

# Status Survey

for

Gypsum Townsend's Aster (*Townsendia gypsophila*), Sivinski's Scorpionweed (*Phacelia sivinskii*), Todilto Stickleaf (*Mentzelia todiltoensis*), and Tufted Sand Verbena (*Abronia bigelovii*).

on Zia Pueblo Lands  
in Sandoval County, New Mexico



Daniela Roth  
EMNRD-Forestry Division, Santa Fe, NM  
Prepared for the  
U.S. Fish & Wildlife Service, Region 2  
Albuquerque, NM

## INTRODUCTION

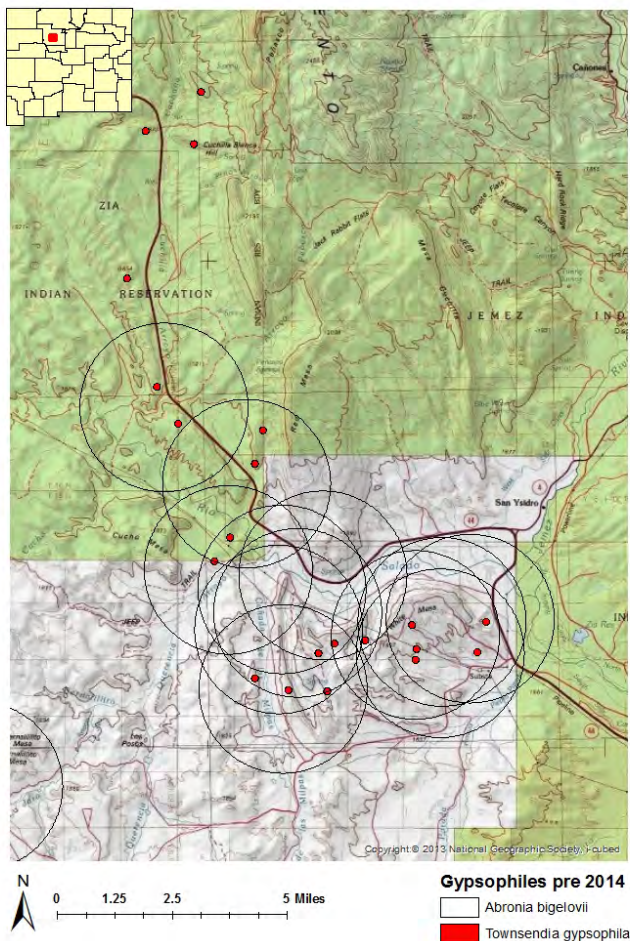
The White Mesa region is located in a geological diverse region of mostly Jurassic-age sedimentary strata in west-central Sandoval County, New Mexico. The gypsum outcrops of this area are well known habitat for rare gypsophilic plant species including *Townsendia gypsophila* (gypsum Townsend aster), *Abronia bigelovii* (tufted sand verbena), *Phacelia sivinskii* (Sivinski's scorpionweed) and *Mentzelia todiltoensis* (Todilto stickleaf). All four species are USFWS and State of New Mexico Species of Concern (NMRPTC 1999).

The purpose of this survey and status report is to provide information to land managers and regulatory agencies on the current status and distribution on these four endemic species to help making management decisions with respect to land use practices.

## STUDY AREA

The White Mesa region stretches from south of San Ysidro, north and northwest for approximately 20 miles (Figure 1). Twelve study sites previously reported from Zia Pueblo lands for *Townsendia gypsophila* were the focus areas for this survey (Lowrey & Knight 1994). Outcroppings of the Jurassic-age gypseous Todilto and

Summerville formations are found across much of west-central New Mexico and provide habitat for the gypsophilic plants of this region. The Todilto and the overlying Summerville gypsum strata have previously been placed in the Jurassic-age Morrison Formation by some researchers, but are no longer recognized as Morrison strata and are now separated as distinct formations by geologists (Lucas and Heckert 2003). Soil substrates grade from almost pure gypsum with gypsite/lichen crust to gypseous sandy loam. Elevations at the 12 study sites range between approximately 5,500 and 6,800ft. Vegetation cover is very sparse and includes scattered *Juniperus monosperma* (one-seed juniper), *Pinus edulis* (pinion pine), *Quercus x undulata* (wavyleaf oak), *Ephedra torreyana* (Torrey jointfir), *Yucca baileyi* (Bailey's yucca), and several common and widespread gypsophilic species including *Sporobolus nealleyi* (gyp dropseed), *Tiquilia hispidissima* (hairy crinklemat), *Oenothera hartwegii* subsp. *filifolia* (Hartweg's sundrops), *Tetradymia filifolia* (threadleaf horsebrush) and *Ascleiathanes lanceolata* (lanceleaf moonpod). A dark cryptogamic crust composed of cyanobacteria, algae, lichen and mosses frequently covers the gypsum soils in the habitat of all four species.



**Figure 1.** Documented rare plant locations prior to this study. No information was available on the distribution of *Phacelia sivinskii* and *Mentzelia todiltoensis*.

## METHODS

Field surveys occurred during spring and fall of 2015. All sites were visited twice to maximize documentation of spring and summer flowering species. Twelve previously documented sites for *Townsendia gypsophila* on Zia Pueblo lands were revisited in 2015 and were the general targeted sampling areas for this survey (Lowrey and Knight 1994). No formal surveys had previously been conducted to document the occurrences and distribution of *Abronia bigelovii*, *Mentzelia todiltoensis*, and *Phacelia sivistrii*. Limited existing occurrence documentation for *Townsendia gypsophila* and *Abronia bigelovii* was provided by Natural Heritage New Mexico (Figure 1).

Two different methods of GPS mapping were employed for this field survey. Both *Townsendia gypsophila* and *Abronia bigelovii* occur in small scattered patches of plants and were not usually suited for walking polygons around occupied habitat. These two species were marked with GPS waypoints when encountered, then an estimated 100-foot radius around the point was thoroughly searched and the number of plants recorded. *Mentzelia todiltoensis* and *Phacelia sivistrii* are generally far more abundant and often continuously distributed across large gypsum outcrops, therefore cannot be easily recorded with waypoints. Where applicable, occupied habitat for these species was mapped as polygons. Waypoints were used for these two species when isolated patches of plants were encountered. Population density counts of individuals were not usually attempted within the polygons for these two locally abundant species and were visually estimated. Plant populations are separated based on the 2004 NatureServe Habitat Based Strategy for Delimiting Plant Element Occurrences, which separates populations if they are more than 1 km apart within suitable habitat (NatureServe 2004).

## RESULTS

Not all suitable habitat was surveyed in 2015, but all four gypsum endemic plant species were found in the appropriate habitats at the majority of the 12 target sites (Figure 2). Although *Townsendia gypsophila* and *Abronia bigelovii* were found at Site 8, no *Phacelia sivistrii* or *Mentzelia todiltoensis* were observed in that area. Overall *Townsendia gypsophila* was found in similar numbers to the 1994 survey results, although apparent declines were observed in several sites. *Abronia bigelovii* was present at all 12 sites, but population numbers were lowest among the four gypsum endemics.

Few invasive species were documented in the habitat of the four species throughout the survey area. Only Russian thistle was documented from one area, along the main access road at the White Mesa gypsum mine. The primary threat to all four species is active gypsum mining and associated infrastructure development in the White Mesa area (Sites 8, 9, 10, 11). Other documented disturbances include livestock trampling, off-road vehicle use, and some recreational biking. No predation or insect damage was noted for any of the four plant species.

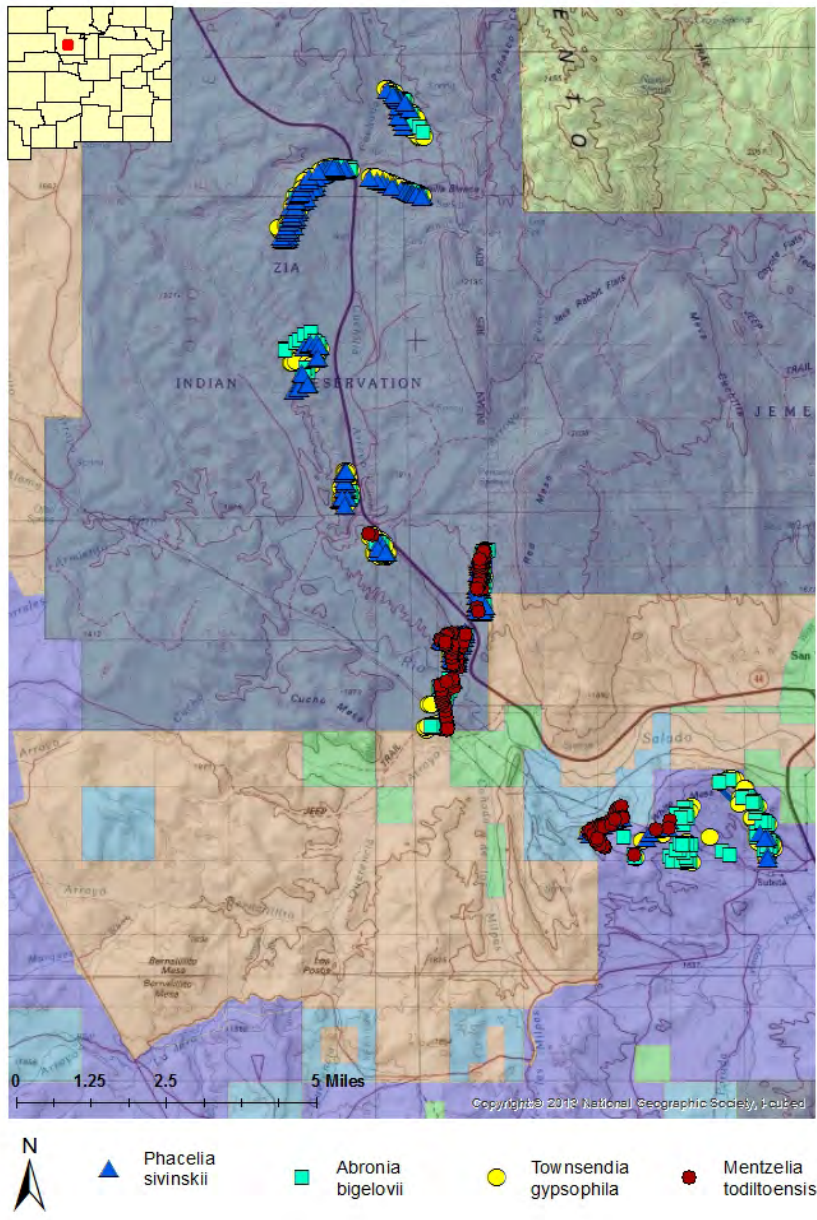


Figure 2. 2015 distribution of four rare gypsum endemics on Zia Pueblo lands in Sandoval County, NM.

# *Townsendia gypsophila*

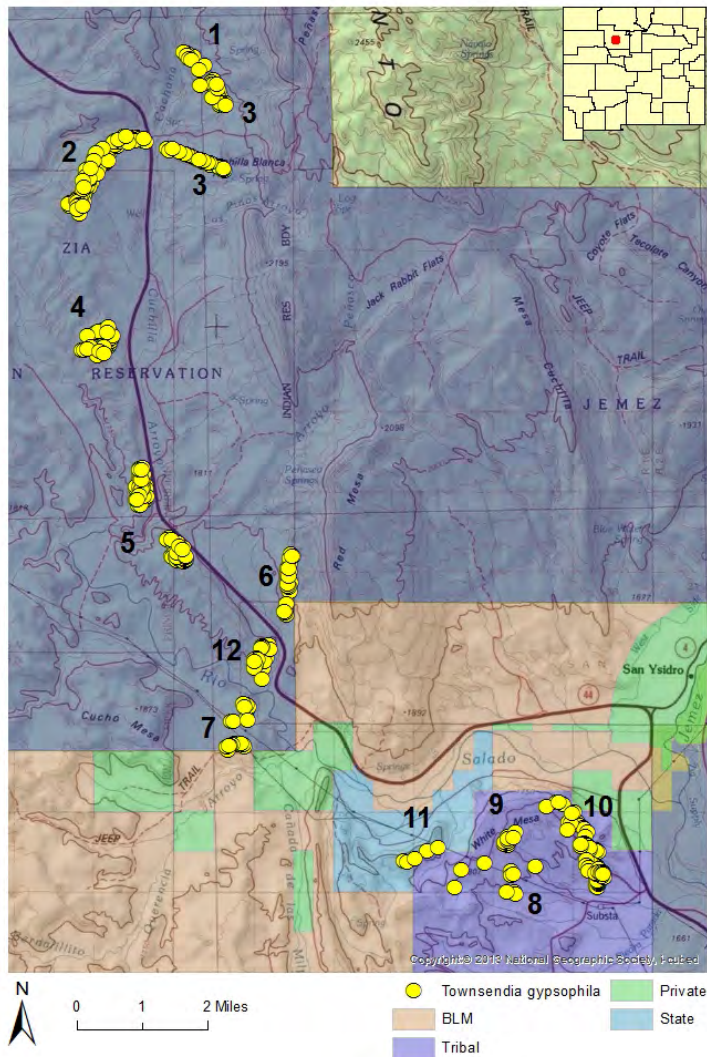
(Gypsum Townsend aster)



*Townsendia gypsophila* is a low-growing, caespitose perennial herb in the aster family (Asteraceae). It has white ray flowers and short strigose-pubescent leaves. It is entirely endemic to the Todilto and Summerville gypsum formations in White Mesa region near San Ysidro, New Mexico, at elevations between approximately 5,500 and 6,800ft. The entire world-wide range is less than 20 miles of discontinuous gypsum outcrops in west-central Sandoval County (Lowrey and Knight 1994). *Townsendia gypsophila* flowers from spring through early autumn. It is more often found on a sandy gypsum layer of the lower Summerville Formation than on the underlying barren Tonque Member of the Todilto Formation, which is more pure gypsum (Roth & Sivinski 2015). Disturbed areas are devoid of this plant.

*Townsendia gypsophila* is a USFWS and NM State Species of Concern. This localized endemic has a NatureServe rank of G2/S2 (imperiled) due to its limited range and known threats. The New Mexico Rare Plant Technical Council R-E-D Code (R = Rarity, E = Endangerment, D = Distribution) for this rare plant is 2-2-3,

meaning it is confined to several populations or one extended population; is endangered in a portion of its range; and is endemic to New Mexico (NMRPTC 1999).



**Figure 3.** 2015 distribution of *Townsendia gypsophila* on Zia Pueblo lands

In 2015, *Townsendia gypsophila* was found in all of the 12 previously documented locations on gypsum outcrops on Zia Pueblo lands. Based on the 2004 NatureServe guidance for delimiting plant occurrences, there are 7 populations of *Townsendia gypsophila* distributed among these 12 locations (Table 1). The species typically occurs as scattered patches of a few individuals on ridge tops, rolling hills and caprock rims. It can occur on all topographic exposures including some steep slopes. In 2015, a total of 4,790 individuals was documented from 437 waypoints (Figure 3). A similar number of plants was reported in from all 12 sites in 1994 (approximately 4,593). The majority of waypoints contained small groupings of plants ranging from 1 to 10 individuals. The highest concentrations of plants were found at Site 2 (Figure 3; Table 1). Plants were observed flowering in spring and fall and were in overall good condition. Although the spring and summer of 2015 were relatively wet with abundant rainfall, very few *Townsendia gypsophila* seedlings were observed.

**Table 1.** Number of *Townsendia gypsophila* plants in 1994 and 2015 at 12 locations on Zia Pueblo lands in Sandoval County, NM.

Site No	1994 Location Name	1994 No of Plants	2015 No of Plants	Population
1	Unsurveyed Section 30 (T17N R1E)	341	384	1
2	Unsurveyed Section 36 (T17N R1E)	325	1,478	1
3	Unsurveyed Section 31 (T17N R1E)	511	449	1,2
4	Section 13 & 14 (T16N R1E)	105	186	3
5	Section 24 & 25 (T16N R1E)	1,411	833	4, 5
6	Unsurveyed Sections 29 & 32 (T16N R1E)	Several hundreds (300)	313	6
7	Unsurveyed Section 6 (T15N R1E)	639	186	6
8	Sections 22 & 23 (T15N R1E)	84	10	7
9	Section 14 (T15N R1E)	386	156	7
10	Section 13 (T15N R1E)	263	572	7
11	Section 15 (T15N R1E)	28	36	7
12	Unsurveyed Section 30 (T16N R1E)	200 +	187	6



# SITE 1

## Unsurveyed Section 30 (T17N R1E)

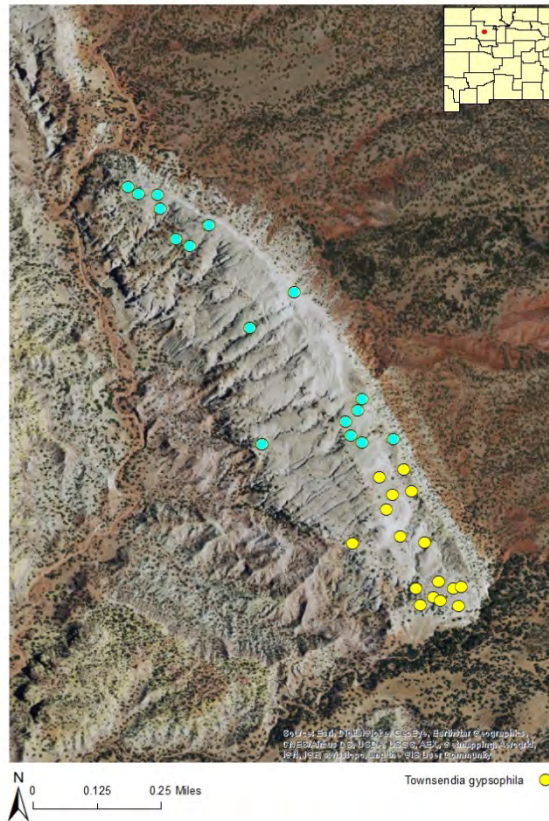


Figure 4. *Townsendia gypsophila* Site 1 (blue highlighted dots)

Site 1 is located on the northern end of an unnamed north-south running ridge, just north of Cuchilla Blanca (Site 3). It represents the northernmost known location for *Townsendia gypsophila* (Figure 4). The number of observed plants at this site was similar in 2015 (384) to 1994 results (341). This site is composed of mostly barren, steep, west facing slopes with a scattered pinion-juniper-oak community, including small pockets of rubber rabbitbrush (*Ericameria nauseosa*), mesa pepperwort (*Lepidium alyssoides*), thrift mock goldenweed (*Stenotus armerioides*), New Mexico feathergrass (*Hesperostipa neomexicana*), Torrey jointfir (*Ephedra torreyana*), Sivinski's scorpionweed, tufted sand verbena, and Todilto stickleaf. *Townsendia gypsophila* was documented from 16 waypoints at this location, including a total of 384 plants. It occurs primarily in small groupings of less than 10 plants (56%), with the exception of the northern tip of the ridge. The majority of all plants (70%) were located in the vicinity of four waypoints at this location (267 individuals). The waypoint with the most individuals contained 131 plants. In May of 2015, plants were found in fair to good condition, mostly flowering. Plants appeared to prefer lighter tan colored soils and soils without heavy cryptogamic crusts. No disturbances were observed at the northern portion of this ridge (Site 1). No invasive or nonnative species were documented at this location.



## SITE 2

### Unsurveyed Section 36 (T17N R1E)

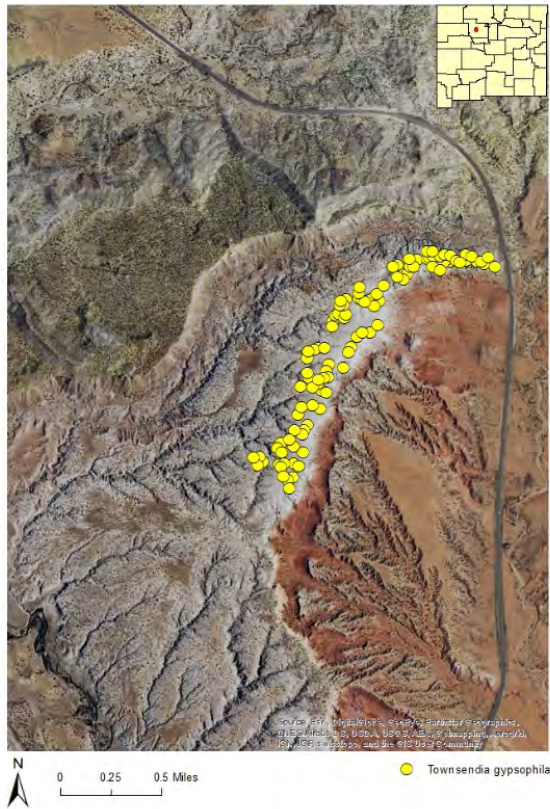


Figure 5. *Townsendia gypsophila* Site 2

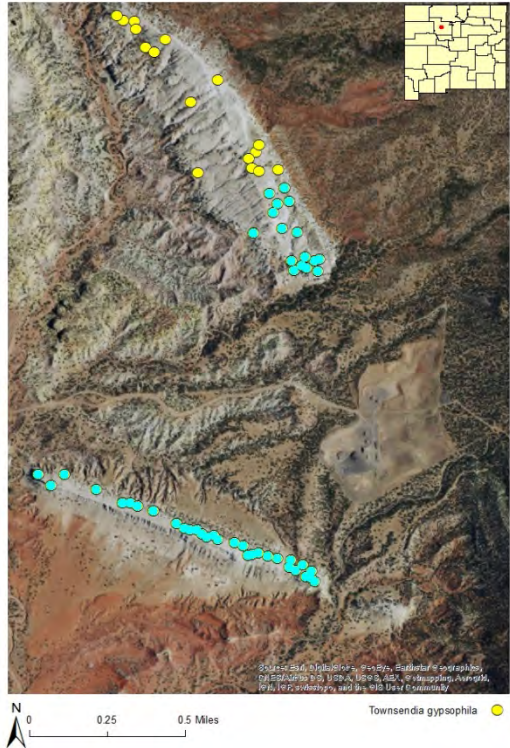
rated in fair condition and preferred lighter tan colored gypsum outcrops and also shallow drainages and depressions. Plants were mostly flowering in May of 2015. No invasive or nonnative plants were documented. No evidence of livestock or other disturbances were observed.

This site is a mostly barren west- and northwest-facing escarpment on the west side of HWY 550 (Figure 5). The suitable habitat in this location extends significantly further south than was surveyed and is more or less continuous along the escarpment west of HWY 550, including Sites 4 and 5, ending at Sites 7 and 12. *Townsendia gypsophila* grows at Site 2 with scattered pinion, juniper, Torrey jointfir, New Mexico feathergrass, mesa pepperwort, thrift mock goldenweed, Sivinski's scorpionweed, tufted sand verbena, and Todilto stickleaf. The largest number of *Townsendia gypsophila* plants was documented in 2015 at this site (Table 1). Plants were documented from 105 waypoints, including a total of 1,478 individuals. This is a significant increase over the number of plants documented in 1994 (325). However, the total area surveyed was approximately 3 times larger than the area surveyed in 1994. In addition, survey effort was twice the time spent in 1994. The majority of plants were distributed in small groupings of 10 or fewer plants (69%). The largest site contained 268 plants over a 200 x 200 m area. Plants were found in good to excellent condition at the large site on north- and northwest-facing slopes, in heavy cryptogamic soils. At the smaller sites plants were



## SITE 3

### Unsurveyed Section 31 (T17N R1E)



**Figure 6.** *Townsendia gypsophila* Site 3 (blue highlighted dots)

area on the southern portion of the escarpment (all of the northern portion of Site 3). Livestock trailing was notable in the southern portion of this escarpment. A human trail extended along the ridgeline. In addition, the eastern portion of Cuchilla Blanca Hill was significantly impacted by off-road vehicle traffic and included a parking area, human and livestock trailing. No invasive or nonnative plants were documented.

Site 3 contains two general locations, Cuchilla Blanca Hill to the south, and the northwest corner of unsurveyed Section 31, on an unnamed ridge north of Cuchilla Blanca Hill (partially Site 1)(Figure 6). The number of *Townsendia gypsophila* plants were lower in 2015 (449) than in 1994 (511)(Table 1). Plants occurred on mostly barren north- and west-facing slopes with scattered pinion, juniper, Sivinski's scorpionweed, Todilto stickleaf, tufted sand verbena, big sagebrush (*Artemisia tridentata*), Bailey's yucca, blue grama (*Bouteloua gracilis*), and rubber rabbitbrush. A total of 449 individuals were found at 47 waypoints; 299 individuals were documented from Cuchilla Hill and an additional 150 plants from the southern portion of the unnamed ridge north of Cuchilla Hill (Figure 6). The majority of plants were in groupings of less than 10 plants (70%). The largest site contained 48 plants and was located on the unnamed southern portion of the ridge north of Cuchilla Hill. Plants were found in fair condition, mostly flowering.

The NW corner of this section, on the unnamed ridge north of Cuchilla Blanca Hill, has been disturbed in the past by some gypsum mining activities. In 2015, the access road had washed out and had not been used in some time. However, in the fall of 2015 new survey stakes and flags were found along the gypsum outcrop boundaries, over approximately half occupied habitat



# SITE 4

Section 13 & 14 (T16N R1E)

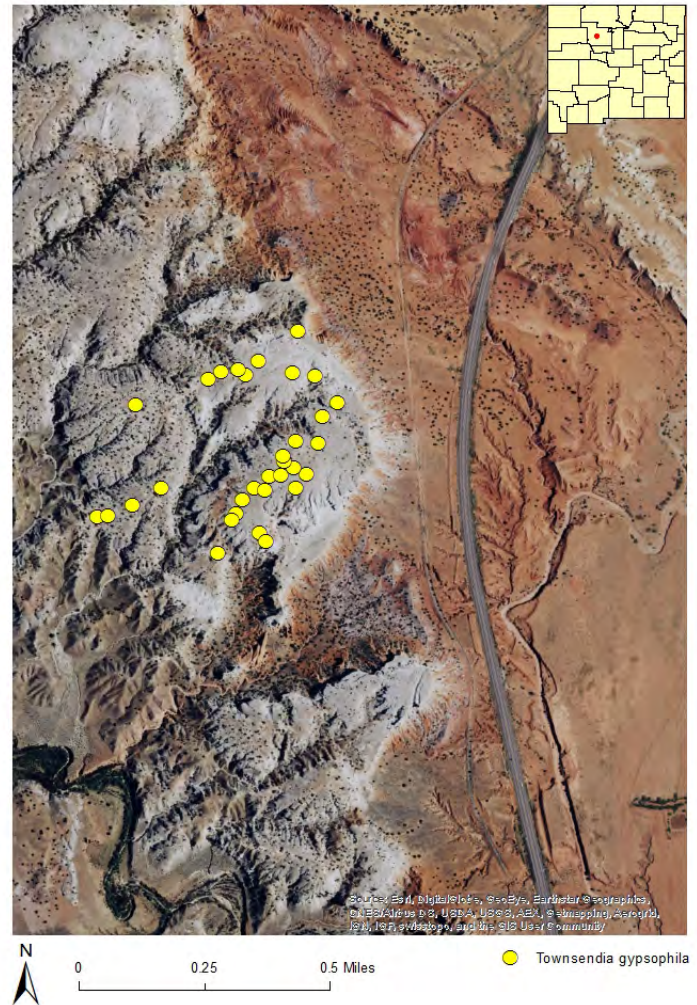
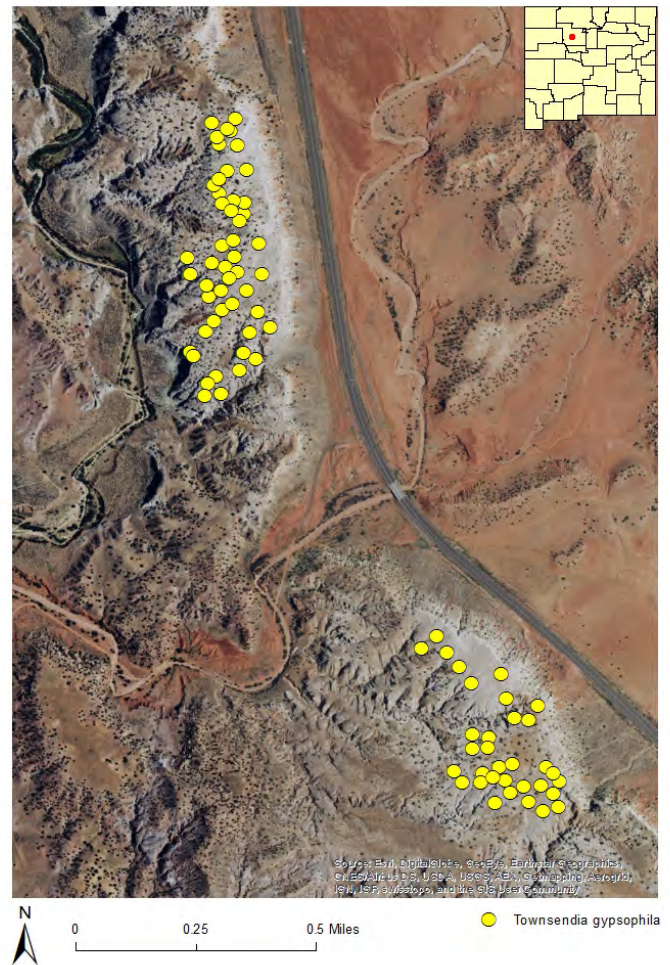


Figure 7. *Townsendia gypsophila* Site 4

Site 4 is a mostly barren, gently sloping, west-facing escarpment on the west side of HWY 550 (Figure 7). The suitable habitat in this location extends significantly further north and south than was surveyed and is more or less continuous along the escarpment west of HWY 550, extending north to Site 2 and south, ending at Sites 7 and 12. *Townsendia gypsophila* occurs on Site 4 with scattered pinion, juniper, big sagebrush, cliffrose (*Purshia stansburyana*), *Cryptantha*, Indian ricegrass (*Achnatherum hymenoides*), rubber rabbitbrush, galleta (*Hilaria jamesii*), Sivinski's scorpionweed, Todilto stickleaf, and tufted sand verbena. The number of *Townsendia gypsophila* plants documented was higher in 2015 (186) than in 1994 (105) (Table 1). In 2015, *Townsendia gypsophila* was documented from 32 waypoints containing 186 individuals. The vast majority of sites occur in small groupings of 10 or fewer plants (88%). Only four sites had more than 10 plants (13, 14, 15, and 22 plants).

In the past the site was accessed from a now defunct dirt road leading from the west side to an old inactive quarry. The site surrounding the quarry has been significantly disturbed in the past but other than limited livestock trailing, no recent disturbances were observed. No invasive nonnative species were documented.

**SITE 5**  
Section 24 &25 (T16N R1E)

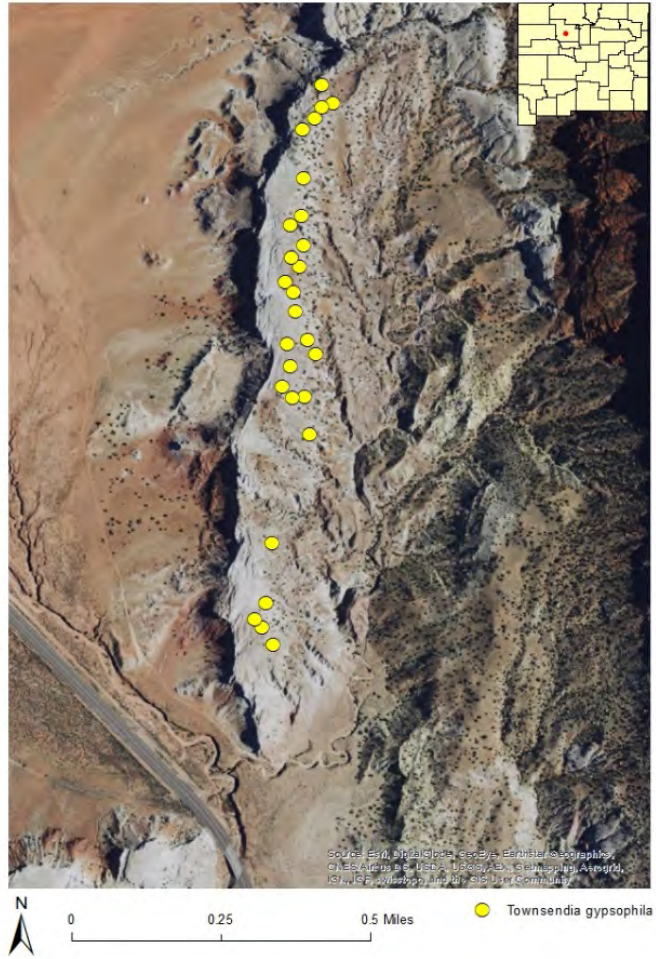


**Figure 8.** *Townsendia gypsophila* Site 5

Site 5 is located north and south of where Cuchilla Arroyo cuts through the escarpment west of HWY 550 (Figure 8). The suitable habitat in this location extends significantly further north and south than was surveyed and is more or less continuous along the escarpment west of HWY 550, extending north to Sites 2 and 4, and south, ending at Sites 7 and 12. Plants are located on a gently sloping mostly barren west-facing escarpment. Associated species include widely scattered pinion-juniper with pockets of Indian ricegrass, thrift mock goldenweed, Torrey joint-fir, Bailey’s yucca, New Mexico feathergrass, fine-leaf woollywhite (*Hymenopappus fililifolius*), Sivinski’s scorpionweed, tufted sand verbena, and Todilto stickleaf. Significantly fewer plants were found in 2015 (833) from 1994 counts (1,411) (Table 1). In 2015, 833 individual were documented from 82 waypoints. The majority of waypoints had fewer than 10 individuals (76%). Twenty waypoints had more than 10 plants. The largest site contained 48 plants. Plants were found in fair to good condition, mostly flowering, preferentially located on lighter tan colored gypsum outcrops and among soils with heavy cryptogamic crusts. No disturbances were observed except for some livestock trailing and a recent bicycle track on the southern escarpment. No invasive nonnative species were documented.

## SITE 6

### Unsurveyed Sections 29 & 32 (T16N R1E)



**Figure 9.** *Townsendia gypsophila* Site 6

Site 6 is a north-south trending ridge on the north side of HWY 550 (Figure 9). The occupied habitat of *Townsendia gypsophila* is on east-facing slopes primarily near the top of the escarpment. The escarpment is sparsely vegetated with pinion-juniper, big sagebrush, Indian ricegrass, galleta, Bailey’s yucca, Sivinski’s scorpionweed, Todilto stickleaf, and tufted sand verbena. The population of *Townsendia gypsophila* in 2015 is likely similar to what was reported in 1994 (several hundred) (Table 1). In 2015, 313 plants were documented from 27 waypoints. The majority of sites contained fewer than 10 plants (67%). The largest site had 56 individuals. Plants were found in good condition, mostly flowering, and preferred the lighter tan colored gypsum soils with only a thin layer of cryptogamic crusts. Except for some livestock trailing, no disturbances were observed. No invasive nonnative species were documented.

# SITE 7

## Unsurveyed Section 6 (T15N R1E)

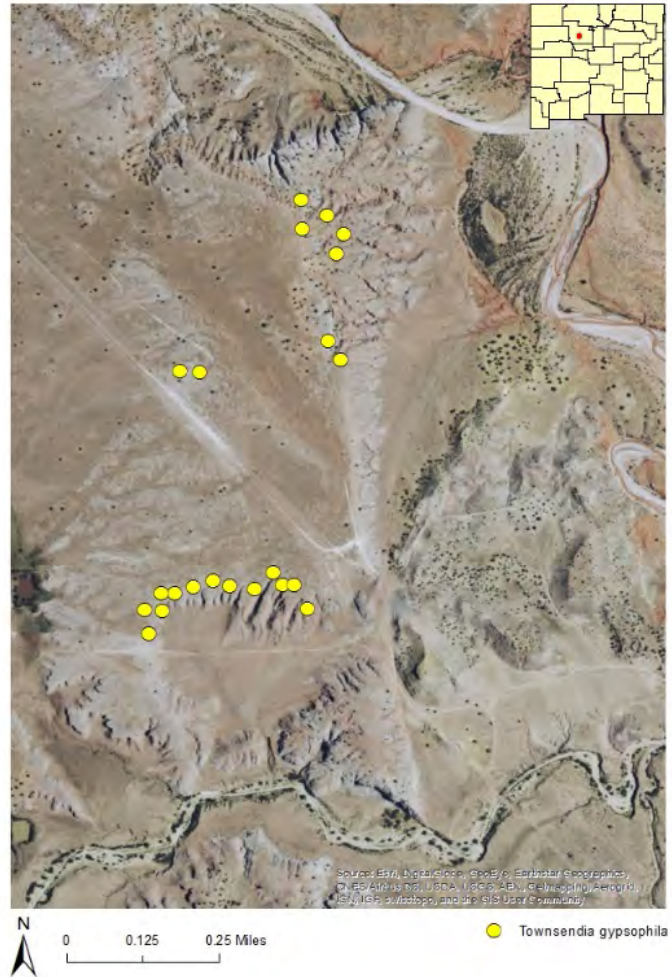


Figure 10. *Townsendia gypsophila* Site 7

Site 7 is located just north of the boundary with the BLM and south of Rio Salado (Figure 10). The suitable habitat in this location extends significantly further north than was surveyed and is more or less continuous along the escarpment west of HWY 550, extending north to Sites 12, and northwest to Sites 2, 4, and 5. The number of plants found at Site 7 (186) was significantly lower in 2015 than in 1994 (639) (Table 1). Suitable habitat for *Townsendia gypsophila* at Site 7 is limited and restricted to gypsum outcrops of rolling hills, primarily on south and southeast facing slopes. Associated species include scattered pinon and juniper, New Mexico feathergrass, galleta, Torrey joint-fir, snakeweed (*Gutierrezia sarothrae*), *Cryptantha*, Hartweg's sundrops, buckwheat (*Eriogonum sp.*), tufted sand verbena, Sivinski's scorpionweed, and Todilto stickleaf. In 2015 a total of 186 individuals were documented from 22 waypoints. The majority of sites contained fewer than 10 plants (77%). The largest site contained 57 plants. Some livestock trailing was observed in the area. Other disturbances include a powerline and associated access roads. No invasive nonnative plants were documented.

# SITE 8

## Sections 22 & 23 (T15N R1E)



Site 8 is located at the southern end of White Mesa and is part of the White Mesa gypsum mine (Figure 11). Only 10 individuals were located at Site 8 in 2015, in Section 23, and none in Section 22. In 1994, 84 plants were documented from the northern parts of these 2 sections (Table 1). This site is largely located on the spurs of the southern flank of White Mesa and is composed of south-facing gentle slopes with widely scattered pinion, juniper, Bigelow sagebrush, galleta, Indian ricegrass, Bailey's yucca, hairy crinklemat, Torrey joint-fir, and tufted sand verbena. Plants were documented from 3 waypoints with fewer than 5 plants each. Plants were found flowering, in good condition. Off-road vehicle trails were found throughout the general area, primarily associated with the powerline and apparent recent surveys, as indicated by survey stakes found through the area (Figure 12). Limited livestock impacts were evident. No invasive nonnative species were documented.

**Figure 11.** *Townsendia gypsophila* Site 8



**Figure 12.** *Townsendia gypsophila* Site 8, disturbed area

# SITE 9

## Section 14 (T15N R1E)

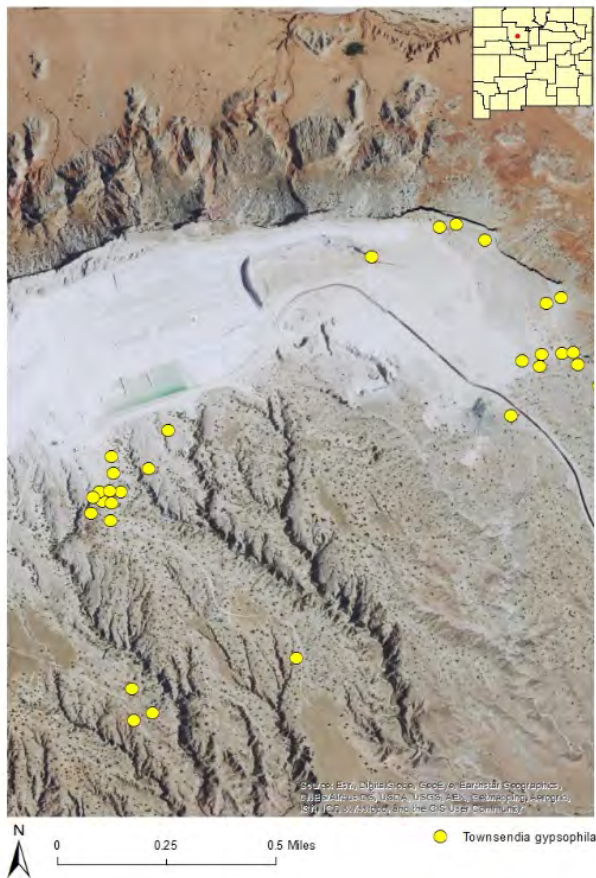


Figure 13. *Townsendia gypsophila* Site 9

Site 9 (including the SE corner of section 11) surrounds the active part of the White Mesa gypsum mine and currently contains the most disturbed and impacted population of *Townsendia gypsophila* (Figures 13 & 14). Significantly fewer plants were documented from this site (156) over 1994 plant counts (386) (Table 1). The site is primarily composed of gently sloping south and southwest-facing hills with scattered pinion, juniper, wavyleaf oak, rubber rabbitbrush and hairy crinklemat, Sivinski's scorpionweed, Todilto stickleaf, and tufted sand verbena. In 2015, 156 individuals were documented from 25 waypoints, primarily containing 10 or fewer plants (88%). The largest site contained 34 individuals. Plants were found in good condition, either flowering or in late flowering stage. Plants were not found in disturbed areas, but in the immediate perimeter of active gypsum mining operations. The site is significantly disturbed by mining activities and associated infrastructure (roads, spur roads, buildings, waste piles, powerlines, recent survey stakes, active mine area) (Figure 14). Limited livestock impacts were evident. Russian thistle (*Salsola kali*) was documented along the mine access road. Some tamarisk (*Tamarix* sp.) were seen in shallow depressions.



Figure 14. *Townsendia gypsophila* Site 9, in the immediate vicinity of active gypsum mining.



## SITE 10

Section 13 (T15N R1E)

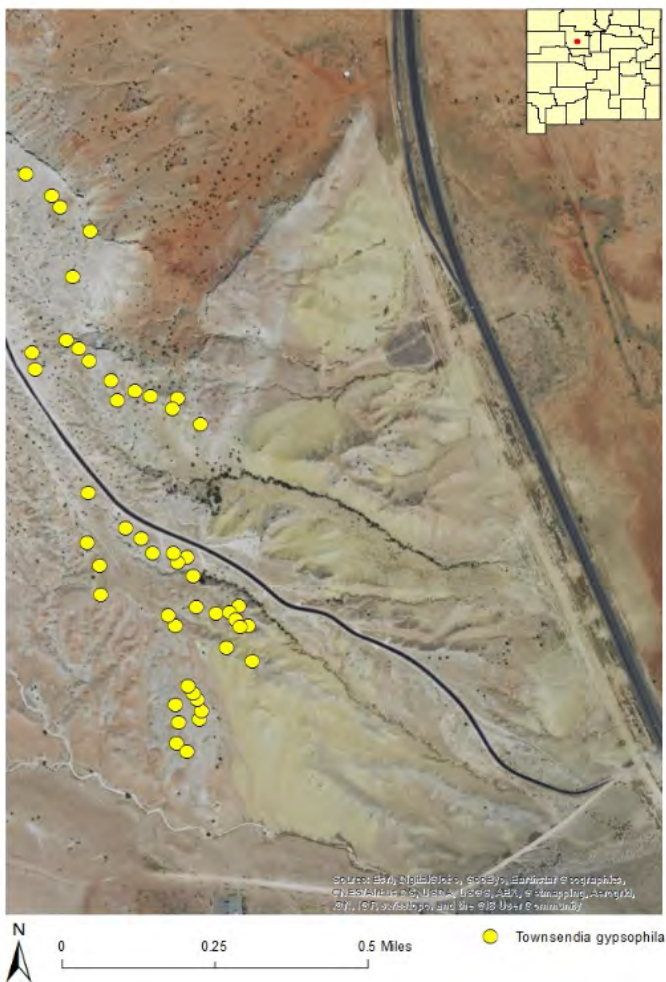


Figure 15. *Townsendia gypsophila* Site 10

Site 10 is located north and south of the paved main access road to the White Mesa gypsum mine (Figure 15). In 2015 approximately twice the number of plants (572) were found in Site 10 than were documented in 1992 (263) (Table 1). Suitable occupied habitat was largely distributed along roads and flat areas, and gentle south- and southeast facing slopes with scattered pinion, juniper, wavyleaf oak, Torrey jointfir, rubber rabbitbrush, hairy crinklemat, galleta, Bailey's yucca, fine-leaf woolywhite, Sivinski's scorpionweed, Todilto stickleaf, and tufted sand verbena. Plants were documented from 52 waypoints, found primarily in small groupings of 10 or fewer plants (71%), north and south of the gypsum mine access road. The largest site contained 51 individuals. Plants were found in good to excellent condition, mostly flowering in May and October. Plants were not found in disturbed areas, but primarily just outside immediate perimeter of active gypsum mining operations. Much of the site is significantly disturbed by mining activities and associated infrastructure (roads, spur roads, buildings, waste piles, powerlines, recent survey stakes). No livestock impacts were evident. Russian thistle (*Salsola kali*) was documented along the mine access road.

## Site 11

### Section 15 (T15N R1E)

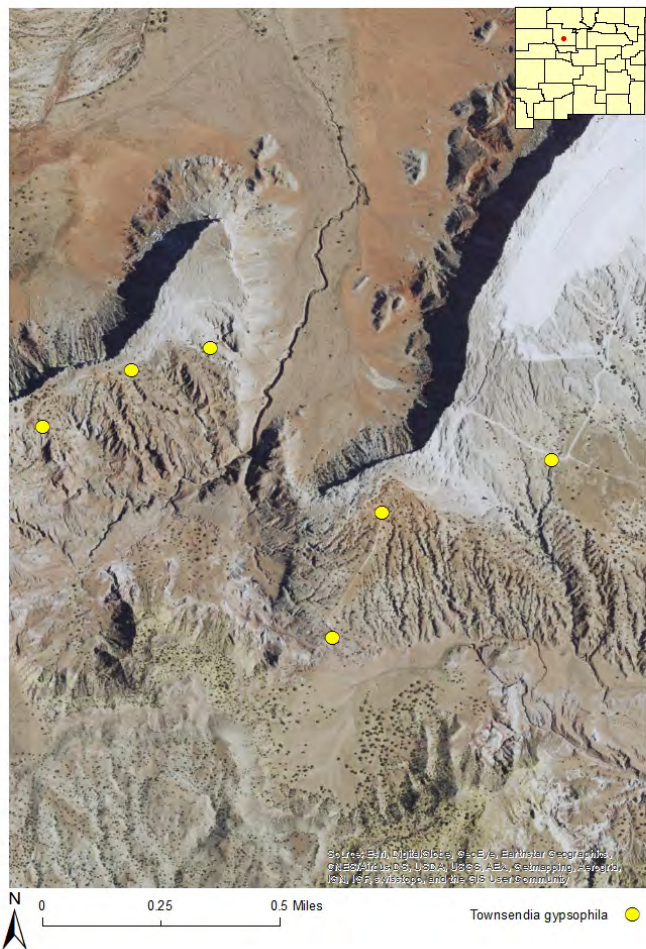
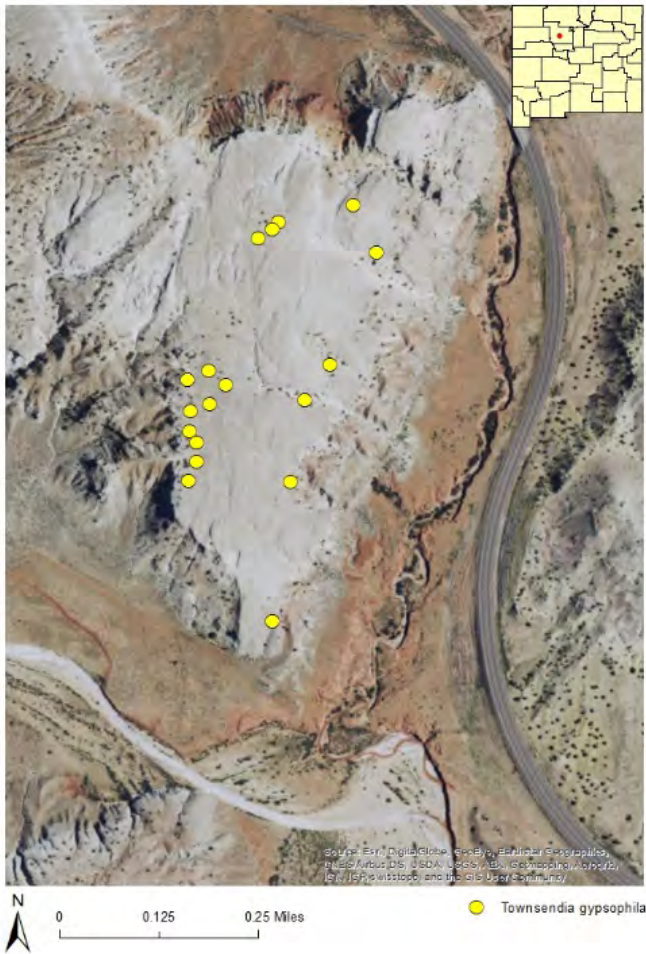


Figure 16. *Townsendia gypsophila* Site 11

Site 11 is located at the northwest corner of the White Mesa gypsum mine and Zia Pueblo lands, at the border with State Trust lands (Figure 16). Similar numbers of plants were documented in Site 11 in 2015 (36) as there had been documented in 1994 (28), although they were not mapped in the same locations as in 1994 (Table 1). In 2015, a total of 36 individuals were documented from 6 waypoints, primarily composed of 1 or two plants (83%). The largest waypoint contained 28 individuals. Plants were found in good condition, mostly flowering. Associated species include widely distributed sparse pinion, juniper, badlands mules-ears (*Wyethia scabra*), snakeweed, Indian ricegrass, Torrey's joint-fir, 4-wing saltbush, rubber rabbitbrush, Sivinski's scorpionweed, Todilto stickleaf, and tufted sand verbena. Observed disturbance include transmission towers, various access roads and some bike trailing. No livestock impacts were observed. No invasive nonnative species were documented.

# SITE 12

## Unsurveyed Section 30 (T16N R1E)



Site 12 is located west of HWY 550 and north of Rio Salado and Site 7 (Figure 17). In 2015 the site contained similar or fewer numbers of plants (187) than were recorded in 1994 (200+) (Table 1). The site is composed of a large southeast facing escarpment with widely scattered pinion, juniper, wavyleaf oak, Hartweg's sundrops, fine-leaf woollywhite, Sivinski's scorpionweed, Todilto stickleaf, and tufted sand verbena. *Townsendia gypsophila* was documented from 18 waypoints, containing a total of 187 individuals. The majority of waypoints contained fewer than 10 plants (61%). The largest waypoint contained 31 individuals. No livestock impacts or other disturbances were observed. No invasive nonnative species were documented.

Figure 17. *Townsendia gypsophila* Site 12

# *Abronia bigelovii*

(Tufted sand verbena)



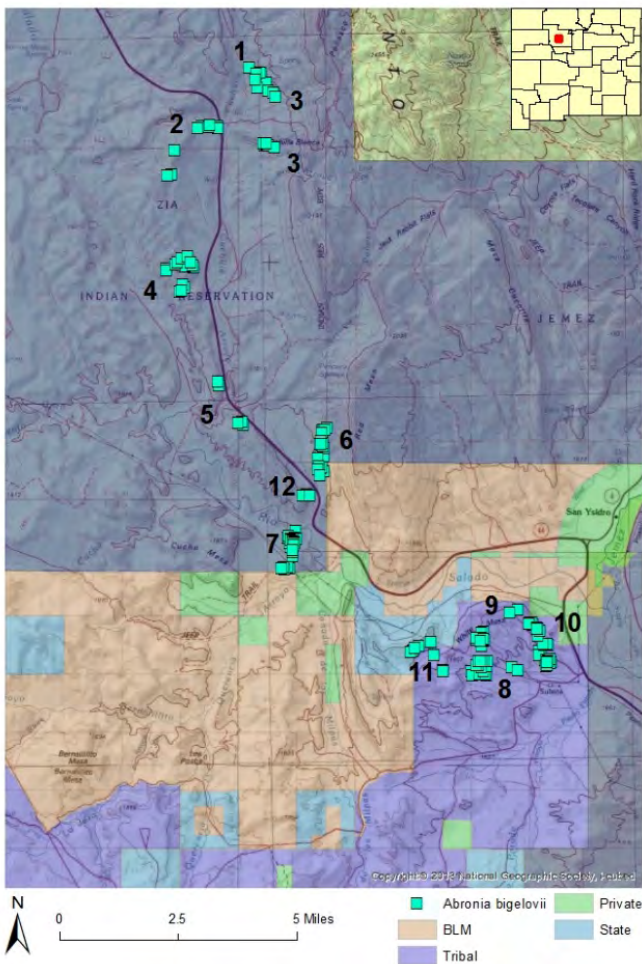
*Abronia bigelovii* is a low-growing, caespitose perennial herb in the four o'clock family (Nyctaginaceae). It has an umbellate inflorescence of tubular white flowers and nearly linear semi-succulent leaves. It is entirely endemic to the northern outcrops of the Todilto and Summerville formations in Rio Arriba, Sandoval and Santa Fe counties (NMRPTC 1999). Typical habitats for *A. bigelovii* are gypseous sandy loams on the eroding breaks of hillsides and ridges at elevations between 5,700 and 7,400 ft. It occurs on all topographic exposures and can often occupy very steep eroding slopes.

*Abronia bigelovii* is a USFWS and NM State Species of Concern. This localized endemic has a NatureServe rank of G2/S2 (imperiled) because of its highly restricted range and habitat, the number of occurrences and documented threats in its habitat. The New Mexico Rare Plant Technical Council R-E-D Code for this rare plant is 1-1-3, meaning it is rare, but found in sufficient numbers and distributed widely enough that the potential for extinction is low for the foreseeable future; is not endangered; and is endemic to New Mexico (NMRPTC 1999).

*Abronia bigelovii* occurs on almost all of the same gypsum outcrops on Zia Pueblo lands as does *Townsendia gypsophila* and was found at all 12 sites where *Townsendia gypsophila* was documented (Figure 18). *Abronia* however, is less abundant than the *Townsendia*. It generally occurs widely scattered and is often found on pure gypsum outcrops, but can also tolerate the margins of gypsum outcrops with more sandy soils. In 2015, *Abronia bigelovii* was documented from 174 waypoints, containing a total of 1,052 individuals, distributed in 9 populations (Table 2). Similar to *Townsendia gypsophila*, *Abronia bigelovii* primarily occurs in small patches of 10 or fewer individuals (87% of 174 sites). The largest number of plants found at a waypoint was 50 individuals (Site 3). The largest total number of plants was found at Site 9, where a total of 240 individuals were documented from 28 waypoints. In May 2015 the majority of plants were found in good condition, budding or in early flowering stage. Habitat, associated species, and observed disturbances are described for each of the 12 *Townsendia gypsophila* sites.

**Table 2.** Number of *Abronia bigelovii* plants and waypoints found at 12 sites on Zia Pueblo lands.

Site Number	Number of Waypoints	Number of Plants	Population
1	6	18	1
2	11	44	2
3	10	142	1, 3
4	16	97	4
5	5	8	5, 6
6	27	100	7
7	28	164	8
8	4	41	9
9	28	240	9
10	27	129	9
11	9	65	9
12	3	4	7
<b>Total</b>	<b>174</b>	<b>1,052</b>	



**Figure 18.** 2015 distribution of *Abronia bigelovii* on Zia Pueblo lands

# Mentzelia todiltoensis

(Todilto stickleaf)



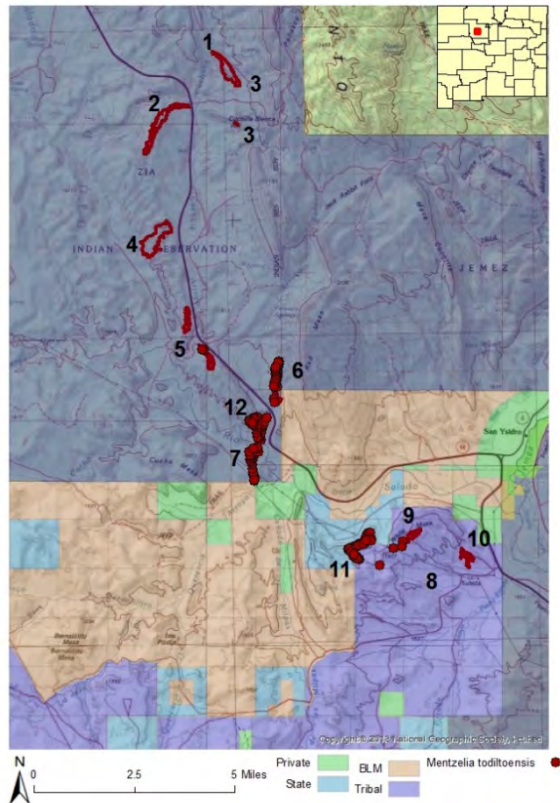
*Mentzelia todiltoensis* is a stout, mostly perennial herb in the Loasa family (Loasaceae). It branches from the base with entire or pinnatisect leaves and has sulphur yellow or cream flowers. It is one of the most recently described gypsophilic plant species from outcrops of Todilto Formation gypsum in north-central New Mexico at elevations between 5,600 and 6,700 ft (Atwood and Welsh 2005). This species was originally described for two widely separated populations – one near Tohajiilee in Cibola County and the other near Galisteo Dam in southern Santa Fe County. In the strict sense, this species is a strong perennial with entire, linear leaves and pale yellow flowers. However, the intervening Todilto gypsum outcrops near San Felipe and San Ysidro have extensive populations of mostly biennial plants with pinnatisect leaves that will be placed within a broader circumscription of *M. todiltoensis* in the Flora of North America (as cited in Roth & Sivinski 2015). This broader circumscription of the species extends its distribution to all the large Todilto gypsum outcrops in Bernalillo, Cibola, Sandoval and Santa Fe counties, where it can be locally common. Based on this recent

information *Mentzelia todiltoensis* has a NatureServe rank of G3/S3 (vulnerable). The 2007 New Mexico Rare Plant Technical Council R-E-D Code for this species is not currently relevant since the NM Rare Plants website report has not been updated with new information (NMRPTC 1999).

*Mentzelia todiltoensis* occurs on most of gypsum outcrops within the survey area, except for Site 8 (Figure 19). This plant does generally not occur in dense populations, but is fairly continuously distributed and therefore was primarily delineated by habitat polygons. It is frequently found growing together with *Phacelia sivinskii*, but with the exception of Site 5, has a broader distribution and tends to be less abundant ( $1/10$  to  $1/2$  of the numbers observed for *Phacelia sivinskii*). Scattered locations were marked with waypoints. *Mentzelia todiltoensis* occurs on both the Todilto and Summerville gypsum strata. It is most frequently found along steep slopes and on eroded bedrock and crumbling blocky colluvium at the bases of slopes. It can occupy all topographic exposures and will also tolerate some soil disturbance. Plants were observed growing on road berms at the edges of the White Mesa gypsum mine access roads and in the immediate vicinity of associated mine infrastructure. Plants were distributed in 8 populations and documented from 104 waypoints and 11 polygons (Table 3). *Mentzelia todiltoensis* generally occurs in small groupings distributed throughout the polygons and surrounding the waypoints, numbering from a few plants to several hundred individuals (Table 3). The largest concentration of plants were found at Sites 5 and 11, where over a thousand individuals were documented. No plants were documented at Site 8. Plants were in good condition and in late flowering or early seed set stage in September and October of 2015. Only a few rosettes or seedlings were observed. Habitat, associated species and observed disturbances are described for each of the 12 *Townsendia gypsophila* sites.

**Table 3.** Number of *Mentzelia todiltoensis* plants and waypoints found at 12 sites on Zia Pueblo lands (number of waypoints in parentheses)

Site Number	Number of Plants	Estimate Method	Population
1	300- 400	Polygon	1
2	500 - 1000	Polygon	2
3	300	Polygon	1, 3
4	300-500	Polygon	4
5	800-1200	Polygon	5
6	248-263	Count (27)	6
7	463-518	Count (23)	6
8	0	0	
9	500	Polygon	7
10	300	Polygon	8
11	1019-1224	Count (28)	7
12	522-632	Count (26)	6



**Figure 19.** 2015 distribution of *Mentzelia todiltoensis* on Zia Pueblo lands

## *Phacelia sivinskii*

(Sivinski's scorpion weed)

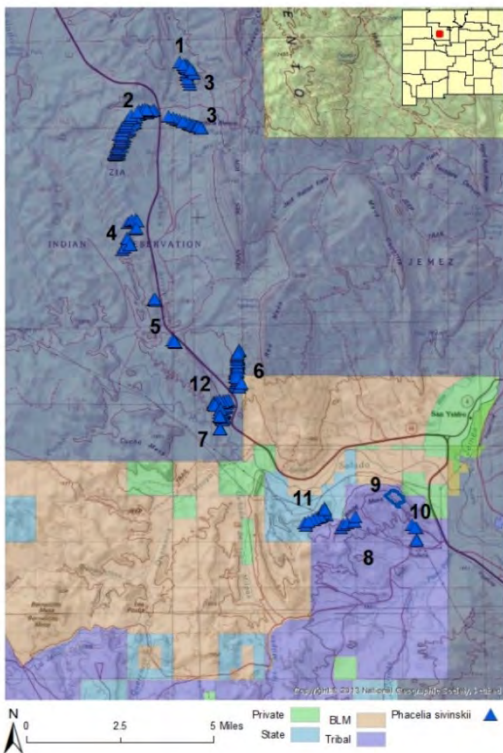


*Phacelia sivinskii* is an erect, leafy biennial herb in the waterleaf family (Hydrophyllaceae). It has crenate-dentate leaves and sticky glandular hairs on the stems and leaves. Its small violet flowers are in coiled cymes at the ends of branches and there are numerous floriferous branches at the leaf axils from the top of the plant down to its base. It was described fairly recently from the Todilto gypsum of north-central New Mexico (Atwood and Welsh 2005). It co-occurs with *Mentzelia todiltoensis* and has the same range as that species on the Todilto Formation, but also extends somewhat further south onto gypsum outcrops of the Permian-age Yeso Formation in Valencia and Socorro counties (Roth & Sivinski 2015). It can be locally abundant on the nearly barren outcrops of Todilto gypsum in the White Mesa region. It is rarely observed on Summerville sandy gypsum and then only near the contact with the underlying Todilto gypsum. It is most frequently found along steep slopes but can occupy all topographic exposures and flat areas at elevations between 5,600 and 6,700 ft (Figure 21).



*Phacelia sivinskii* is a USFWS and NM State Species of Concern. The New Mexico Rare Plant Technical Council gives *Phacelia sivinskii* a R-E-D Code of 1-1-3, meaning it is rare, but found in sufficient numbers and distributed widely enough that the potential for extinction is low for the foreseeable future; is not endangered; and is endemic to New Mexico (NMRPTC 1999). Based on the most current information on abundance, distribution and threats, *Phacelia sivinskii* has a NatureServe rank of G3/S3 (vulnerable).

In 2015 only 3 of the 12 sites had enough plants to be mapped with polygons (Sites 2, 3, 9) (Figure 20). Individual patches of plants were documented from a total of 217 waypoints. No *Phacelia sivinskii* plants were found in Site 8 in the fall of 2015. Otherwise plants occurred in distinct grouping of a few scattered plants to several hundreds within 100 feet of a waypoint. Plants were distributed in 7 populations (Table 4). The largest number of individuals were found at Sites 2, 9, and 12, where plants occurred in the thousands (Table 4). *Phacelia sivinskii* can readily occupy disturbed areas and was found in the thousands along the White Mesa gypsum mine access road and in areas previously mined (Sites 9 and 10) (Figure 22). In spring of 2015 plants were present in the form of rosettes or left-over skeletons from the previous year. No rosettes were found in Sites 7, 8, or 12 during spring surveys. Plant skeletons were observed in Site 8, but no rosettes. More plant skeletons than rosettes were observed in Sites 3, 4 and 5 in the spring. In the fall of 2015, rosettes were found at all sites, except Site 8, ranging from a few individuals to as many, or more, than flowering individuals. Half of the sites reported very few rosettes (Sites 2, 3, 4, 5, 6, 10) and 3 sites documented abundant rosettes (Sites 9, 11, 12). In September and October 2015 plants were found largely in fair to good condition, primarily in late flowering or early seed set stage. Plants were found depauperate and poor condition at Sites 1 and 5. Plants were most abundant and vigorous in disturbed sites at the White Mesa gypsum mine and sites with the heaviest gypsum content (Sites 9, 11, 12). Habitat, associated species and observed disturbances are described for each of the 12 *Townsendia gypsophila* sites.



**Figure 20.** 2015 distribution of *Phacelia sivinskii* on Zia Pueblo lands

**Table 4.** Number of *Phacelia sivinskii* plants found in 12 sites on Zia Pueblo lands.

Site	Number of plants	Population
1	476-631	1
2	3622-4562 (7500 – 9000 polygon estimate)	2
3	683-918 (1000-1500 polygon estimate)	1, 2
4	347-402	3
5	27	4, 5
6	895-1170	6
7	16	6
8	0	
9	2000 – 3000 (polygon estimate)	7
10	31	7
11	464-574	7
12	2308-2908	6



**Figure 21.** *Phacelia sivinskii* on steep slopes of Cuchilla Blanca Hill.



**Figure 22.** *Phacelia sivinskii* recolonizing disturbed sites at the White Mesa gypsum mine.

## CONCLUSIONS AND RECOMMENDATIONS

All four rare gypsum endemics were found on suitable gypsum outcrop habitats at the majority of the 12 target sites on Zia Pueblo lands in the White Mesa region. No previously collected population data was available for the three of the four rare plant species and therefore it is not possible to assess population trends for *Mentzelia todiltoensis*, *Phacelia sivinskii*, or *Abronia bigelovii*.

Overall, *Townsendia gypsophila* population density during the 2015 survey was similar to numbers reported in 1994. However, plant numbers were found to be significantly lower at three of the 12 target sites (Sites 5, 7, and 8) and seemed generally sparse throughout all the habitats surveyed in 2015. Comparison of population estimates for the two survey periods is somewhat ambiguous since we do not know the survey effort or areal extent of the 1994 survey. However, some of the sites had limited habitat availability, therefore restricting the survey area; hence survey results should be comparable to those documented in 1994 (Sites 1, 3, 6, 7, 12).

Except for Site 7, these surveyed areas showed comparable numbers of plants in 2015 as reported in 1994. The reason for the steep decline of the number of reported plants at Site 7 are unclear. Similar results were reported for the adjoining Section 7 on BLM lands where the *Townsendia gypsophila* population was estimated at 200,000 plants between the northern boundary fence with Zia Pueblo lands and Querencia Arroyo. A 2014 survey of this location documented only between 314 and 339 plants in that same area, which was only about 0.17% of the 1994 estimate (Roth and Sivinski 2015). Less pronounced declines were reported for several other *Townsendia gypsophila* locations on BLM lands. However, a 2014 survey on State Trust lands reported similar numbers of plants to 1994 estimates (Lowrey and Hafler 2014). In general, survey effort appears to have been somewhat larger for the 2014 & 2015 surveys on State, BLM, and Zia lands and may therefore not accurately reflect a population trend. Population trend monitoring would clearly benefit our understanding of the degree of endangerment this species is experiencing. The causes for possible declines at Sites 5, 7, and 8, as well as on BLM lands, is likely the combination of direct impacts to plants and their limited habitat in the form of gypsum mining and associated infrastructure development, livestock trampling, bicycle trailing, powerline access roads, as well as prolonged drought and other impacts associated with climate change.

In 2015, *Abronia gypsophila* had the lowest population numbers among the 4 rare gypsophiles. Although it was found in all 12 target sites, numbers were generally low with only very few plants per site. Similar results were reported from adjacent BLM and State Trust lands, where the species was also found in low numbers, distributed in scattered small patches, but was generally found to be more abundant than *Townsendia gypsophila* (Roth & Sivinski 2015; Lowrey and Hafler 2014).

Local abundance of *Phacelia sivinskii* can vary dramatically from year to year in response to the amount and timing of precipitation, which can be highly localized. In addition, it is likely that seeds may have to undergo a period of dormancy combined with various degrees of scarification before they can germinate. For example, adult flowering was reported abundant in the autumn of 2014 when large patches of plants on gypsum hillsides and benches numbered in the thousands along the Tierra Amarilla Anticline on BLM lands (Roth & Sivinski 2015). Despite abundant rainfall in 2015, adult plant density was much lower in 2015 on BLM lands with no plants or a few scattered individuals in the same places where they were abundant during the previous year. Similar trends were observed on Zia Pueblo lands. Despite the unusual spring rains, no rosettes were observed in the spring of 2015 in 3 out of the 12 target sites. Although old skeletons of plants were found at Site 8 in the spring of 2015, no flowering adults or rosettes were documented in the fall, despite abundant summer rains. Although the species is generally viewed as a biennial plant, the majority of plants apparently germinate with the summer rains and flower that same season, but a portion of them also live through the winter in the form of rosettes, or germinate in the spring, if enough moisture is available.

*Mentzelia bigelovii* in the White Mesa area appears to be largely a biennial or short lived perennial plant with pinnatisect leaves. Few plants were observed with clear perennial characteristics. However, only very few seedlings or rosettes were observed at either of the surveys periods. The majority of observed plants were flowering or in late flowering stage in the fall. The species tolerates some levels of disturbance, can be found in disturbed areas, and a relatively broad spectrum of gypsum soils, with a preferences of soils with the highest gypsum content.

Gypsum mining in the White Mesa area is the largest current threat actively impacting the habitat of all four gypsum endemics and is the most current and widespread land use impacting gypsum habitats on Zia Pueblo lands. Habitat and plants of these species were likely lost to this development, although *Mentzelia todiltoensis* and *Phacelia sivistrii* can tolerate this level of disturbance and may be able to persist on mined lands. The White Mesa gypsum mine is the largest gypsum mining operation in the state and enabled New Mexico to rank seventh among the 20 gypsum producing U.S. states in the year 2000 (Berglof and McLemore 2003). This mine feeds raw gypsum to the large wall-board manufacturing plant in Bernalillo, 21 miles to the southeast. The wall-board plant has been inactive since 2010 after the collapse of the real estate market, but could reopen and increase gypsum mining when the market recovers and construction activities resume. The mines also supply small amounts of gypsum for cement and agricultural amendments (Berglof and McLemore 2003). Current and future development of gypsum mining in the White Mesa area is high and will likely continue into the future (BLM 2010). Future mining of the Todilto gypsum in this region will further diminish habitat for *Townsendia gypsophila* and *Abronia bigelovii*, both of which are intolerant of soil disturbance and will not quickly reoccupy the remnant gypsum deposits in quarried areas. Previous comments in the Lowrey and Knight (1994) survey report that *T. gypsophila* habitats on the gypseous Morrison strata (now called Summerville strata) are not threatened by gypsum mining. However, the Summerville gypseous sandstone is only thin layer over the more pure and minable Tonque gypsum stratum of the Todilto Formation. The Summerville gypsum habitat layer could be removed and discarded as overburden in a strip mining operation, if economically supported by gypsum commodity prices. Therefore, neither the Todilto nor Summerville gypsum habitats for rare gypsophilic plants are protected from mining impacts.

In addition to providing habitat for rare gypsophilic vascular plant species, gypsum outcrops usually develop biological soil crusts formed by a diverse community of lichens, mosses, and cyanobacteria (photosynthetic blue-green algae). These cryptogamic soil crusts are diverse biotic communities that contribute to the larger ecosystem functions by controlling erosion, improving water infiltration, and converting inorganic elements such as nitrogen into biologically useful forms (Belnap et al. 2001a). The extent to which rare gypsophilic vascular plants rely on the ecological services of cryptogamic soil crusts is not known, but there is likely some benefit conferred to these rare plants, including increased seed, water, and macronutrient retention, seed germination and establishment, and overall survival (Belnap et al. 2001b).

Management direction should include avoidance or minimizing impacts on plants or their habitat, and potentially setting aside some of the occupied habitat areas as conservation sites, especially those with good populations of *Townsendia gypsophila*, which is not known to occur on any other gypsum outcrops outside of the White Mesa area. Other conservation measures should include ex-situ seed storage and the development of seed germination and establishment protocols. Population trend monitoring to document the impacts of climate change and land use practices would improve our understanding of the species' response to threats and help guide management activities as needed. Management opportunities are limited with respect to buffering impacts of climate change and prolonged drought conditions. However, considering a potential decline, overall rarity and current threats to these 4 species and their habitat, especially *Townsendia gypsophila*, it is highly recommended to restrict development in gypsum habitats, restrict or prohibit recreational bicycling, and provide regular monitoring to document population trends.

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