Final Report
New Mexico Department of Game and Fish, Share with Wildlife Program

Year 1

January 30, 2026

Project Title*:*
Foraging habitat restoration and eDNA surveys for nectar bats on the Double E WMA

Contract No.:
25-516-0000-00030

Bat Conservation International
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Project Need

The Mexican long-nosed bat (*Leptonycteris nivalis*; federally endangered, IUCN 'Endangered'), Lesser long-nosed bat (*Leptonycteris yerbabuenae*), and Mexican long-tongued bat (*Choeronycteris mexicana*) are identified as Species of Greatest Conservation Need (SGCN) in the New Mexico Department of Game and Fish (NMDGF) State Wildlife Action Plan (NMDGF, 2016). Each year, these bats follow a "nectar corridor" of blooming columnar cacti and agaves as they migrate from central Mexico to the southwestern United States (Cockrum, 1991). All three species co-occur in southwestern New Mexico, where they seasonally share common roosts and agave food sources (Bogan and Cryan, 2006). Increasingly, *L. yerbabuenae* is being observed in the Gila region feeding on residential hummingbird feeders, with observations ranging from White Signal in 2010, to frequent observations in Silver City and Piños Altos, the Gila Cliff Valley, and as far north as Glenwood (Ramsey and Whiteman, 2011; Geluso and Geluso, 2021; Laws et al, 2023). Poor body condition is reported in *L. yerbabuenae* captured late in the season that appear to be relying solely on hummingbird feeders for food (M. Davies, personal communication). Recently, a biological consultant documented a new *L. yerbabuenae* roost near Redrock (M. Davies and M. Ramsey, personal communication).

These extralimital observations could suggest that a range expansion by nectar bats is anthropogenically induced. However, in 2021, after Jennifer D'Annibale, NMDGF Habitat Biologist for the Southwestern Region of New Mexico, posted a patch of *Agave palmeri* on the Double E Wildlife Management Area (WMA) on iNaturalist, she and R. Burke conducted monitoring for nectar bats at the site and recorded high *Leptonycteris* activity during peak flowering from late July to September (R. Burke, unpublished data). These recordings are likely the only detections of nectar bats in their natural foraging grounds in an area otherwise dominated by anthropogenic resource use, emphasizing the importance of the area for providing high-quality food sources for these bats prior to their fall migration.

With climate change, the Gila region is predicted to become more important for both nectar bats and agaves (Piccioli Cappelli et al., 2021; Gomez-Ruiz and Lacher, 2019). However, the Gila region is at risk of dramatic environmental change, as exemplified by several catastrophic wildfires over the past two decades. *Agave palmeri* can withstand low-intensity fire, but less is known about the impacts of high-intensity fire (Slauson, 2002). At the Double E WMA, the isolated nature of the agaves and the dense woody vegetation in which they occur may increase the agaves' susceptibility to high-intensity fire, with dense woody vegetation a likely result of past heavy grazing (NMDGF, 2017). In 2023, the high-severity Turkey Fire perimeter was within 1.5 miles of the Double E WMA (USFS, 2024). Under current management, the uplands of the Double E WMA are undergoing a transition back to more reference plant communities as it recovers from a legacy of heavy livestock use (NMDGF, 2017).

Because *A. palmeri* is susceptible to long-term impacts from livestock (Widmer, 2002), there is now an opportunity to establish a robust and resilient metapopulation.

Enhancing *A. palmeri* habitat at the Double E WMA will benefit nectar bats in the face of increasing habitat degradation elsewhere and aligns with Double E Ranch Management Plan priorities, and will enable NMDGF to further improve habitat for SGCN. This work will build upon the increasing knowledge about nectar bats in the region, the potential disproportionate importance of the Double E WMA for these bats, and the need to mitigate potential fire risks. We will address these issues by completing the Tasks outlined below.

Project Activities and Methods

Task 1: Collect seed in the existing patch of agaves (*Agave palmeri*) on the Double E WMA following the "Seeds of Success" sampling protocol to ensure that sustainable amounts of seed with appropriate genetic diversity are collected (BLM, 2024). Access the site on foot and clip 1-2 umbels from individual plants with telescoping loppers or shake stalks over a tarp to harvest the seeds. Send collected seeds to nursery partners to grow approximately 600 agave plants. Place remaining seeds in cold storage for future restoration work.

Task 2: Coordinate with the Agency to identify at least 3 reasonably-accessible agave translocation sites on the Double E WMA using existing habitat models, vegetation maps, soil surveys, and other ecological data and on-the-ground evaluations conducted throughout the winter. Coordinate with the Agency's archaeologist to ensure completion of all necessary Section 106 compliance paperwork and any on-the-ground archaeological surveys prior to translocating pups.

Task 3: Task 3 in the original contract was amended in its entirety to read as follows: Conduct a site assessment to determine the number of agave pups that can be sustainably removed from the existing agave patch without negatively impacting recruitment. During the winter of 2025, since existing pups are lacking, plant 150 agaves in ecologically appropriate sites on the Double E WMA identified in Task 2 above that are grown from regionally appropriate seed previously collected by the Contractor in the Peloncillo Mountains. For each agave planting, dig a hole approximately 15.24 cm x 15.24 cm in area. Limit total ground surface disturbance associated with planting agave seedlings to 3.5 square meters across the Double E WMA. Mulch seedlings with onsite rock materials and partially shade them with burlap to improve plant survivorship.

Task 4: Conduct environmental DNA (eDNA) surveys of the existing agave patch to test for the presence of 3 nectar bat species (Mexican long-nosed bat [*Leptonycteris nivalis*], Lesser long-nosed bat [*L. yerbabuenae*], and Mexican long-tongued bat [*Choeronycteris mexicana*]). Visit the agave patch shortly after sunrise up to 4 times during the peak flowering season in 2025 and collect up to 160 samples for eDNA analysis by swabbing open flowers with a sterile swab. Send samples to the Bat Ecology & Genetics Lab at Northern Arizona University for genetic analysis. Access all survey locations for agave eDNA sampling and field activities described in Tasks 1 through 3 above by using vehicles on established roads or, where established roads are not available, on foot. If

camping is necessary, the Contractor will minimize disturbance to sites by camping where allowed by the Agency and primarily on already-disturbed ground (e.g., trails) and at least 25 feet away from any flowering agaves. Limit ground surface disturbance associated with collecting and transplanting agave pups, as described in Task 3 above, to a maximum of 464 square centimeters per pup and a maximum of 7 square meters across the Double E WMA.

This Task (4) was also amended to include: Create a comprehensive map of existing agave stands on the Double E WMA. Coordinate field work with Agency biologists to determine when access is permitted and the best access points. Prioritize areas within Hills Ecological Sites (R038XB103NM) and conduct all surveys in upland habitat outside of the riparian zone. Record agave presence as waypoints, delineate clusters using polygons, and record relative density. Produce a map of agave habitat suitability based on existing models, ecological sites, and soil map units data.

Summary of Results

As of January 5, 2026, field work for Task 1 (agave seed collection), Task 2 (identification of agave planting sites), and Task 3 (planting of agaves) has been completed. Environmental DNA field sampling for Task 4 has been completed, and we anticipate that lab analysis and mapping of agave patches for this Task will be completed by January 31, 2026. All map and geodatabase deliverables will be produced in January 2026 and provided with the final report.

Task 1: Collect seed in the existing patch of agaves (*Agave palmeri*) on the Double E Wildlife Management Area (WMA)

BCI staff Rachel Burke (Agave Restoration Coordinator) and Brianna Mann (Restoration Specialist) collected *A. palmeri* seeds from the existing agave patch on the Double E WMA with NMDGF Southwestern Region Habitat Biologist, Jennifer D'Annibale. We collected 2-3 umbels (rebranching group of flower clusters) from 25 individual plants, following the "Seeds of Success" protocol (BLM, 2024). We clipped individual umbels that had developed fruits using a telescoping lopper and collected them in buckets. We allowed the umbels to fully dry to ensure full seed development. We then transported the collection to our nursery partner Borderlands Restoration Network (BRN) and cleaned the seed for propagation and storage.

The agaves had high seed set, indicating high-quality pollination (most likely by bats), and have had excellent germination rates with our partners at BRN. Over 600 seedlings were propagated in January 2025 for the Double E WMA, with additional seedlings propagated for use in restoration work on public lands in the greater Gila region. All seedlings derived from seed collected on the Double E WMA will be used in non-commercial agave restoration work as part of BCI's Agave Restoration Initiative. Seedlings will be ready for transplanting on the Double E WMA in 2027. Any seeds that were not put into immediate propagation have been placed in cold storage at BRN's Seed Lab.

Task 2: Coordinate with the Agency to identify at least 3 reasonably-accessible agave translocation sites using existing habitat models, vegetation maps, soil surveys, and other ecological data and on-the-ground evaluations conducted throughout the winter. Coordinate with the Agency's archaeologist to ensure completion of all necessary section 106 compliance paperwork and any on-the-ground archaeological surveys.

To date, Rachel Burke has conducted 2 site visits to the Double E WMA in coordination with Jennifer D'Annibale. On March 11, 2025, Burke and D'Annibale scouted multiple potential access routes to portions of the Double E WMA which contain suitable agave habitat. On March 12, 2025, Burke and D'Annibale hiked into the north end of the Double E WMA on an old unmaintained road on U.S. Forest Service (USFS) lands off of Turkey Creek Road near the southwestern edge of the Gila Wilderness. Incidentally, we documented multiple *Agave palmeri* patches on USFS lands, further emphasizing the likely importance of this region to nectar bats, as well as on the Double E WMA proper. On the north end of the Double E WMA, we delineated three potential planting clusters within appropriate ecological sites. Each cluster already contained a small number of *A. palmeri*. These northern planting areas comprise 15 acres in total. We determined that access on foot requires an 11-mile round trip hike, but that access on an unmaintained USFS road may be possible with a UTV. Access with a 4x4 truck is possible through private (with permission from a private landowner) and State Trust land to the west of the proposed planting area. In October, Jennifer D'Annibale obtained permission from the landowner for BCI to utilize this private road to conduct project activities. The landowner was informed of planned project dates and is allowing temporary road use for archeological surveys of the planting polygons, planting work, and mapping activities (Task 4). Future access beyond these activities is not guaranteed or granted.

On May 6, 2025, Burke and D'Annibale conducted a site visit to suitable agave habitat on the south side of the Double E WMA. We accessed sites through New Mexico state trust and BLM-administered lands on the eastern edge of the Double E WMA near Hell's Half Acre.

We did not encounter any existing *A. palmeri* at these sites; however, suitable vegetation and soil types exist for habitat enhancement. We delineated potential planting areas near Medina Tank and on an isolated portion on the southern edge of the Double E WMA. Access on foot involved an 8-mile round trip hike. However, with permission from the Casitas De Gila, UTV access to these sites is feasible from the west side on an existing road. We delineated three possible planting areas along this route, adjacent to the existing road for access feasibility. In total, these areas comprise 8 acres. BCI is not allowed to utilize this private access route without being accompanied by NMDGF personnel.

Shapefiles for these ground-validated planting areas were provided to our staff cultural resource specialist, Amalia Kenward, in order to determine the necessary level of compliance in coordination with NMDGF Archaeologist Jack Young. Kenward, along with another BCI cultural resource specialist, Douglas Lynne, were then able to conduct site surveys in October. Joined by Burke and D'Annibale, surveys at the southern end of

the Double E WMA took place on October 15, 2025. We were able to obtain permission from the O'Connors to utilize their private road with a UTV, provided a NMDGF employee (D'Annibale) was present.

On October 15, we visited the southern proposed planting polygons. Surveys revealed that our preferred planting area in the south was no longer eligible for ground disturbance due to Section 106 concerns. Kenward is in communication with the NMDGF to submit corresponding reports.

On October 16, Kenward and Lynne surveyed the northern polygons. There were no Section 106 concerns in this area. Kenward reported findings from both the southern area and northern area to Jack Young upon returning to the office. It was determined that: a) no plantings are to occur in the southern polygon; and b) plantings could continue in the northern area provided that Kenward is present to monitor the planting work to ensure that there are no adverse impacts to cultural resources in that area.

There is one polygon that we had delineated as a suitable site on the southern end of the Double E WMA that we were unable to access for archaeological clearance. However, we determined that the three approved polygons on the northern end would provide the most benefit to the bats, given the polygons' distance from the existing agave patch and their potential to provide more foraging connectivity between the Double E WMA and patches of agave on USFS lands to the north.

Task 3: During the winter of 2025, due to the lack of pups available for transplanting, plant 150 agaves in ecologically-appropriate sites on the Double E WMA (identified in Task 2 above) that were grown from regionally-appropriate seed previously collected by the Contractor in the Peloncillo Mountains. For each agave planting, dig a hole approximately 15.24 cm x 15.24 cm in area. Limit total ground surface disturbance associated with planting agave seedlings to 3.5 square meters across the Double E WMA. Mulch seedlings with onsite rock materials and partially shade them with burlap to improve plant survivorship.

Due to the lack of pups available for harvesting from the existing agave patch for transplanting elsewhere, we modified our planting plans to utilize seed-grown nursery agaves instead of on-site pups. We obtained 150 3-year-old *Agave palmeri* seedlings, derived from seeds collected in the Peloncillo Mountains, from one of our nursery partners. These seeds were collected by our partners at Borderlands Restoration Network on the Coronado National Forest along Geronimo Trail Road (NFSR 63) under Coronado National Forest Special Use Permit number SUP0122. These 150 transplants will introduce more genetic diversity to the Double E WMA agave population, and will be complimented by the 600 agaves from the on-site seed collection that will be ready for planting in 2027.

Plantings in the northern polygons were scheduled to avoid work on the Double E WMA during any open hunts. We were able to schedule work for the brief window between deer and elk season during the week of December 15, 2025. On December 16 and 17,

we planted 150 *A. palmeri* seedlings on the northern end of the Double E WMA, with 50 in each delineated polygon. We dug a hole of approximately 15.24 cm x 15.24 cm for each agave seedling, filled in each hole after inserting the seedling, and mulched and secured each plant with a small ring of onsite rock material. Plants were shaded with a small piece of burlap for additional protection as they acclimate to the site. We were able to access the planting site on the existing private road with permission from the landowner.

Task 4: Conduct environmental DNA (eDNA) surveys of the existing agave patch to test for the presence of 3 nectar bat species (Mexican long-nosed bat [*Leptonycteris nivalis*], Lesser long-nosed bat [*L. yerbabuenae*], and Mexican long-tongued bat [*Choeronycteris mexicana*]).

On August 5, 2025, Burke scouted the existing agave patch on the Double E WMA to determine the number of flowering agave stalks in the patch and establish a sampling design based on flowering density. Unfortunately, upon accessing the site, it was determined that only 4 plants in the entire patch were bolting and would flower this season. We determined that we would sample all available flowers in the patch throughout the sampling window. Initially, we had planned to sample mid-August through mid-September to correspond with the highest likelihood of nectar bat presence in the region, which tends to occur later in the summer. However, after being informed that we were not allowed to sample on the Double E WMA during any open hunt periods, we had to modify our plans to sample only in August prior to hunting season.

We collected samples from all available flowering agaves in the patch on August 12, August 19, and August 26. Upon accessing the site on August 12, only 3 stalks were flowering (one of the 4 bolting plants had unusually-delayed phenology and still had not produced any branches or buds by that date). We collected 2 swabs from all 3 flowering plants on each sampling occasion, collecting 18 swabs in total throughout the sampling period. The fourth plant still had not produced flowers by the last day of sampling.

eDNA samples were stored in the freezer until the end of the sampling season, and then delivered to the Bat Ecology and Genetics Lab at Northern Arizona University for analysis.

The lab conducted qPCR analysis on each sample, testing for the presence of the lesser long-nosed bat, Mexican long-nosed bat, and Mexican long-tongued bat in each. We have received preliminary results from the lab that indicate the potential presence of all three nectar bat species on the Double E WMA. Due to management implications associated with any detections of the federally endangered Mexican long-nosed bat, the lab re-sequences any positive detections of this species. We have provided preliminary eDNA results in a supporting geodatabase. We also interpret preliminary results in Figure 13. Based on these preliminary results, all three nectar bat species were present on the Double E WMA throughout the sampling period. All three species utilized all available flowering agaves in the patch throughout the sampling period, adding further support to the assumption that *A. palmeri* availability in the greater Gila region is

disproportionately important to these species in the late summer months prior to fall migration. It appears as though even during periods of poor flowering, the Double E WMA still provides critical resources to nectar bats.

Due to the reduced number of samples collected than we had originally budgeted for, we amended this task to include the production of a map of existing agave on the Double E WMA based on conducting new surveys to determine if any other patches exist. In December 2025 and January 2026, we surveyed portions of the Double E WMA that we considered to be potential agave habitat based on underlying ecological sites. We conducted hiking transects throughout Hills Ecological Sites (R038XB103NM) on the northern and southern end of the WMA. Because mature agaves are typically detectable from long distances, we followed ridgelines and scanned the surrounding area using binoculars (10 x 50 mm) as we hiked. If we identified any agave, we walked to the individual plants to document the relative density of plants within a patch.

In the field, we determined that these methods enabled us to view individual agaves approximately 500 meters from our hiking route depending on topography. To estimate the total survey coverage and detection likelihoods using this method, we conducted a viewshed analysis in ArcGIS Pro using all hiking tracks and a 30-m resolution digital elevation model. We converted this into a binary model to identify visible versus non-visible areas along the survey route. This approximation indicates that we were able to survey around 40 percent of the predicted agave habitat on the WMA (i.e., 40 percent of the Hills Ecological Site). Shapefiles to denote visible areas along the survey routes are provided in the supporting geodatabase.

In addition to the known large *A. palmeri* patch on the WMA, we identified several scattered individual agaves, one low-density cluster of plants, and one medium-density cluster. All agaves were determined to be *A. palmeri.* All new agave detections were on the north end of the WMA adjacent to the Gila National Forest. All agaves on the WMA are within the same soil map unit (Muzzler-Rock outcrop association, 25 to 45 percent slopes). We collected individual waypoints for all new agave observations and delineated the patch with a polygon in ArcGIS Pro. Within the attribute table, we denote the relative density of plants and estimated number of individuals. We did not collect individual points within the known large agave patch, but delineated the patch with a polygon. We estimate that there are more than a thousand individual plants within this patch.

Although the sample size of observed individual agaves across the WMA was too small to generate a statistically robust predictive model, we anecdotally observed that all documented plants on the WMA are on southeast-, south-, and southwest-facing slopes within the Muzzler-Rock outcrop association. This is likely because within MLRA 038X, where the Double E WMA occurs and within which R038XB103 NM Hills Ecological Site is classified, northern slopes are more densely forested than elsewhere throughout the range of *A. palmeri*. Although potential agave habitat on the WMA can still be defined by the R038XB103NM Hills Ecological Site, it can be further refined to southern aspects within the Muzzler-Rock outcrop association. We provide shapefiles for each of these

options, as each may have different management applications depending on the need for specificity or level of conservativism when estimating potential habitat. We have provided a map of the predicted *A. palmeri* habitat on the Double E WMA based on our field surveys and confirmed occurrences (Figure 14). Associated shapefiles of survey routes, presence records, and polygons with relative densities are provided within the supporting geodatabase.

Limited access to the Double E WMA made thorough agave surveys difficult. The timing of our surveys was limited to periods between open hunts on the WMA, and physical access required long hikes and coordination with surrounding landowners. We developed our survey methods of long hiking transects and viewshed surveys along vantage points based on this limited access in order to cover as much ground as possible. There are portions of the WMA that we were unable to access due to difficult terrain; we recommend future surveys take place in these areas, including the far northeastern end of the WMA near Brushy Canyon and Seep Springs Canyon. To facilitate access for this specific project, we were given one-time permission from surrounding landowners to use their private roads. However, no access is guaranteed in the future, so further surveys may require upwards of 10-15 miles of hiking on rugged terrain. Our specific survey routes are provided in the supporting geodatabase.

While conducting our surveys, we observed a large group of trespass cattle on the south end of the WMA. We first observed them around Medina Tank, and then on, in, and around the large *A. palmeri* patch on the south side of the WMA. Because livestock will eat agave stalks as the stalks go to flower (typically during the early bolting season when stalks are most palatable), we recommend that these trespass cattle be removed as soon as possible. Our preliminary eDNA survey results indicate that even during years of poor agave flowering, all three species of nectar bats rely on these agaves, including the federally endangered Mexican long-nosed bat. Even a small loss of flower availability due to livestock herbivory could have a disproportionate impact on nectar bats given the limited availability of *A. palmeri* in the Gila region.

Figures

Figure 1. (left to right) Brianna Mann (BCI Restoration Specialist), Rachel Burke (BCI Agave Restoration Coordinator), and Jennifer D'Annibale (NMDGF), with a developed *Agave palmeri* umbel on the Double E WMA. Photo credit: Brianna Mann, Bat Conservation International.

Figure 2. Dried *Agave palmeri* fruit collected on the Double E WMA. The black seeds in the pod are all viable seeds, while white seeds are inert. The high proportion of black seed indicates high-quality pollination. Photo credit: Rachel Burke, Bat Conservation International.

Figure 3. Rachel Burke (Bat Conservation International) holding *Agave palmeri* seedlings that are growing in the greenhouse at Borderlands Restoration Network (Patagonia, AZ) from seeds collected at the Double E WMA. Photo credit: Francesca Claverie, BRN.

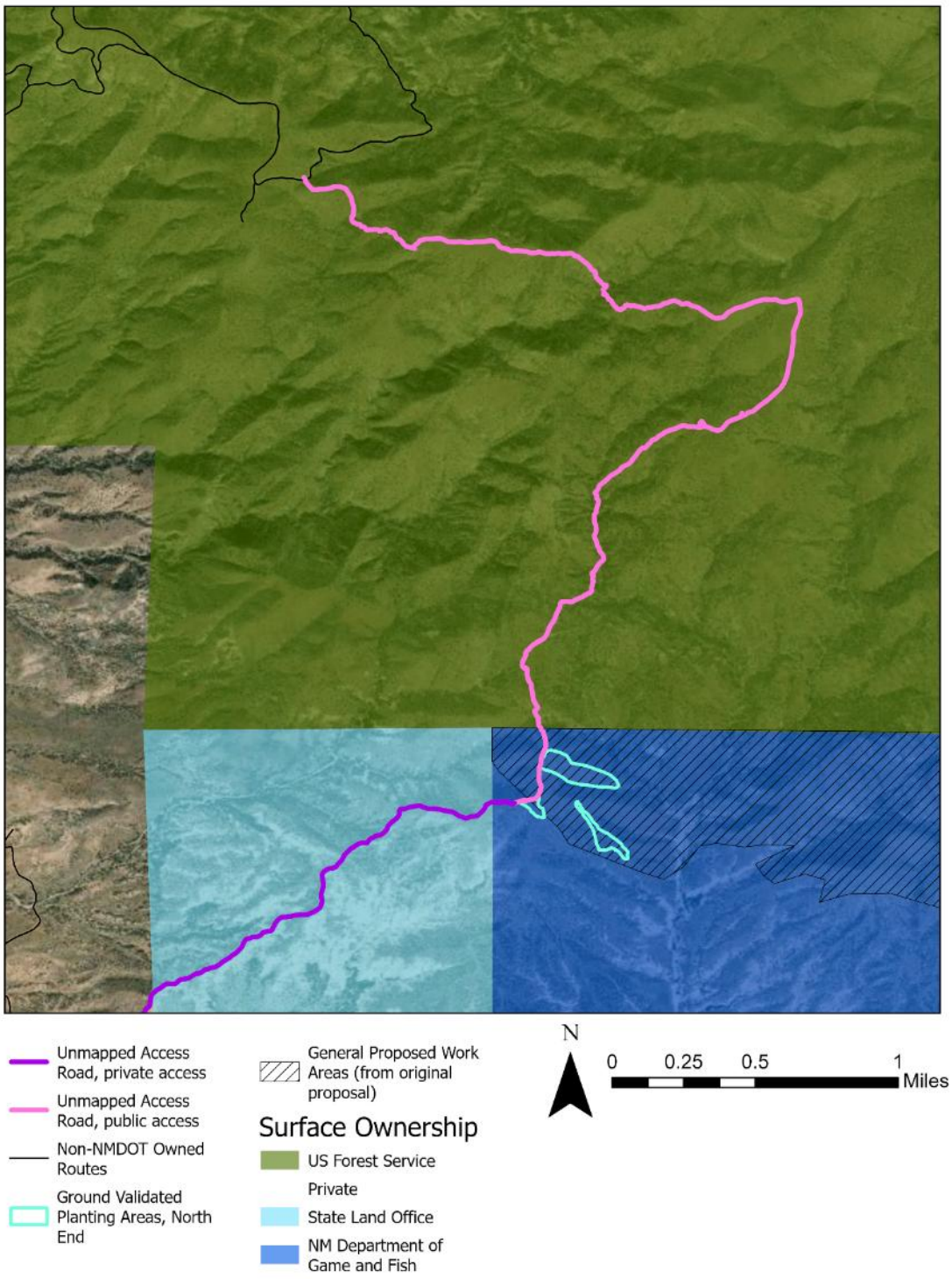

Figure 4. *Agave palmeri* planting areas delineated on the northern edge of the Double E WMA.

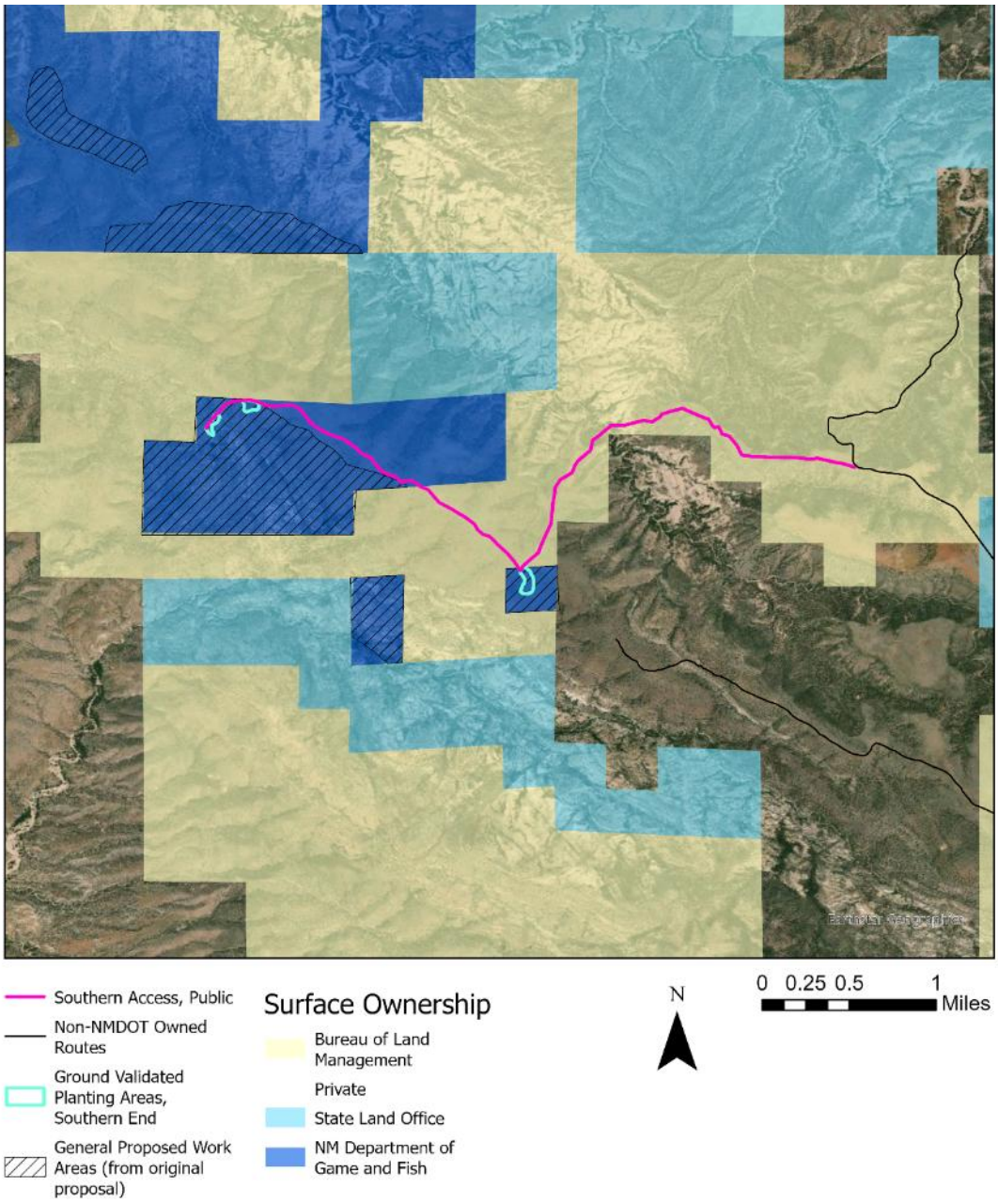

Figure 5. *Agave palmeri* planting areas delineated on the southern edge of the Double E WMA.

Figure 6. Left: Example of a proposed *Agave palmeri* planting area on the north side of the Double E WMA along an existing road. Right: Example of a proposed planting area on the south side of the Double E WMA. Photo credits: Rachel Burke, Bat Conservation International.

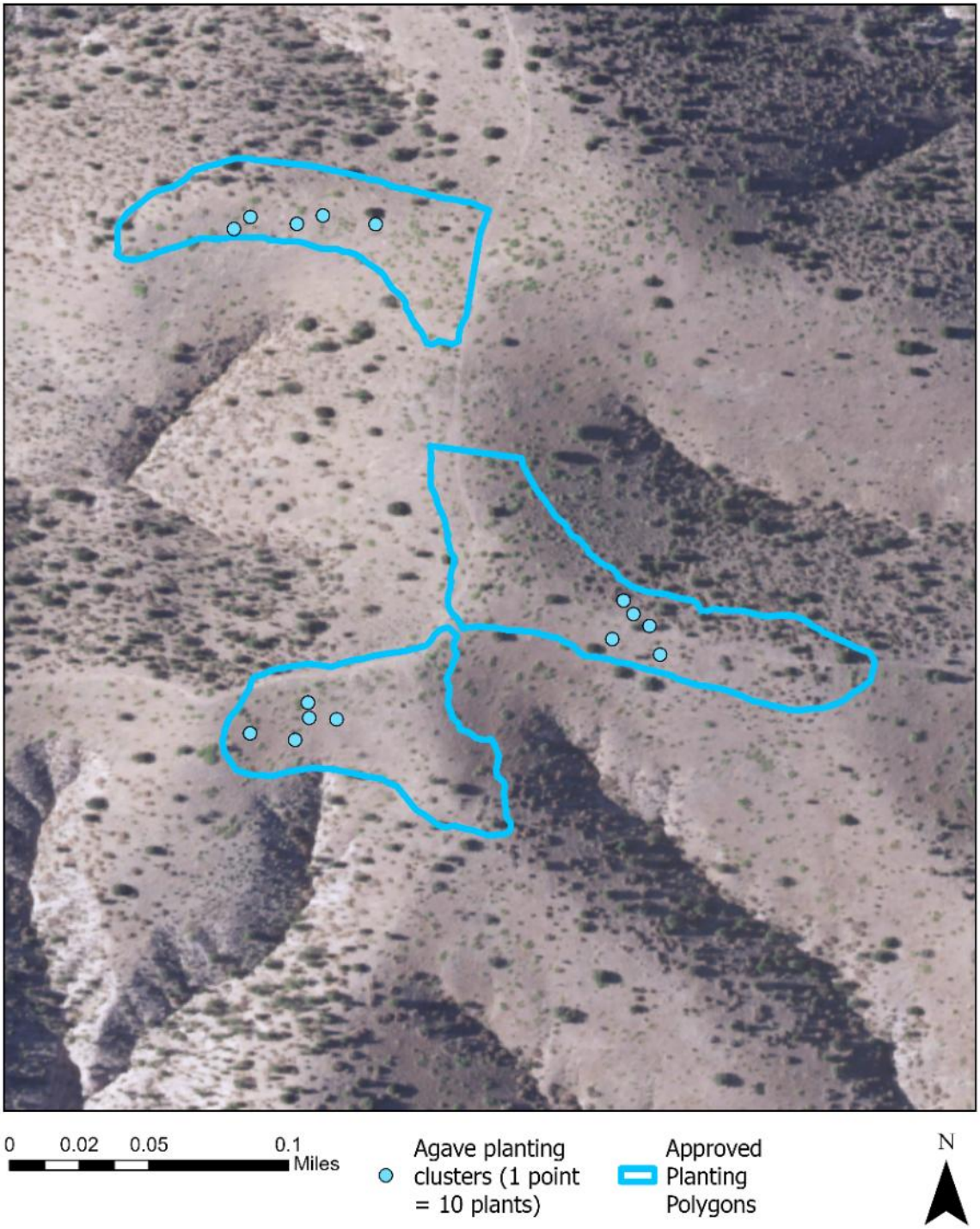

Figure 7. Approved *Agave palmeri* planting areas upon archeological clearance and planting clusters from December 2025. Southern planting areas were omitted due to Section 106 concerns.

Figure 8. BCI Technician Devin Robbins planting *Agave palmeri* in the northern portion of the Double E WMA. Photo credit: Rachel Burke, Bat Conservation International.

Figure 9. *Agave palmeri* seedling planted with rock mulch on the Double E WMA (before installing burlap shade). Photo credit: Rachel Burke, Bat Conservation International.

Figure 10. Habitat view of planting area number 3 on the north end of the Double E WMA. Photo credit: Rachel Burke, Bat Conservation International.

Figure 11. BCI staff collecting eDNA samples from blooming agaves on the Double E WMA. Photo credits: Rachel Burke, Bat Conservation International.

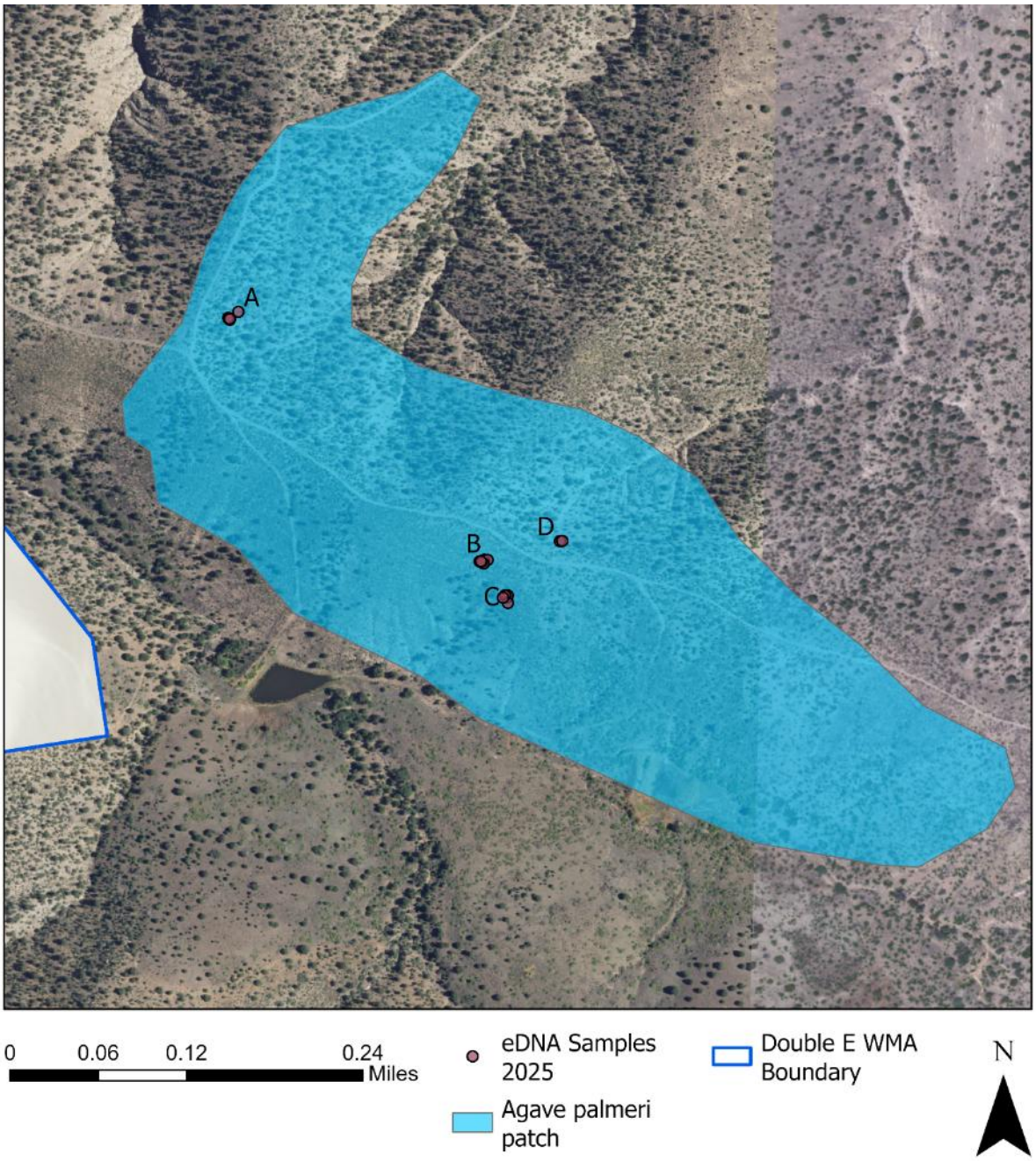

Figure 12. Year 1 eDNA sample locations. Throughout this large *Agave palmeri* patch, these points represent the only flowering agaves in 2025.

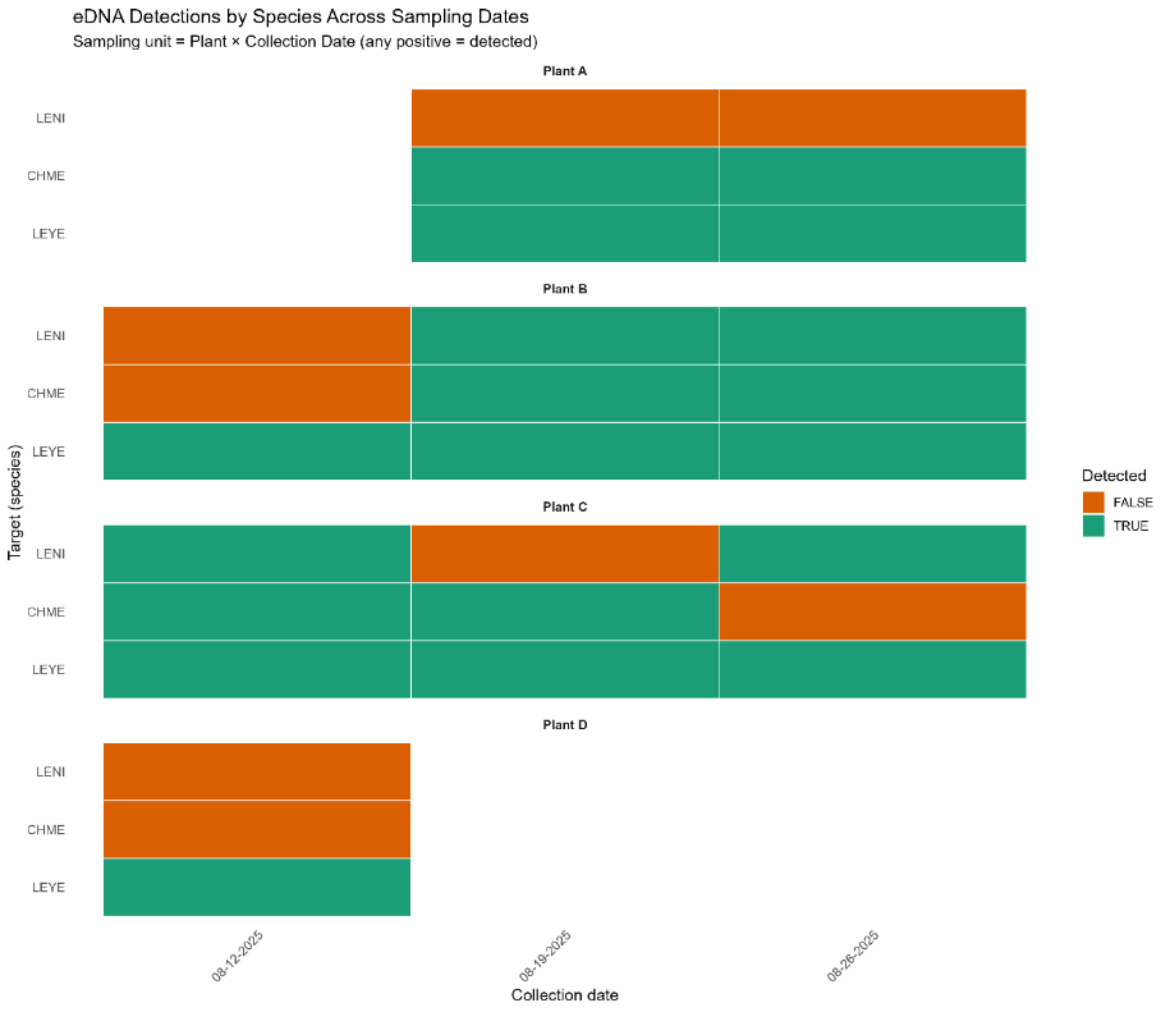

Figure 13. Preliminary eDNA survey results for Year 1. Results are currently being verified with re-sequencing by the lab. If a plant was not surveyed at each sampling event, it either was not flowering yet (Plant A on 8/12/2025) or fell over (Plant D after 8/12/2025).

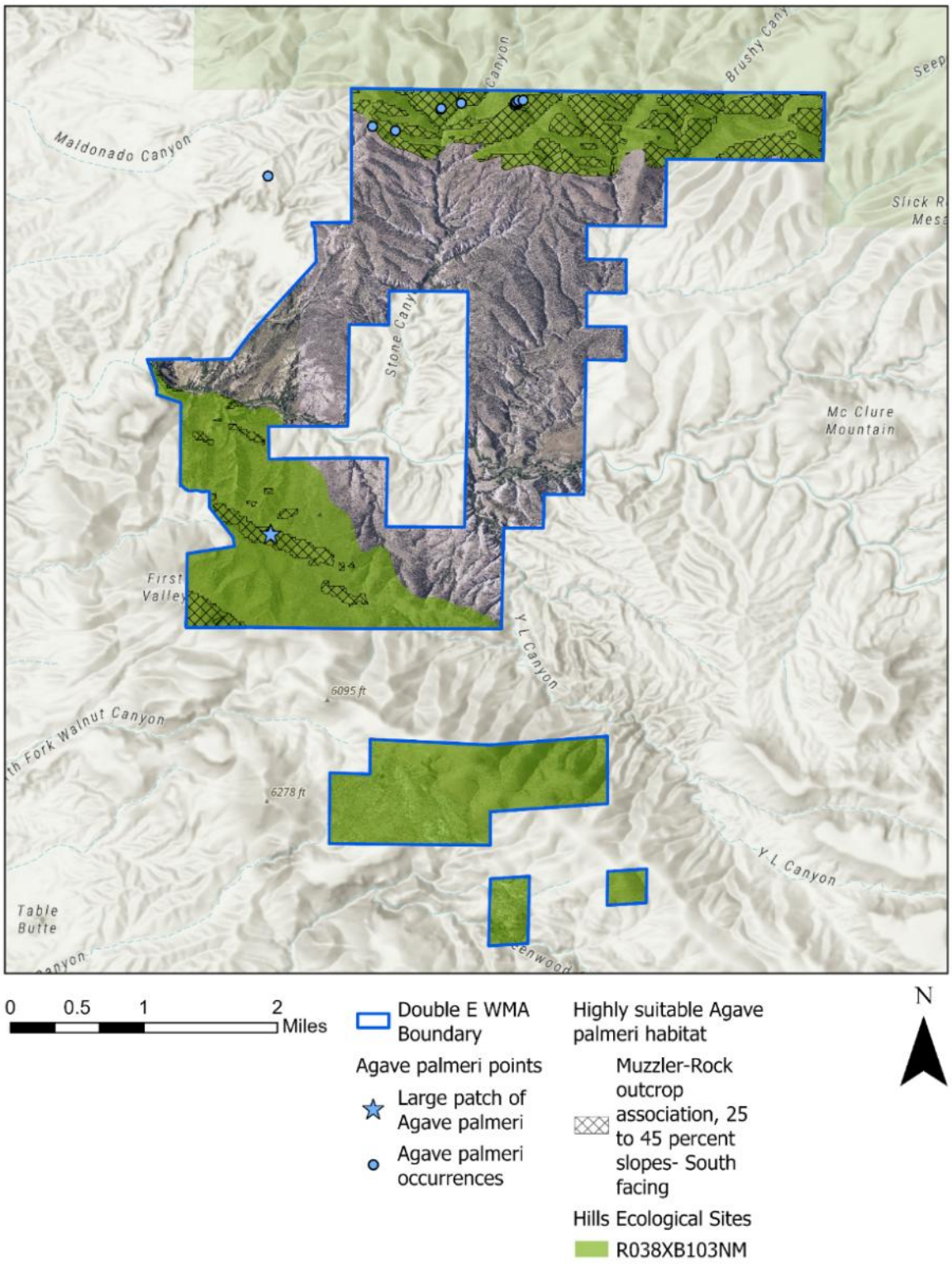

Figure 14. *Agave palmeri* mapping results and associated habitat suitability. Points, density polygons, survey routes, and predicted suitability are provided in the supporting geodatabase.

Acknowledgements

We gratefully acknowledge the funding provided by the Share with Wildlife program of the New Mexico Department of Game and Fish, Wildlife Restoration Section 4 Grant #W-240-R-1. We thank Jennifer D'Annibale for facilitating access to the Double E WMA and coordinating access with landowners. We thank Karen Gaines for providing logistical and editing support and Ginny Seamster for logistical support for this project.

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