

STATUS REPORT FOR ZUNI FLEABANE ON THE CIBOLA NATIONAL FOREST, NEW MEXICO

DANIELA ROTH¹
ROBERT SIVINSKI²

for

U.S. FOREST SERVICE, CIBOLA NATIONAL FOREST
DECEMBER 2014

INTRODUCTION

Zuni fleabane (*Erigeron rhizomatus* Cronquist) is a rare regional endemic plant that is listed as threatened by the federal Endangered Species Act (50 FR 16680-16682). It has three widely scattered population centers: two in western New Mexico (Figure 1) and one in northeastern Arizona. Most of the known New Mexico locations for Zuni fleabane occur on lands managed by the Cibola National Forest. There are two small populations in the Zuni Mountains of McKinley County (Zuni meta-population). The southernmost population occurs in the Datil/Sawtooth Mountains of northern Catron County. The Datil/Sawtooth meta-population consists of localized outcrops of suitable habitat occupied by groups of plants ranging from less than 10 to several hundred individuals.



The Zuni fleabane recovery plan (USFWS 1988) and 5-year review (USFWS 2007) identify the greatest potential threat to this species as uranium exploration and mine development. Both recommend that recovery actions focus upon administratively removing the ability to claim federal minerals underneath Zuni fleabane populations in New Mexico. The primary purpose of this survey was to document the current status of this species on Cibola National Forest lands, with particular emphasis on the sites proposed for withdrawal in 1994 (D1, D2, D3, D4) and provide current recommendations. Previous recommendations for the permanent protection of Zuni fleabane on Cibola National Forest lands included the withdrawal of 6 key areas occupied by the largest populations of Zuni fleabane in the Zuni and Datil/Sawtooth Mountains (Sivinski 1994). The two Zuni Mountain populations were withdrawn from mineral claims.

Four sites in the Datil/Sawtooth Mountains are still pending (D1 (Site 1), D2 (Site2), D3 (Site 12), and D4 (sites 14, 15, and 16)), two of which have existing claims (D3 and D4). A secondary purpose of the survey was to determine alternative areas with lower mineral development potential for withdrawal to implement the Zuni Fleabane Recovery Plan with the potential

¹ NM Energy, Minerals and Natural Resources Department-Forestry Division, Santa Fe

² RCS Southwest, Santa Fe, NM

to delist the species. If sufficient habitat and a number of Zuni fleabane populations can be formally withdrawn from mineral development on Federal lands, this rare plant could recover and be delisted.

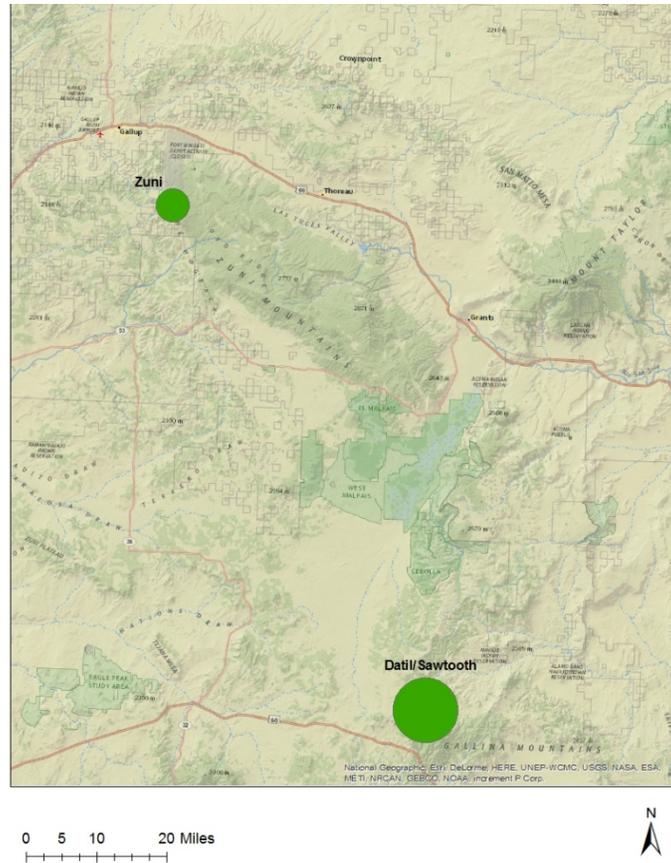


Figure 1. General location of the Zuni and Datil/Sawtooth meta-populations of Zuni fleabane in New Mexico.

METHODS

All known locations of Zuni fleabane on the Cibola National Forest (and adjacent BLM) were visited from mid-June through mid-July of 2014 to determine population size and plant vigor, and assess threats to the plants and their habitat. Locational information for 33 sites was provided by the Cibola National Forest in the form of GIS shapefiles, or the SEINet herbarium database (<http://swbiodiversity.org/seinet/>). Locations consisted of the 2 known sites in the Zuni Mountains (type locality and Six-Mile Canyon); the 19 Datil/Sawtooth mountains sites discovered in 1991 by Sivinski and Lightfoot (Sites 1-19); the several Datil/Sawtooth mountains pre-1991 locations – presumably discovered by USFS Region 3 Botanist, Reggie Fletcher; and one Datil Mountain location discovered during a uranium exploration project in 2009 (Site 20). Suitable habitat was surveyed in the general area of known occupation and new locations were recorded whenever found. The SEINet herbarium database was searched for other documented locations, resulting in 2 additional sites. One site within

the Datil/Sawtooth meta-population located on adjacent BLM lands (BLM Sawtooth Area of Critical Environmental Concern (ACEC)) was also surveyed.

A meta-population is defined as a general geographic location composed of one to many occupied sites between which it is reasonable to assume that gene flow may occur via cross pollination. Meta-populations are separated by distance across unsuitable habitat and reasonable distance traveled by pollinators. A site is defined here as a geographically distinct location of Zuni fleabane habitat separated from other sites by unsuitable, unsurveyed, or unoccupied habitat. A site may be composed of one to many patches of occupied habitat.

The field survey initially attempted to walk a polygon around the perimeter of each Zuni fleabane patch with a GPS unit to determine the area of occupied habitat. This method proved to not be regularly feasible by the second day in the field. Plant distribution within patches of occupied habitat is scattered and discontinuous, and caprock cliffs and boulders often inhibit access to the edges of habitats. Therefore, single plants and small patches of plants were simply marked with GPS waypoints to show the extent of occupied habitat. Each waypoint usually represents the habitat area of less than 100 linear feet along a geologic outcrop that is usually less than 25 feet wide. Rhizomatous plants are often difficult to distinguish as individuals during a population count. For this survey, plants counted at each waypoint or polygon were considered to be individuals if they were at least two feet from their nearest neighbor.

RESULTS

Thirty-eight sites were evaluated for their presence of Zuni fleabane in 2014. A total of 3,395 individual plants were documented in 2014 from the two New Mexico meta-populations. Extant plants were documented from 34 of the 38 sites. Of these, five sites were documented for the first time in 2014. Two sites no longer contained any plants, and 2 sites were either mismapped or misidentified. Two specimen records were obtained through SEINet but were determined to be inaccurate. A search of the Zuni Mountains location on the specimen label by K.D. Heil et al. 29450 (SJNM) failed to find any Zuni fleabane or suitable habitat at or near the described location. The R. Kass 2469 (RM) specimen from near Grants, NM was determined to be misidentified (Dr. Ron Hartman, Rocky Mountain Herbarium Curator, personal communication, July 2014).

DATIL/SAWTOOTH MOUNTAINS

The Sawtooth Mountains are simply the western end of the Datil Mountain range where volcanic extrusions form steep cliff faces and spires. The Datil/Sawtooth range of mountains is in northeastern Catron County and contains the southern-most population of Zuni fleabane. This rare plant occurs on suitable geologic outcrops in most of the Sawtooth part of the range and extends eastward into the northern slope of the Datil Mountains as far east as Red Canyon. A total of 33 large and small sites with Zuni fleabane were assessed on Forest Service lands during the 2014 field survey (Table 1). Of these, 28 were previously known sites and 5 new sites were discovered. One additional site located on BLM lands was also surveyed in 2014 (BLM Sawtooth ACEC). Not all suitable habitat was surveyed and it is estimated that at least one-third Zuni fleabane habitat in the Datil/Sawtooth mountains remains unsurveyed.

Habitat

Zuni fleabane habitat in the Datil/Sawtooth Mountains occurs on outcrops of the sedimentary Baca Formation that are exposed at the bases of the rhyolitic intrusions forming the higher elevations of the Datil volcanic region (Figures 2 and 3). This plant occurs at elevations between 7,300 feet (2,225 m) and 8,300 feet (2,530 m). It is usually found on steep slopes and at all exposures, but most commonly on north-facing slopes. Occupied substrates include weathered soft sandstone strata that are pink or almost white (Figure 10). Pink or red shale strata that weather into small indurate sand-sized pieces are also occupied. In all cases Zuni fleabane plants occur on recently weathered detrital slopes or cliff benches with sandy soils. An odor of selenium is sometimes detectable on these outcrops – especially when damp. *Astragalus flavus* occurs at Site 2 and is a primary indicator of selenium-laden soils (Cannon 1960). *Astragalus albulus* is a secondary indicator of selenium-laden soils (Cannon 1960) that occurs at almost all sites occupied by Zuni fleabane in the Datil/Sawtooth Mountains.

The most common dominant plant associates in the Datil/Sawtooth habitats are *Pinus edulis*, *Cercocarpus montanus*, *Juniperus monosperma*, *Ericameria nauseosa*, *Yucca baileyi*, *Gutierrezia sarothrae*, *Achnatherum hymenoides*, *Hesperostipa comata*, *Eriogonum jamesii*, *Hymenopappus filifolius*, *Xanthisma grindeloides*, *Tetranneuris argentea*, and *Oxytropis lambertii*. Some associates occurring in more mesic conditions in shaded habitats at the heads of small canyons and bases of cliffs include *Pseudotsuga menziesii*, *Forestiera pubescens* and *Solidago* sp.



Figure 2. Zuni fleabane habitat in the Sawtooth Mountains at Site 1.



Figure 3. Zuni fleabane habitat in the Datil Mountains at Site 21.

Datil/Sawtooth Meta-population

Small and large sites of Zuni fleabane are scattered across a linear distance of 12.2 miles (20 km) from Site 18 in Red Canyon west to the BLM Sawtooth ACEC, which is 1.6 miles (2.6 km) northwest of Site 5 (Figure 4, Table 1). The 33 sites visited in 2014 on Forest Service lands are usually less than 2 miles (3.2 km) from a nearest neighboring site. The only exception is the 2.7-mile distance between Site 7 and Site 12, but even in this case there are habitats less than 2 miles from Site 7 that have not yet been surveyed and could have additional patches of Zuni fleabane. The areas between almost all other confirmed sites also have habitats that are not yet thoroughly surveyed and likely have undiscovered small patches of plants.

The Datil/Sawtooth Mountains population of Zuni fleabane is a meta-population of large and small sites of plants scattered across a large area (Datil/Sawtooth meta-population). The small sites are usually associated with small outcrops of suitable habitat and become established by seed dispersal. Scattered patches of plants are close enough to each other to occasionally exchange pollen and maintain some gene flow throughout the meta-population. The pollinators of Zuni fleabane are unknown, but are assumed to be generalist insects such as bees, flies, butterflies and beetles. Insect transfer of pollen over the long distances between Zuni fleabane patches is unlikely to be sufficient to account for a majority of

annual fertilization and seed set, which is likely dependent on within-patch pollination (see Schulke and Waser 2001 for lit. summary). Long distance pollen transfer of more than a mile by generalist pollinators, however, can account for a surprising number of cross pollinations that infuse genetic diversity into isolated patches of rare plant species (Millar et al. 2014). Therefore, even the small isolated patches of Zuni fleabane are important as seed sources for colonizing adjacent habitats and as stepping stones for pollen transfer and gene flow through the meta-population.

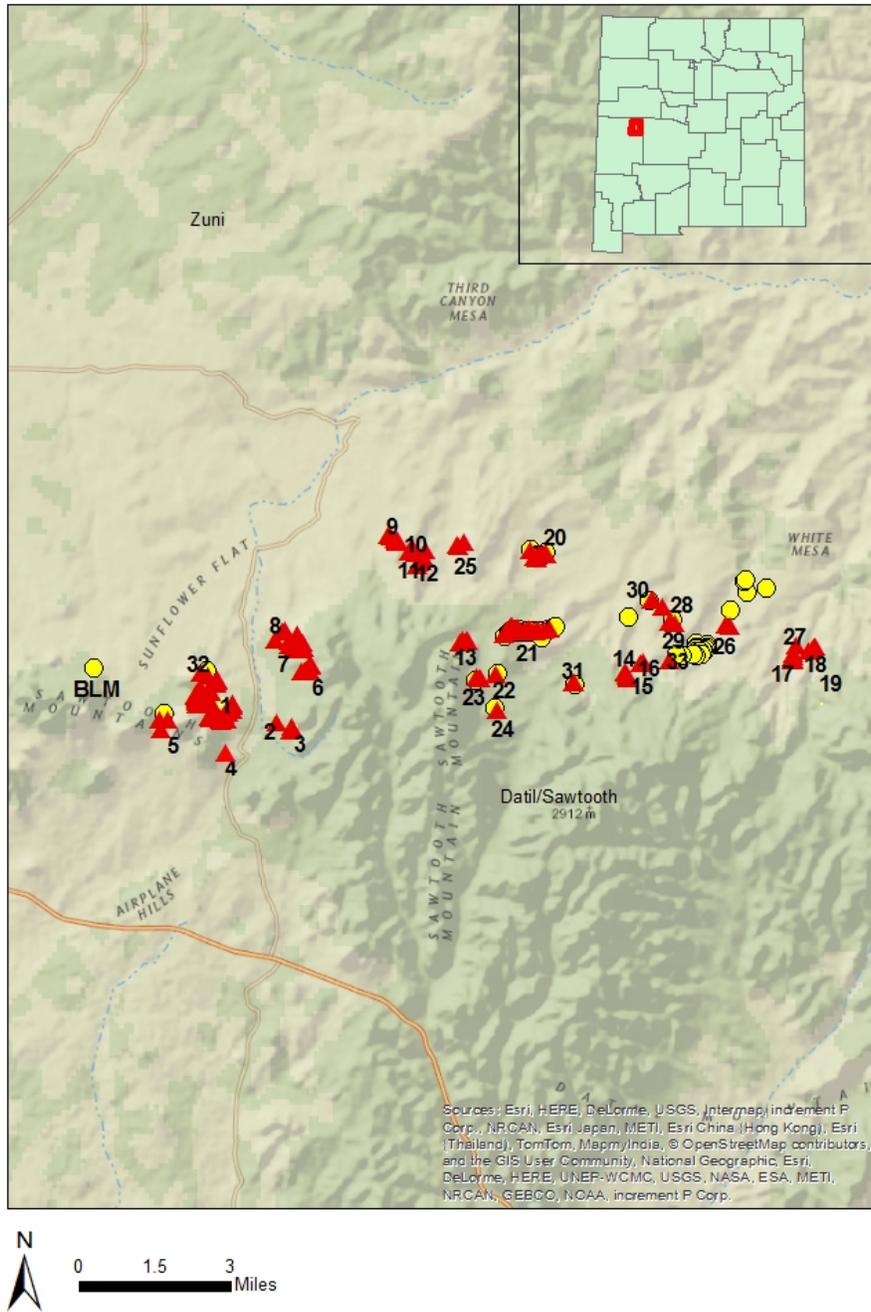


Figure 4. Overview of the 2014 Datil/Sawtooth meta-population. Pre-1991 location records are yellow dots.

A total of 2,920 Zuni fleabane plants were counted at 33 sites in the Datil/Sawtooth mountains on the Cibola National Forest in 2014 (Table 1, Appendix). The majority of plants were either post-flowering or non-flowering. The majority of occupied sites had fewer than 100 plants. Only 6 of the 33 sites had more than 100 plants (Sites 1, 2, 6, 7, 12, and 21). Two previously documented sites were no longer occupied (Sites 14 and 19).

The largest part of this meta-population is in the Sawtooth part of the range. Site 1 (D1) had 792 plants scattered in patches over a large outcrop of suitable habitat and can be combined with adjacent Site 32 for a total of 804 plants (Figure 5, Table 1). The combined Sites 2 and 3 also occupy a large outcrop of habitat and total 407 plants (D2). Adjacent Sites 6, 7 and 8 comprise a complex area of small outcrops with Zuni fleabane patches that total 365 plants. The largest area of occupied Zuni fleabane habitat in the Datil Mountains part of the range is located among Sites 10, 11 and 12, which are very close together and have a combined total of 240 plants (D3, Figure 6, Table 1). Site 9 is very close to this cluster, but cannot be added since it was found to be on adjacent private land after a projection problem with the Forest Service map was corrected (Figure 6). Datil Site 21 has 224 plants (Figure 6) and the Red Canyon cluster of Sites 17, 18 and 27 can be combined for a total 180 plants (Figure 7). These areas with relatively large number of plants are the core portions of the Zuni fleabane population in the Datil/Sawtooth Mountains. Sites 14, 15, and 16 forms the smallest cluster of plants (D4), containing 99 plants. All the other known sites are on smaller areas of habitat – each with patches of fewer than 100 plants.

The western-most patch of Zuni fleabane in the Sawtooth Mountains is on BLM land (Figure 4). Habitat there is similar to adjacent Cibola National Forest habitats. The BLM site contained 169 plants in 2014 on 0.8 acres in mostly good condition. This information and GIS shape file have been given to the BLM State Botanist.

In 2014 none of the population sites were rated in excellent condition and no plants were found at 2 sites (14 & 19) (Table 1). Plant vigor at the extant sites in this range of mountains varied from good to poor – sometimes within patches. For instance, at least 10% of the plants at Site 13 appeared to have been dead for at least a year. Most of the other Site 13 plants were stressed, but alive, while a few were vigorous and had flowered and made seeds. Site 23 was also mixed. It consists of three small outcrops of habitat up a hillside. The two lower patches of plants were almost all dead for at least a year while the upper patch was in good condition and had flowered. For 2014 in general, there were more drought-stressed and dead plants in the western and central part of the Datil/Sawtooth meta-population than at the eastern sites, which were often in good condition. This may be the result of differences in habitat substrates or microclimate variables, such as slope and exposure.

Table 1. Zuni fleabane Datil/Sawtooth meta-population estimates for 33 sites on the Cibola National Forest, 2014.

SITE NAME	LOCATION	LAST OBSERVATION YEAR	LAST OBSERVATION SIZE	2014 SIZE	2014 HEALTH
1	Sawtooth Mts	1991	>5000	792	Fair
2	Sawtooth Mts	1991	>1000	345	Fair
3	Sawtooth Mts	1991	>200	62	Fair
4	Sawtooth Mts	1991	9	83	Good
5	Sawtooth Mts	1991	50	30	Fair
6	Sawtooth Mts	1991	>200	116	Fair
7	Sawtooth Mts	1991	>2000	223	Good
8	Sawtooth Mts	1991	>1000	26	Good
9	Datil Mts	1991	>500	36	Good
10	Datil Mts	1991	>500	63	Good
11	Datil Mts	1991	5	9	Good
12	Datil Mts	1991	>500	168	Good
13	Datil Mts	1991	>200	86	Poor
14	Datil Mts	1991	30	0	Extirpated
15	Datil Mts	1991	>500	93	Good
16	Datil Mts	1991	>200	6	Good
17	Datil Mts	1991	10	77	Good
18	Datil Mts	1991	>50	85	Good
19	Datil Mts	1991	10	0	Extirpated
20	Datil Mts	2009	N/A	49	Good
21	Datil Mts	pre-1991	N/A	224	Good
22	Datil Mts	pre-1991	N/A	6	Fair
23	Datil Mts	pre-1991	N/A	55	Poor-Good
24	Datil Mts	pre-1991	N/A	21	Fair
25	Datil Mts	2014		18	Good
26	Datil Mts	2014		78	Good
27	Datil Mts	2014		18	Good
28	Datil Mts	2014		6	Good
29	Datil Mts	pre-1991	N/A	56	Good
30	Datil Mts	pre-1991	N/A	58	Good
31	Datil Mts	pre-1991	N/A	11	Good
32	Sawtooth Mts	pre-1991	N/A	12	Good
33	Datil Mts	2014		8	Good
Total				2,920	

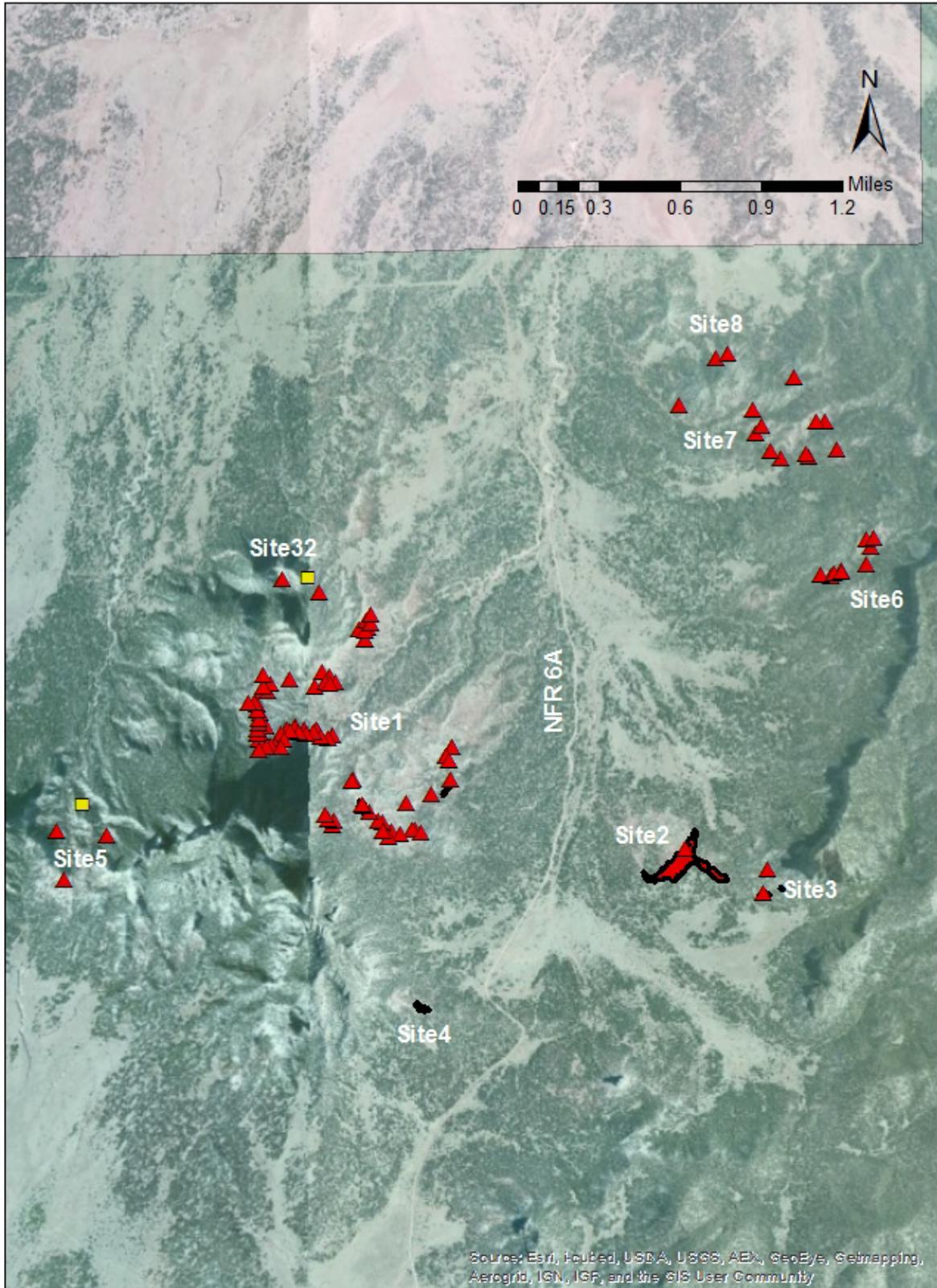


Figure 5. Zuni fleabane patches confirmed extant in 2014 in the Sawtooth Mountains (red triangles and polygons). Yellow squares are pre-1991 location records.

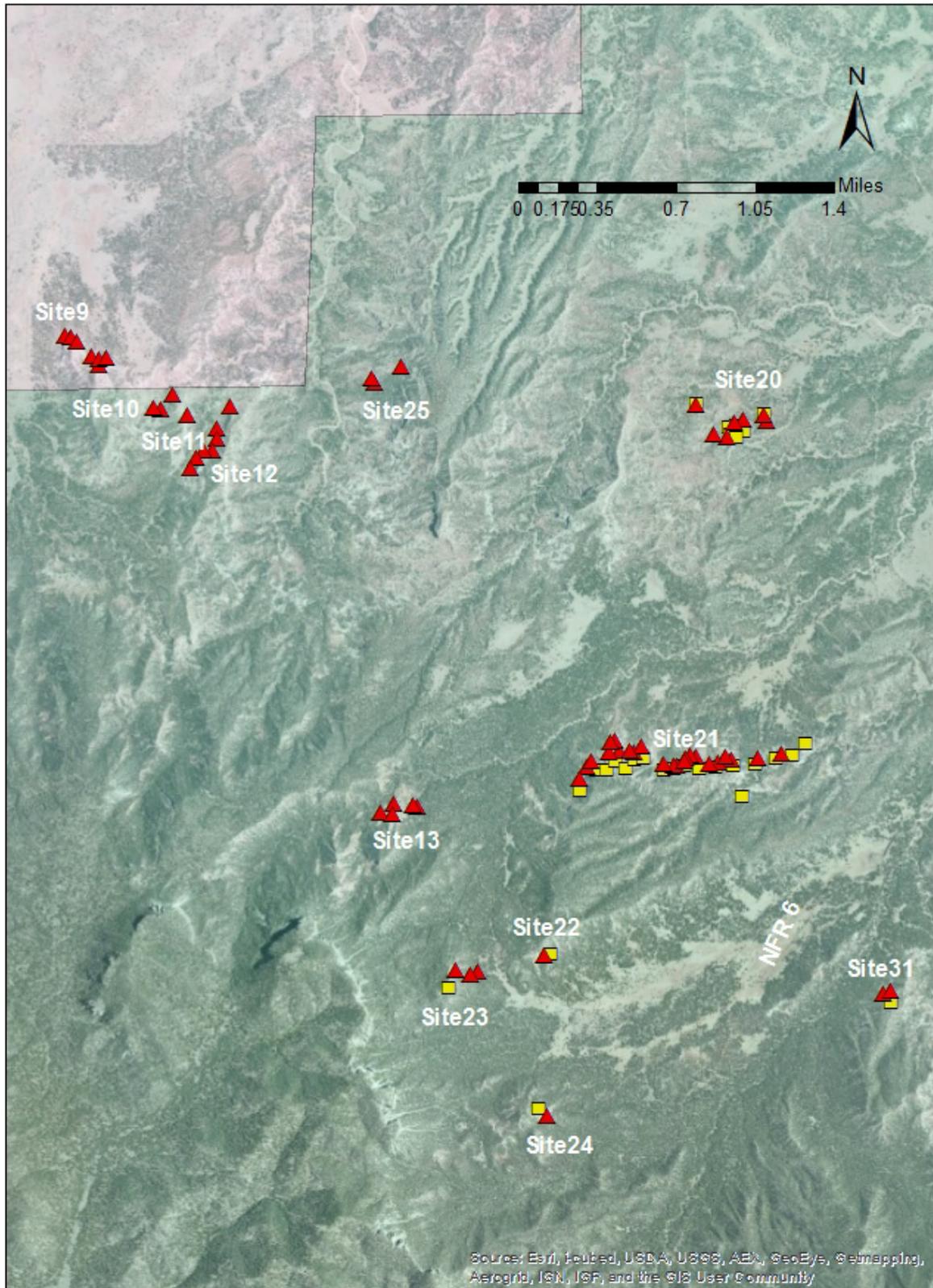


Figure 6. Zuni fleabane patches confirmed extant in 2014 in the Datil/Sawtooth mountains (red triangles). Yellow squares are pre-1991 location records except Site 20, which was discovered in 2009.

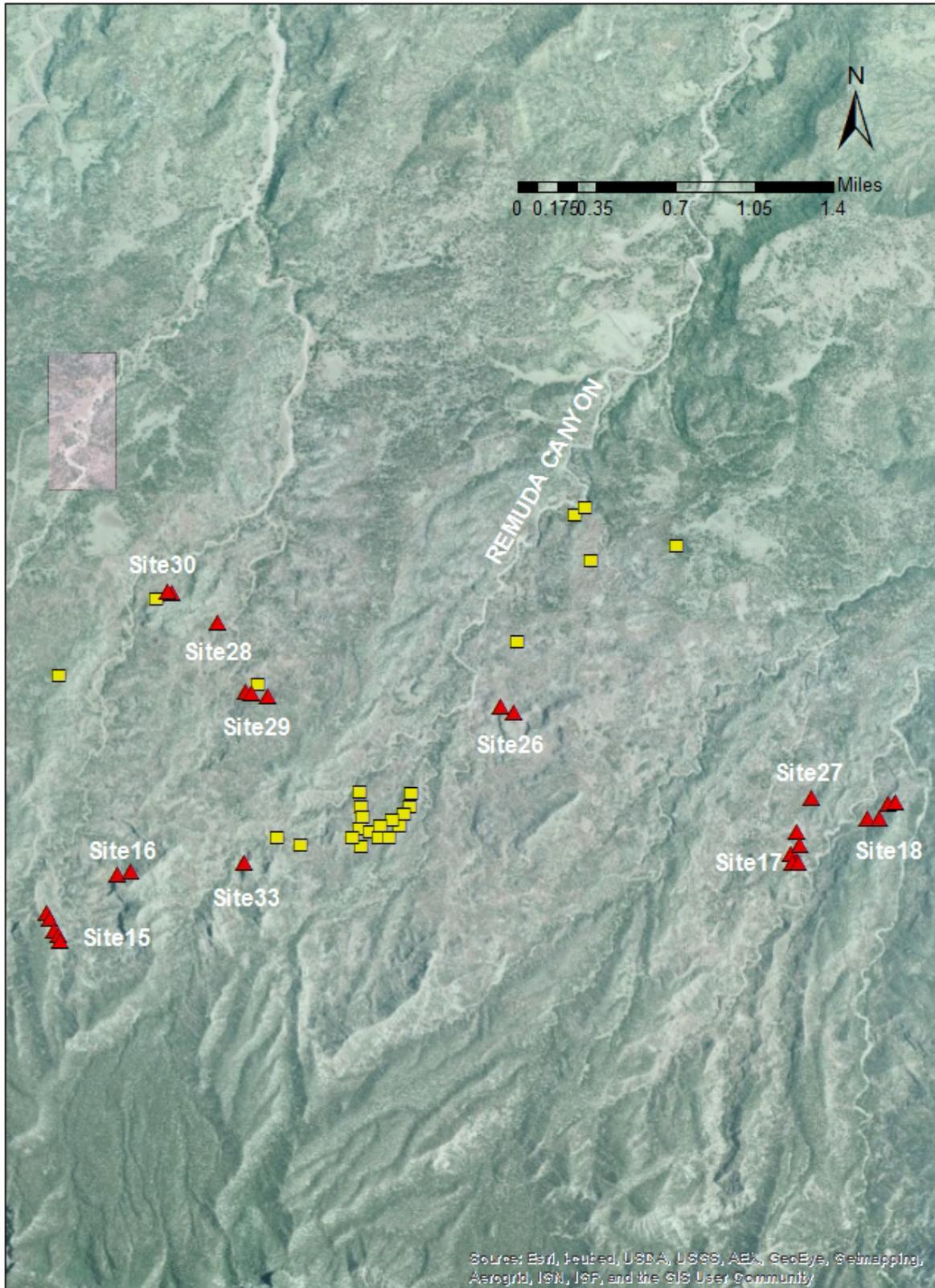


Figure 7. Zuni fleabane patches confirmed extant in 2014 in the Datil Mountains (red triangles). Yellow squares are pre-1991 location records visited again in 2014.

ZUNI MOUNTAINS

Zuni fleabane habitat is located on the north slope of the Zuni Mountains near Fort Wingate in southwestern McKinley County (Figure 8). Distributions and numbers of individuals were assessed at the two known sites – one in Six-mile Canyon (Six-mile) and the other in a canyon south of Fort Wingate (Type locality). A new potential Zuni Mountains location was obtained from exact coordinates and location description on a herbarium specimen label (K.D. Heil et al. 29450 SJNM). A visit to this new Zuni Mountains location did not locate any Zuni fleabane plants and the habitat did not appear suitable for this plant species. The specimen is at San Juan College in Farmington, NM, and was not examined to confirm identity.

Habitat

Geologic substrate for Zuni fleabane in the Zuni Mountains is Chinle Shale (Figures 9 and 11). Plants occur on gray and brown strata that consist of sandy shale or shale that decomposes into very small indurate pieces, which impart a sandy texture to the surface soil. The plants occur on gentle and steep slopes with all exposures at elevations from 7,300 feet (2,225 m) to 7,380 feet (2,250 m). Dominant associated vegetation consists of *Pinus edulis*, *Juniperus monosperma*, *Cercocarpus montanus*, *Quercus gambelii*, *Fraxinus cuspidata*, *Ericameria nauseosa*, *Yucca baileyi*, *Gutierrezia sarothrae*, *Achnatherum hymenoides* and *Pleuraphis jamesii*. No plants that are primary indicator species of selenium-laden soils are present.

Zuni Meta-population

There are only two locations currently known in the Zuni Mountains and both are relatively small (Table 2, Figure 8). The type locality (where originally discovered) had only 231 Zuni fleabane plants in 2014. Their condition was fair considering the extremely dry conditions that caused many to not flower and not fill-out with new stems or root sprouts. The small patch of plants in Six-mile Canyon had 75 individuals and was also in fair condition.

These two locations of known plant occurrence are 3.9 miles (6.2 km) apart, so may be separate populations. Wind dispersal of seeds and pollen transfer by generalist pollinators could potentially occur over this distance so the locations in the Zuni Mountains are more likely parts of a meta-population with occasional gene flow between patches of plants.

Table 2. Zuni fleabane Zuni meta-population estimates for two sites on the Cibola National Forest, 2014.

SITE NAME	LOCATION	LAST OBSERVATION YEAR	LAST OBSERVATION SIZE	2014 SIZE	2014 HEALTH
Type	Zuni Mts	1994	1000	231	Fair
Six-Mile	Zuni Mts	1994	300	75	Fair
Total			1300	306	

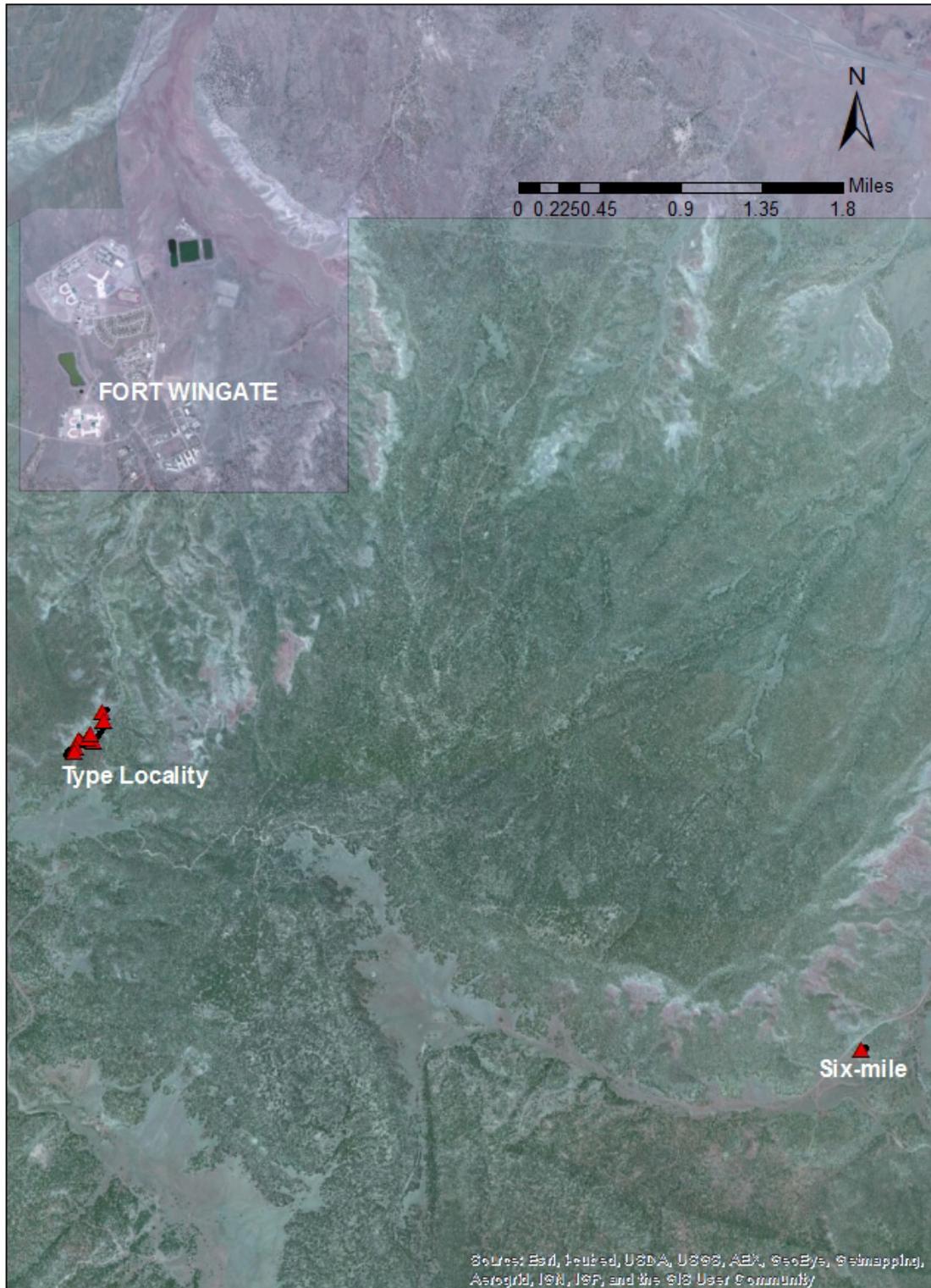


Figure 8. Zuni fleabane locations (red triangles) on the north slope of the Zuni Mountains near Fort Wingate, NM.



Figure 9. Zuni fleabane habitat at the type locality in Zuni Mountains south of Fort Wingate.

POPULATION TREND

Previous population estimates were available for the BLM Sawtooth ACEC (1991), 19 sites from the Datil/Sawtooth meta-population on Cibola NF lands (1991), and the two sites of the Zuni meta-population (1994). No previous population estimates were available for early pre-1991 USFS locations or the recently discovered Site 20 within the Datil/Sawtooth meta-population. In general, we have little knowledge of the original survey effort or survey boundaries. Therefore trend information should be interpreted in a broad way. Overall, the majority of sites visited in 2014 showed a significant decline in the number of plants found in both meta-populations in New Mexico.

Sivinski and Lightfoot made rough estimates of population size at 19 locations in the Datil/Sawtooth mountain region in 1991. These estimates did not count individual plants in the larger populations and were only impressions of relative abundance after walking through habitats with numerous rhizomatous plants. Sivinski also briefly visited the two Zuni Mountains populations and the 19 Datil/Sawtooth locations in 1999 and 2004 (Sivinski 1999 & 2004) to confirm they were still extant. No population estimates were made during these more recent visits and no change in population size was documented. During both surveys all visited sites were considered identical to their conditions in 1991.

Sivinski visited the same 19 sites in the Datil/Sawtooth Mountains and the two Zuni Mountains populations during the 2014 field survey and participated in counting the individual plants. This was the first time actual numbers of plants were counted at each location. Therefore, comparisons to determine population trend for these 19 sites are based upon the differences between original 1991 estimates (>

12,500 plants) and the 2014 count (2,300 plants). In addition, significantly fewer plants were found in the Zuni meta-population and the BLM Sawtooth ACEC. Overall, there appeared to be significantly fewer living Zuni fleabane plants in 2014 than in 1991.

Datil/Sawtooth Meta-population

The 2014 counts of 19 Zuni fleabane sites in the Datil/Sawtooth Mountains were, in most cases, much lower than the 1991 estimates (Table 1, Appendix). For instance, the 1991 estimate of >5,000 individuals at Site 1 had an actual count of 792 plants in 2014. The total 2014 count of 2,300 plants in all of these 19 sites is only about 18% of the estimated total number of >12,500 in 1991. Some of this discrepancy may be explained by the fact that the 1991 estimate is much less accurate than an actual count and could have been unintentionally over-estimated by Sivinski and Lightfoot – especially if a different method of distinguishing individual plants was employed in 1991. Yet Sivinski participated in all surveys and has the distinct impression that there were fewer plants and less habitat occupied at most of these 19 sites during the 2014 survey than the 1991 survey. This is somewhat corroborated by the fact that Sites 14 and 19 were no longer occupied by Zuni fleabane in 2014. These two sites were small in 1991 (30 and 10 individuals respectively), but had still been extant up to 2004. In addition, Sivinski visited the BLM Sawtooth ACEC, which contains a single site of occupation. A 1991 survey report documented 876 plants from this site (Dunmire 1991). In 2014 only 169 plants were found at the ACEC. This population of Zuni fleabane has clearly been declining over the last two decades, assuming methods used to count individuals were roughly similar.

Population trend indications for pre-1991 Zuni fleabane locations in the Datil/Sawtooth Mountains are more difficult to interpret because of lack of data or inaccurate locations. All of these early locations were revisited during the 2014 field survey and several were found to have patches of habitat and extant Zuni fleabane plants at, or very near, the original map locations (Figures 4, 5, 6 and 7). This was not the case, however, for the many pre-1991 location records in Remuda Canyon on the north slope of the Datil Mountains. None of those mapped observation points had any Zuni fleabane plants near them in 2014 (Figure 7). In fact, all of these pre-1991 Remuda Canyon points occur in areas with no, or very little, suitable Zuni fleabane habitat. Therefore, they cannot be presumed extirpated, but may have been inaccurately mapped instead. A two-day search of Remuda Canyon in 2014 found only two new small sites with Zuni fleabane and very little suitable habitat. The actual location of the large population that was previously mapped in this canyon remains a mystery.

Zuni Meta-population

Original estimates of the population numbers for the Zuni meta-population also showed a marked decline in the number of plants between 1994, when the type locality was estimated to contain 1000 plants, and the Six-mile Canyon population which was estimated at 300 plants (Sivinski 1994). In 2014 only 231 and 75 plants were found at the two sites, respectively. Overall, the type locality site in the Zuni Mountains had fewer individual plants scattered throughout the habitat area and were mainly concentrated in just four clusters of plants. The small population in Six-mile Canyon has always been small, but seemed to occupy less area in 2014 than previous years – especially on the east side of the habitat patch.

THREATS

Numerous dead and drought-stressed Zuni fleabane plants were found in the Zuni and Datil/Sawtooth mountains populations during 2014 survey and there are some indications of significant population decline over the last few decades – especially in the Datil/Sawtooth habitats. Unfortunately, there is no continuous long-term weather data from any of the nearby Catron or McKinley county weather stations to show climatic trends (<http://www.wrcc.dri.edu/summary/Climsmnm.html>). The closest rainfall station for the Datil/Sawtooth meta-population is located in Datil and has only been collecting rainfall data since 2003, much of which is incomplete (<http://www.raws.dri.edu/cgi-bin/rawMAIN.pl?nmXDAT>). It is reasonable, however, to assume that the Zuni fleabane population decline is the result of recent climatic stress – specifically drought. Datil rainfall data does indicate an extreme dry year in 2010, with no measurable precipitation during the monsoon months (July – September), which may have resulted in the decline of the fleabane populations. Soil conditions were extremely dry and plant growth negligible during field survey in June 2014. Spring of 2014 was the start of a fourth year of moderate to extreme drought conditions in Catron County (http://www.nmdrought.state.nm.us/df_workgroup.html) and is the most likely reason for the low number of Zuni fleabane plants found in this recent survey.

Drought and climate change were not listed as a threat to the species in the past. Zuni fleabane has survived much longer droughts in recent millennia. Tree ring data from the nearby El Malpais National Monument show a decades-long drought during the sixteenth century that would have impacted the New Mexico populations of Zuni fleabane (Stahle et al. 2000). Current and future droughts, however, will be coincident with higher temperatures (Woodhouse et al. 2010), which may be more lethal to Zuni fleabane. This rare plant has remarkable tolerance to drought, but a climate changing towards drier conditions with higher temperatures and more persistent droughts could become the most serious threat to the survival of this species. In fact, the current status of the species indicates that drought may be the largest threat to the species rangewide in New Mexico.

Datil/Sawtooth Meta-population

There were very few indications of changed land use in the Datil/Sawtooth meta-population of Zuni fleabane in 2014. No recent woodcutter camps were found and only a few cattle trails were found through the Sawtooth Mountains area of habitat. In fact, elk were the most prevalent large herbivore using Zuni fleabane habitats. Neither cattle nor elk were eating Zuni fleabane and none of the plants observed showed any signs of grazing. No new roads were found through the habitats. Most of the existing backcountry access roads in the Datil Mountains part of the range appear to be only rarely used during hunting season and have deteriorated from lack of maintenance and use. No new land use threats were identified for the Datil/Sawtooth meta-population during the 2014 survey. No invasive exotic species were documented at any of the sites during the 2014 surveys.

Uranium exploration and mine development is still a potential threat to Zuni fleabane in the Datil/Sawtooth mountains. Recent mineral claim stakes and exploration drill holes were found within 50 feet of Zuni fleabane plants at Site 20 and there were new claim stakes 150 feet north of occupied habitat at Site 16. A recent 2009 uranium exploration project had occurred in the Datil Mountains, which continues to indicate the potential threat of uranium exploration and mine development for that meta-population. The U.S. Forest Service detected Zuni fleabane plants during the environmental assessment of this recent exploration and did not allow drilling to occur within the habitat occupied by this threatened species (Site 20). Sites 17 and 21 have mineral claim stakes within the occupied habitats, but these stakes are weathered and appear decades old (Figure 10). These old claims may no

longer be valid, but minable uranium may still exist there. Selenium-laden soils near igneous intrusions often co-occur with uranium deposits and can be detected by smell and selenium indicator plant species (Cannon 1957, 1960). Selenium odors and indicator *Astragalus* species are common in the Datil/Sawtooth habitats for Zuni fleabane and indicate uranium mining as the greatest potential land use threat to that population.



Figure 10. Old mineral claim stake in Zuni fleabane habitat at Site 21 in the Datil Mountains. Small green plants on pale sandstone in center and right-center of photo are Zuni fleabane.

Zuni Meta-population

Several individuals of Zuni fleabane in the Zuni Mountains are growing within 50 feet of NM State Route 400 pavement (Figure 11). There were no indications of recent highway right-of-way maintenance or herbicide spraying. However, any future maintenance that might impact the cut slopes on the east side of the highway or the application of herbicides within 50 feet of the pavement can potentially harm or eliminate approximately 20% of the type locality plants. The fence around the Six-mile canyon patch of Zuni fleabane was still functional in 2014, excluding livestock and ORVs. No new land use threats were identified for the Zuni meta-population during the 2014 survey. No invasive exotic species were documented at the Six-mile site during the 2014 surveys. However, the type locality contained several

invasive exotic plant species and trash on both sides of NM State Route 400, including significant numbers of bindweed (*Convolvulus arvensis*) and sweet clover (*Melilotus officinalis*).



Figure 11. Zuni fleabane habitat at type locality in Zuni Mountains on road cut along NM State Route 400.

CONCLUSIONS & RECOMMENDATIONS

The 2014 field survey visited all previously known locations of Zuni fleabane and documented two extant sites of plants in the Zuni Mountains and 31 extant sites in the Datil/Sawtooth Mountains. An additional five new sites were found and two sites were extirpated in the Datil/Sawtooth meta-population. No new sites were documented from the Zuni Mountains. No new land use threats were found at any location, but uranium exploration remains active in the Datil/Sawtooth Mountains. Actual numbers of plants and areas of occupied habitat indicate a significant decline over previous population estimates. This decline is likely the result of recent droughts.

Globally, the entire range of Zuni fleabane is distributed among three meta-populations, two occur in New Mexico, primarily on Cibola National Forest lands (97% of known extant sites), and one meta-population exists in adjacent Arizona, on Navajo Nation lands (Christie 2004). The current status of the Navajo Nation meta-population is unknown, but it may also have incurred a decline in numbers in the decade since the last survey in 2004, due to regional drought conditions. Although the species is listed under the Federal Endangered Species Act, listed plants only receive limited protection under the ESA on tribal lands, as well as under tribal law. Therefore, primary management responsibility for ensuring the continued existence of the species rests with the Cibola National Forest.

Based on our current understanding of the abundance and distribution of Zuni fleabane in New Mexico and the apparent decline of the species in the past 2 decades, it is recommended that all habitat and occupied sites of Zuni fleabane should be protected in perpetuity either through withdrawal of mineral claim or other methods of protecting habitat. Although drought is apparently the largest current threat to the species range-wide, little can be done for these plants in response to drought through land management practices. Hence it is prudent to protect all available, but limited habitat and extant population sites from the impacts of land use practices. Seven key areas were identified holding the largest number of individuals. Small habitat sites with fewer plants are scattered throughout the Datil/Sawtooth meta-population. These may be important for maintaining genetic diversity and population resilience and also need to be protected from land use impacts.

There are three large key areas or site clusters in the Sawtooth Mountains and four in the Datil Mountains. Each have relatively extensive suitable habitat and plant numbers ranging from almost 100 to just over 800 individuals.

At a minimum, it is recommended to permanently protect the 7 key areas, as outlined below:

Sawtooth Mountains:

- All sites associated with D1 (sites 1 and 32)
- All sites associated with D2 (sites 2 and 3)
- Cluster formed by Sites 6, 7, and 8

Datil Mountains:

- Although all sites associated with D3 (Sites 10, 11, and 12) declined significantly, they still hold the largest number of plants in the Datils.
- D4 (Sites 14, 15, and 16) significantly declined since 1991, but still contains approximately 100 plants, habitat and presumably a seed bank.

- Cluster formed by sites 17, 18, and 27
- Site 21

Additional populations of Zuni fleabane may be found in suitable habitat on the Cibola National Forest. An existing Forest Service model outlining suitable habitat in the Datil/Sawtooth Mountains was field tested during the 2014 surveys, but did not correlate well with suitable habitat on the ground. This was likely a result of inaccurate geology GIS layers. A more refined model taking into account all known habitat aspects in combination with satellite imagery and reflective radiation techniques to enhance differences in surficial geology might help identifying suitable habitat and prioritize future surveys.

In addition, regularly monitoring of all known sites of the Zuni fleabane is highly recommended to document any further decline or improvement of their condition and population numbers, as outlined in the recovery plan. Monitoring is an essential recovery action documenting population trends over time, thereby contributing to the recovery and delisting evaluation. Considering the current status of the species and the apparent range-wide decline in New Mexico, collecting seeds and maintaining an ex-situ seed bank by permanently storing seeds in a Center for Plant Conservation approved storage facility would allow for potential future reintroduction projects or ex-situ propagation and conservation of plants.

REFERENCES CITED

- Cannon, H.L. 1957. Description of Indicator Plants and Methods of Botanical Prospecting for Uranium Deposits on the Colorado Plateau. USDI-Geological Survey Bulletin 1030-M, U.S. Printing Office, Washington, DC. Available <http://pubs.usgs.gov/bul/1030m/report.pdf>
- Cannon, H.L. 1962. Botanical Prospecting for Uranium Deposits on the Colorado Plateau. USDI-Geological Survey Bulletin 1085, U.S. Printing Office, Washington, DC. Available <http://pubs.usgs.gov/bul/1085a/report.pdf>
- Christie, K. 2004. *Erigeron rhizomatus*. Survey and status report. Unpublished report prepared for the Navajo Natural Heritage Program, Window Rock, AZ. Available <http://nnhp.nndfw.org/>
- Dunmire, W.W. 1991. T & E and sensitive plant survey, Sawtooth ACEC, Socorro Resource Area, Bureau of Land Management. Prepared for the Bureau of Land Management. The Nature Conservancy, New Mexico Field Office.
- Millar, M.A., D.J. Coates and M. Byrne. 2014. Extensive long-distance pollen dispersal and highly outcrossed mating in historically small and disjunct populations of *Acacia woodmaniorum* (Fabaceae), a rare banded iron formation endemic. *Annals of Botany* doi:10.1093/aob/mcu167. Available <http://aob.oxfordjournals.org/content/early/2014/08/06/aob.mcu167.full.pdf+html>
- Schulke, B. and N.M. Waser. 2001. Long-distance pollinator flights and pollen dispersal between populations of *Delphinium nuttallianum*. *Oecologia* 127:239–245.
- Sivinski, R. 2004. Zuni fleabane (*Erigeron rhizomatus*). Section 6, Segment 18 Progress Report submitted to USDI-Fish and Wildlife Service, Region 2, Albuquerque, NM. Energy, Minerals, and Natural Resources Department, Forestry Division, Santa Fe, NM.
- Sivinski, R. 1999. Zuni fleabane (*Erigeron rhizomatus*). 1998-1999 Progress Report (Section 6, Segment 13). Prepared for USDI-Fish and Wildlife Service, Region 2, Albuquerque, NM. Energy, Minerals, and Natural Resources Department, Forestry Division, Santa Fe, NM.
- Sivinski, R. 1994. *Erigeron rhizomatus* recovery proposal. Prepared for the U.S. Forest Service, Albuquerque, NM. Energy, Minerals, and Natural Resources Department, Forestry Division, Santa Fe, NM.
- Sivinski, R. and K. Lightfoot. 1991. 1991 field survey for the Zuni fleabane in the Datil and Sawtooth Mountains, Cibola National Forest. Prepared for The Nature Conservancy, New Mexico Natural Heritage Program. Energy, Minerals, and Natural Resources Department, Forestry Division, Santa Fe, NM.
- Stahle, D.W., E.R. Cook, M.K. Cleaveland, M.D. Therrell, D.M. Meko, H.D. Grissino-Mayer, E. Watson, and B.H. Luckman. 2000. Tree-ring data document 16th century megadrought over North America. *EOS* 81(12):121-132. Available <http://onlinelibrary.wiley.com/doi/10.1029/00EO00076/pdf>

US Fish and Wildlife Service (USFWS). 1988. Recovery Plan for the Zuni Fleabane (*Erigeron rhizomatus* Cronquist). Region 2 Office, Albuquerque, NM. Available <http://www.fws.gov/southwest/es/Documents/R2ES/ZuniFleabaneRecoveryPlan1988.pdf>

US Fish and Wildlife Service. 2007. Zuni fleabane (*Erigeron rhizomatus*) 5-year review: summary and evaluation. Region 2 Office, Albuquerque, NM. Available <http://www.fws.gov/southwest/es/Documents/R2ES/Zuni%20Fleabane%205-yr%20Review.pdf>

Woodhouse, C.A., D.M. Meko, G.M. MacDonald, D.W. Stahle, and E.R. Cook. 2010. A 1,200-year perspective of 21st century drought in southwestern North America. Proceedings of the National Academy of Sciences 107(50):21283-21288. Available <http://www.pnas.org/content/107/50/21283.full>

APPENDIX

SITE IDENTIFICATION AND PLANT NUMBERS FOR ZUNI FLEABANE
IN THE CIBOLA NATIONAL FOREST AND ADJACENT BLM

SITE/ WAYPOINT NAME	LOCATION	LAST OBS YEAR	LAST OBS SIZE	2014 SIZE	2014 VIGOR	2014 COMMENTS
Type	Zuni Mts	1994	1000	231	Fair	Type locality with 231 plants on 2.5 acres. Less habitat occupied in 2014 than previous observation; and seemed to be fewer plants.
Type 1 (Points ErrhZuni2- 4, 2-5, 2-6)				118		
Type 2				1		
Type 3 (Point ErrhZuni2- 2)				3		
Type 4 (Point ErrhZuni2- 3)				1		
Type 5 (Point ErrhZuni2)				60		
Type 6 (Point Errh- 2-7)				48		
Six-Mile	Zuni Mts	1994	300	75	Fair	Only 75 plants on 0.3 acres. Less habitat occupied in 2014 than previous observations; and seemed to be fewer plants.
6mile (ErrhZuni1)				75		

SITE/ WAYPOINT NAME	LOCATION	LAST OBS YEAR	LAST OBS SIZE	2014 SIZE	2014 VIGOR	2014 COMMENTS
						306 total plants counted in Zuni Mts in 2014.
BLM	Sawtooth Mts	1991	876	169	Good	169 plants on 0.8 acres in mostly good condition.
BLM1				169		
Site 1	Sawtooth Mts	1991	>5000	792	Fair	Plants in small patches widely scattered over a large linear area of outcrop. Condition ranges from poor to good.
Pop1A				5		
Pop1B				4		
Pop1C				4		
Pop1D				18		
Pop1E				20		
Pop1F				4		
Pop1G				1		
Pop1H				13		
Pop1I				3		
Pop1J				10		
Pop1K				65		
Pop1L				4		
Pop1M				5		
Pop1N				12		
Pop1O				2		
Pop1P				12		
Pop1Q				3		
Pop1R				5		
Pop1S				27		
Pop1T				7		
Pop1U				7		
Pop1V				15		
Pop1W				5		

SITE/ WAYPOINT NAME	LOCATION	LAST OBS YEAR	LAST OBS SIZE	2014 SIZE	2014 VIGOR	2014 COMMENTS
Pop1X				3		
Pop1Y				3		
Pop1Z				2		
Pop1AA				4		
Pop1BB				15		
Pop1CC				19		
Pop1DD				16		
Pop1EE				2		
Pop1FF				8		
Pop1GG				12		
Pop1HH				6		
Pop1II				5		
Pop1JJ				8		
Pop1KK				11		
Pop1LL				7		
Pop1MM				2		
Pop1NN				3		
Pop1OO				5		
Errh-ST-1A				6		
Errh-ST-1B				5		
Errh-ST-1-1				5		
Errh-ST-1-2				9		
Errh-ST-1-3				3		
Errh-ST-1-4				15		
Errh-ST-1-5				10		
Errh-ST-1-6				3		
Errh-ST-1-7				26		
Errh-ST-1-8				3		
Errh-ST-1-9				7		
Errh-ST-1-10				10		
Errh-ST-1-11				2		
Errh-ST-1-12				3		
Errh-ST-1-13				22		
Errh-ST-1-14				3		

SITE/ WAYPOINT NAME	LOCATION	LAST OBS YEAR	LAST OBS SIZE	2014 SIZE	2014 VIGOR	2014 COMMENTS
Errh-ST-1-15				10		
Errh-ST-1-16				15		
Errh-ST-1-17				10		
Errh-ST-1-18				7		
Errh-ST-1-19				1		
Errh-ST-1-20				15		
Errh-ST-1-21				9		
Errh-ST-1-22				11		
Errh-ST-1-23				12		
Errh-ST-1-24				10		
Errh-ST-1-25				3		
Errh-ST-1-26				5		
Errh-ST-1-27				35		
Errh-ST-1-28				6		
Errh-ST-1-29				1		
Errh-ST-1-30				2		
Errh-ST1-31				22		
Errh-ST-1-32				48		
Err-ST-1-32				36		
Errh-ST-1-33				15		
Errh-ST-1-34-14				2		
Errh-ST-1-35-14				3		

SITE/ WAYPOINT NAME	LOCATION	LAST OBS YEAR	LAST OBS SIZE	2014 SIZE	2014 VIGOR	2014 COMMENTS
Site 2	Sawtooth Mts	1991	>1000	345	Fair	2014 occupied habitat roughly the same as previous observations, but plants very dry with several appearing dead.
Pop2 Point Errh-ST- Pop2)				345		
Site 3	Sawtooth Mts	1991	>200	62	Fair	Three small patches on about half an acre. Very drought stressed. Several plants appear dead.
Errh-ST-3A				4		
Pop3B				9		
Errh-ST-3C				49		
Site 4	Sawtooth Mts	1991	9	83	Good	About half an acre of habitat occupied by 83 plants in mostly good condition.
Pop4A				83		
Site5	Sawtooth Mts	1991	50	30	Fair	30 plants in three scattered patches. Area around Pop5A had about 50 plants in 1991.
Pop5A		1991	50	1		
Pop5B				14		
Pop5C				15		
Site 6	Sawtooth Mts	1991	>200	116	Fair	Scattered patches of plants. 2014 observation similar to 1991 estimate.
Pop6A				26		
Pop6B				3		

SITE/ WAYPOINT NAME	LOCATION	LAST OBS YEAR	LAST OBS SIZE	2014 SIZE	2014 VIGOR	2014 COMMENTS
Pop6C				6		
Pop6D				6		
Errh-ST-6-1				7		
Errh-ST-6-2				31		
Errh-ST-6-3				28		
Errh-ST-6-4				2		
Errh-ST-6-5				10		
Site 7	Sawtooth Mts	1991	>2000	223	Good	Several small patches of plants. 2014 number of individuals greatly reduced from 1991 estimate.
Pop7A				22		
Pop7B				62		
Pop7C				26		
Pop7D				26		
Pop7E				5		
Pop7F				12		
Pop7G				27		
Errh-ST-8-1				3		
Errh-ST-7-2				3		
Errh-ST-7-3				6		
Errh-ST-7-4				1		
Errh-ST-7B				30		
Site 8	Sawtooth Mts	1991	>1000	26	Good	Two small patches of plants. 2014 number of individuals greatly reduced from 1991 estimate.
Pop8A				8		
Errh-ST-8A				18		
Site 9	Datil Mts	1991	>500	36	Good	Several small patches of plants. 2014 number of individuals reduced from 1991 estimate.
Pop9A				2		

SITE/ WAYPOINT NAME	LOCATION	LAST OBS YEAR	LAST OBS SIZE	2014 SIZE	2014 VIGOR	2014 COMMENTS
Pop9B				3		
Pop9C				5		
Pop9D				4		
Pop9E				7		
Pop9F				11		
Pop9G				4		
Site 10	Datil Mts	1991	>500	63	Good	Three large patches of plants. 2014 number of individuals reduced from 1991 estimate.
Pop10A				13		
Pop10B				12		
Pop10C				38		
Site 11	Datil Mts	1991	5	9	Good	One small patch of plants between Pop10 and Pop12. About the same as 1991.
Pop11A				9		
Site 12	Datil Mts	1991	>500	168	Good	Small and large patches of plants growing on sandstone cliff and slope below. Similar to 1991 observation, but fewer plants.
Pop12A				21		
Pop12B				12		
Pop12C				4		
Pop12D				25		
Pop12E				4		
Pop12F				42		
Pop12G				60		
Site 13	Datil Mts	1991	>200	86	Poor	Small and large patches of plants. At least 10% of 2014 plants appear dead for

SITE/ WAYPOINT NAME	LOCATION	LAST OBS YEAR	LAST OBS SIZE	2014 SIZE	2014 VIGOR	2014 COMMENTS
						a year or more.
Pop13A				32		
Pop13B				29		
Pop13C				12		
Pop13D				8		
Pop13E				5		
Site 14	Datil Mts	1991	30	0		This patch of habitat was unoccupied in 2014.
Site 15	Datil Mts	1991	>500	93	Good	Small and large patches of plants growing on sandstone cliff and slope below. Similar to 1991 observation, but fewer plants.
Pop15A				19		
Pop15B				54		
Pop15C				4		
Pop15D				8		
Pop15E				8		
Site 16	Datil Mts	1991	>200	6	Good	Only two small patches of occupied habitat in 2014. Smaller than 1991 observation. New mineral claim stakes just N of this location.
Pop16A				5		
Pop16B				1		
Site 17	Datil Mts	1991	10	77	Good	Pop17 covers a larger area with more plants than detected in 1991.
Pop17a-14				15		Old mineral claim stake at this point.
Pop17B				1		

SITE/ WAYPOINT NAME	LOCATION	LAST OBS YEAR	LAST OBS SIZE	2014 SIZE	2014 VIGOR	2014 COMMENTS
Pop17C				3		
Pop17D				3		
Pop17-1-14				17		
Pop17-2-14				38		
Site 18	Datil Mts	1991	>50	85	Good	More plants observed at this location in 2014 than in 1991.
Pop18A				3		
Pop18-1-14				20		
Pop18-2-14				56		
Pop18-3-14				6		
Site 19	Datil Mts	1991	10	0		This patch of habitat was unoccupied in 2014.
Site 20	Datil Mts	2009		49	Good	Discovered in 2009. Recent uranium claim on north side of this population.
Pop20A				7		
Pop20B				18		
Pop20C				4		
Pop20D				2		
Pop20E				10		
Pop20F				4		
Pop20G				4		
Site 21	Datil Mts			224	Good	Pre-1991 FS location (Reggie Fletcher). Previously known as Population 1. Very old mineral claim stakes within population.
Pop21A				22		
Pop21B				10		
Pop21C				6		
Pop21D				4		

SITE/ WAYPOINT NAME	LOCATION	LAST OBS YEAR	LAST OBS SIZE	2014 SIZE	2014 VIGOR	2014 COMMENTS
Pop21E				45		
Pop21F				15		
Pop21G				10		
Pop21H				21		
Pop21I				4		
Pop21J				3		
Pop21K				21		
Pop21-39- 14				5		
Pop21-40- 14				5		
Pop21-42- 14				6		
Pop21-42b- 14				3		
Pop21-44- 14				3		
Pop21-47- 14				8		
Pop21-47b- 14				14		
Pop21-49- 14				6		
Pop21-49b- 14				3		
Pop21-50- 14				3		
Pop21-51- 14				4		
Pop21-52- 14				3		
Site 22	Datil Mts			6	Fair	Pre-1991 FS location (Reggie Fletcher).
Errh4-14				6		
Site 23	Datil Mts			55	Poor- Good	Pre-1991 FS location (Reggie Fletcher).
RF3A				19		All but 1 plant completely dead.
RF3B				15		All plants dead.

SITE/ WAYPOINT NAME	LOCATION	LAST OBS YEAR	LAST OBS SIZE	2014 SIZE	2014 VIGOR	2014 COMMENTS
RF3C				21		All plants in good condition.
Site 24	Datil Mts			21	Fair	Pre-1991 FS location (Reggie Fletcher).
RF5A				21		
Site 25	Datil Mts			18	Good	Three small patches discovered during 2014 survey.
Pop25A				8		
Pop25B				6		
Pop25C				4		
Site 26	Datil Mts			78	Good	Two patches of plants discovered during 2014 survey.
Pop26A				23		
Pop26B				55		
Site 27	Datil Mts			18	Good	One small patch of plants discovered during 2014 survey.
Errh-27-14				18		
Site 28	Datil Mts			6	Good	One small patch of plants discovered during 2014 survey.
Errh-28-14				6		
Site 29	Datil Mts			56	Good	Pre-1991 FS location (Reggie Fletcher).
RF9A				28		
RF9B				9		
RF9C				19		
Site 30	Datil Mts			58	Good	Pre-1991 FS location (Reggie Fletcher).
RF8A				46		
Errh8-2-14				12		

SITE/ WAYPOINT NAME	LOCATION	LAST OBS YEAR	LAST OBS SIZE	2014 SIZE	2014 VIGOR	2014 COMMENTS
Site 31	Datil Mts			11	Good	Pre-1991 FS location (Reggie Fletcher).
RF6A				5		
RF6B				6		
Site 32	Sawtooth Mts			12	Good	Pre-1991 FS location (Reggie Fletcher).
RF1				2		
RF1-2-14				10		
Site 33	Datil Mts			8	Good	One small patch of plants discovered during 2014 survey.
Pop33A				8		
						3,089 total plants counted in the Datil/Sawtooth Mountains in 2014