano, C.R. Conrad and S.L. Haire. 2020. Contemporary fire regimes provide a critical perspective on restoration needs in the Mexico-United States borderlands. *Air, Soil and Water Research* 13:1-18.
- Waples, R. and O. Gaggiotto. 2006. What is a population? An empirical evaluation of some genetic methods for identifying the number of gene pools and their degree of connectivity. *Molecular Ecology* 15: 1419-1439.
- Western Association of Fish and Wildlife Agencies (WAFWA). 2019. Guidelines for health screening and handling of galliforms. WAFWA Wildlife Health Committee, Fort Collins, Colorado, USA.
- Willging, R.C. 1987. Status, distribution, and habitat use of Gould's turkey in the Peloncillo Mountains, New Mexico. Thesis. New Mexico State University, Las Cruces, NM.
- York, D.L. 1991. Habitat use, diet, movements, and home range of Gould's turkey in the Peloncillo Mountains, New Mexico. Thesis. New Mexico State University, Las Cruces, NM.
- York, D.L. and S.D. Schemnitz. 2003. Home range, habitat use, and diet of Gould's turkeys, Peloncillo Mountains, New Mexico. *Southwestern Naturalist* 48: 231-240.
- Zeedyk, W.D. 1996. Peloncillo Mountains Gould's turkey surveys. New Mexico Department of Game and Fish Contract 96-516-30.
- Zeedyk, W.D. 1997a. Peloncillo Mountains Gould's turkey surveys. New Mexico Department of Game and Fish Contract 97-516-47.
- Zeedyk, W.D. 1997b. Animas – San Luis Mountains Gould's turkey surveys. New Mexico Department of Game and Fish Contract 97-516-47.
- Zeedyk, W.D. 1998a. Peloncillo Mountains Gould's turkey surveys. New Mexico Department of Game and Fish Contract 98-516.51.
- Zeedyk, W.D. 1998b. Animas – San Luis Mountains Gould's turkey surveys. New Mexico Department of Game and Fish Contract 98-516.51.
- Zornes, M. L. 1993. Ecology and habitat evaluation of Gould's wild turkey. in the Peloncillo Mountains, New Mexico. Thesis. New Mexico State University, Las Cruces, NM.
- Zornes, M. L. and S. D. Schemnitz. 1993. Gould's wild turkey management recommendations and habitat suitability index. Department of Fishery and Wildlife Sciences. New Mexico State University, Las Cruces, NM.

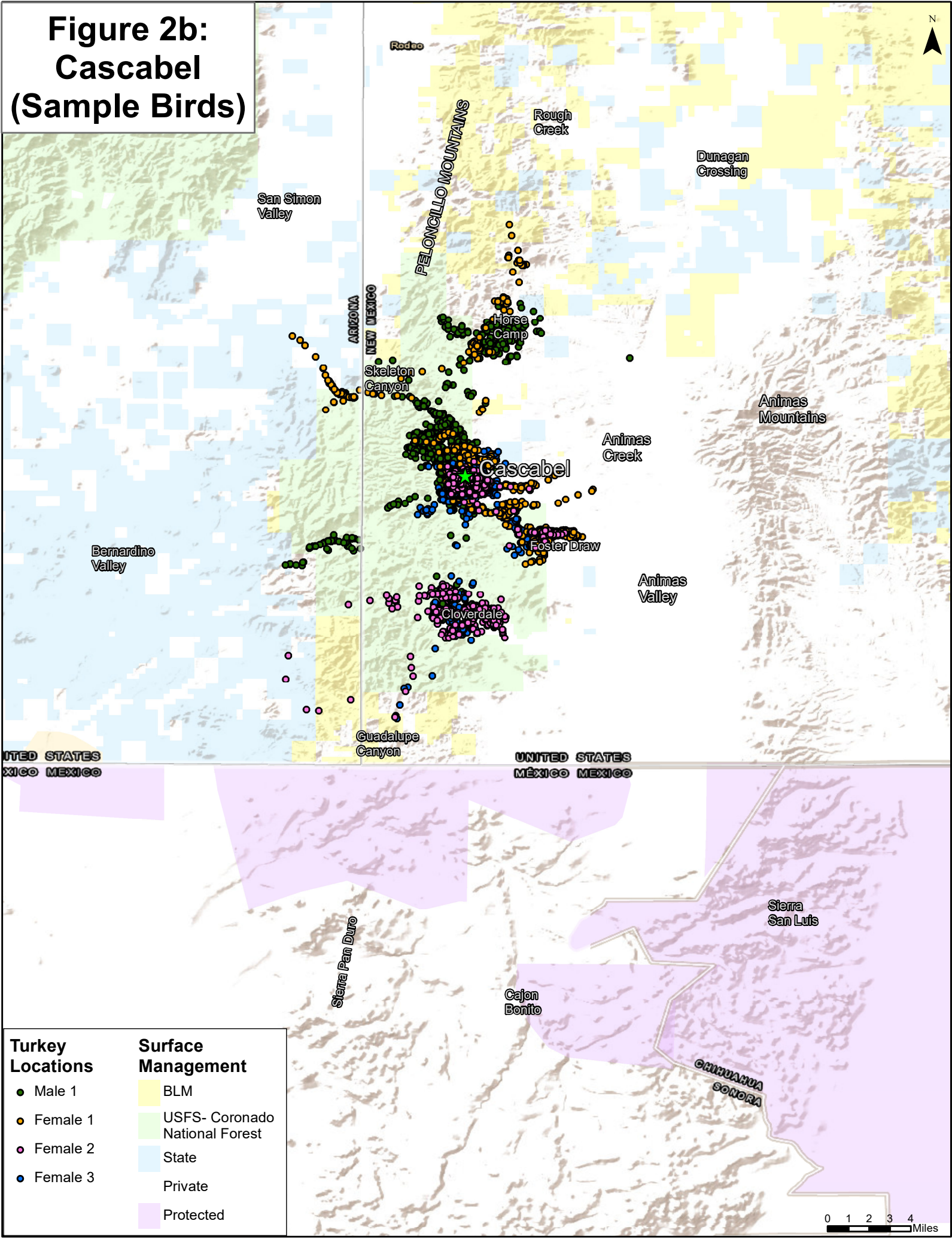
Figure 1: All Gould's Locations



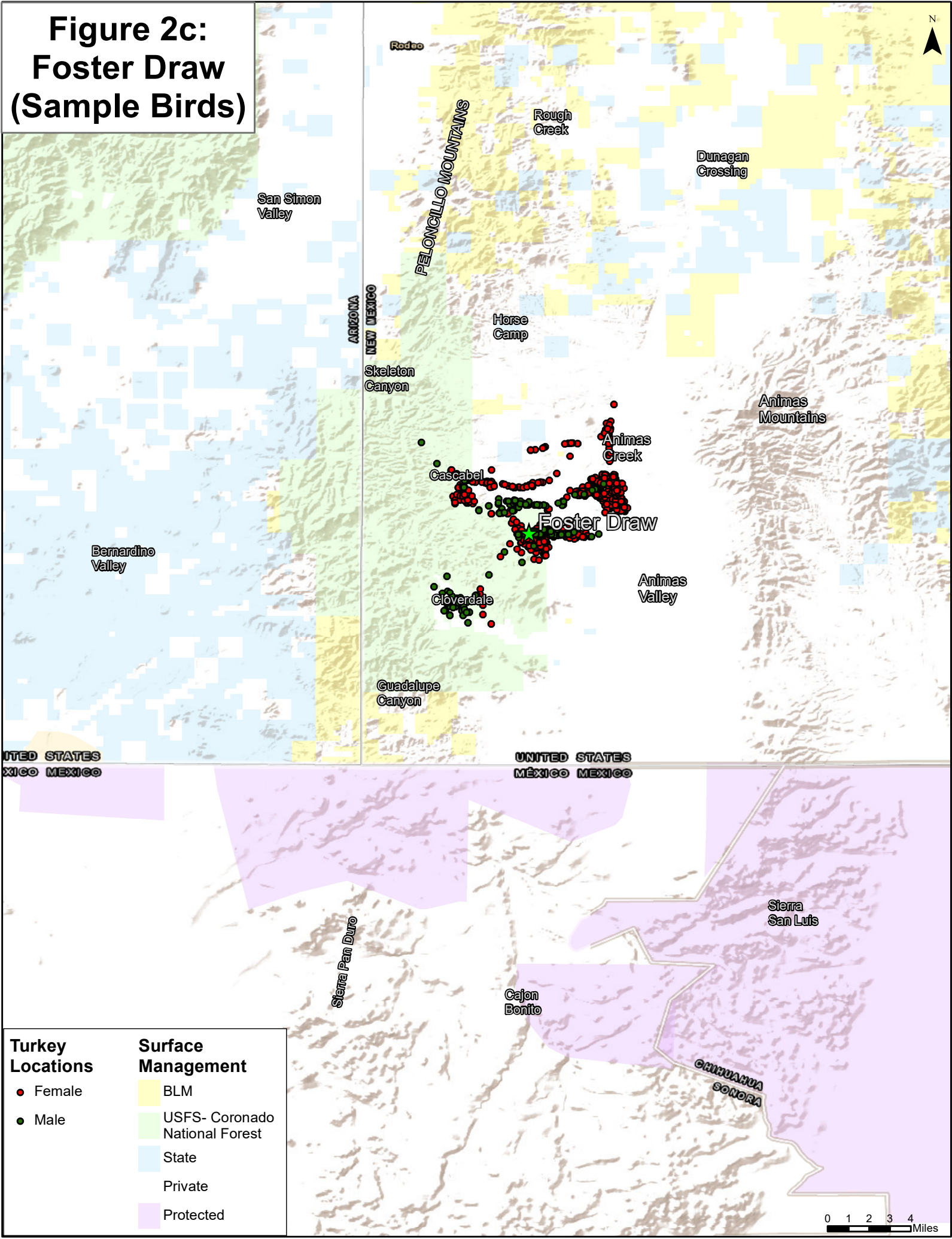
**Figure 2a:
Cloverdale
(Sample Birds)**



**Figure 2b:
Cascabel
(Sample Birds)**



**Figure 2c:
Foster Draw
(Sample Birds)**



**Figure 3:
Turkey Habitat Selection
(SW GAP)**

**GAP Habitat Types
(% Use by Turkeys)**

- Turkey Locations
- Apacherian-Chihuahuan Mesquite Upland Scrub (0.2%)
- Apacherian-Chihuahuan Piedmont Semi-Desert Grassland and Steppe (66.4%)
- Chihuahuan Creosotebush, Mixed Desert and Thorn Scrub (0.8%)
- Chihuahuan Mixed Salt Desert Scrub (0.8%)
- Chihuahuan Sandy Plains Semi-Desert Grassland (0.2%)
- Chihuahuan Succulent Desert Scrub (0.01%)
- Madrean Encinal (23.4%)
- Madrean Juniper Savanna (2.3%)
- Madrean Pine-Oak Forest and Woodland (0.01%)
- Madrean Pinyon-Juniper Woodland (2.3%)
- Madrean Upper Montane Conifer-Oak Forest and Woodland (2.3%)
- Mogollon Chaparral (0.6%)
- North American Warm Desert Bedrock Cliff and Outcrop (0.03%)
- North American Warm Desert Lower Montane Riparian Woodland and Shrubland (2.3%)
- North American Warm Desert Volcanic Rockland (0.02%)
- North American Warm Desert Wash (0.04%)

PELONCILLO MOUNTAINS

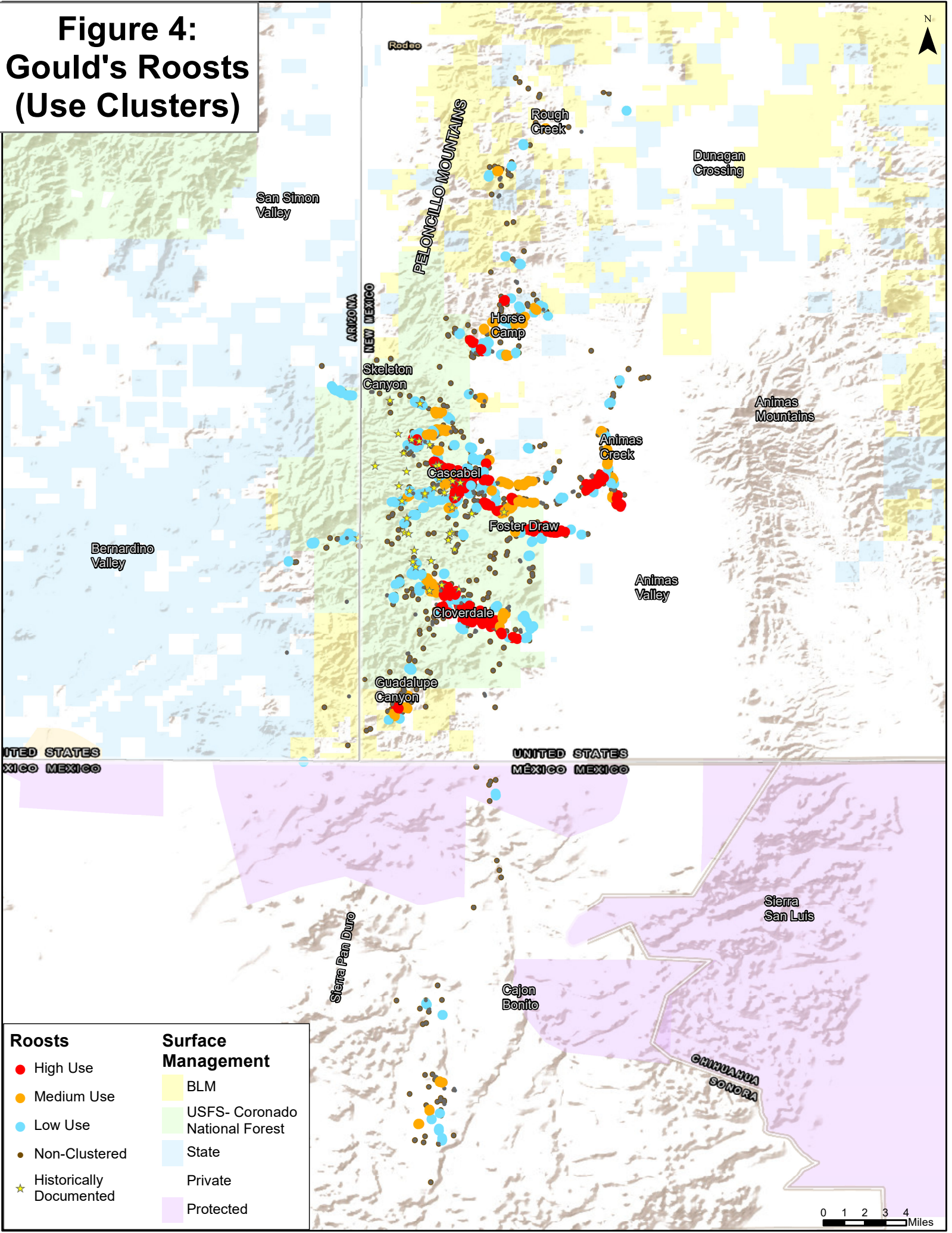
Dunagan Crossing

Animas Mountains

Animas Valley

0 1 2 3 4 Miles

**Figure 4:
Gould's Roosts
(Use Clusters)**



**Figure 5:
Nest and Brood Locations**

