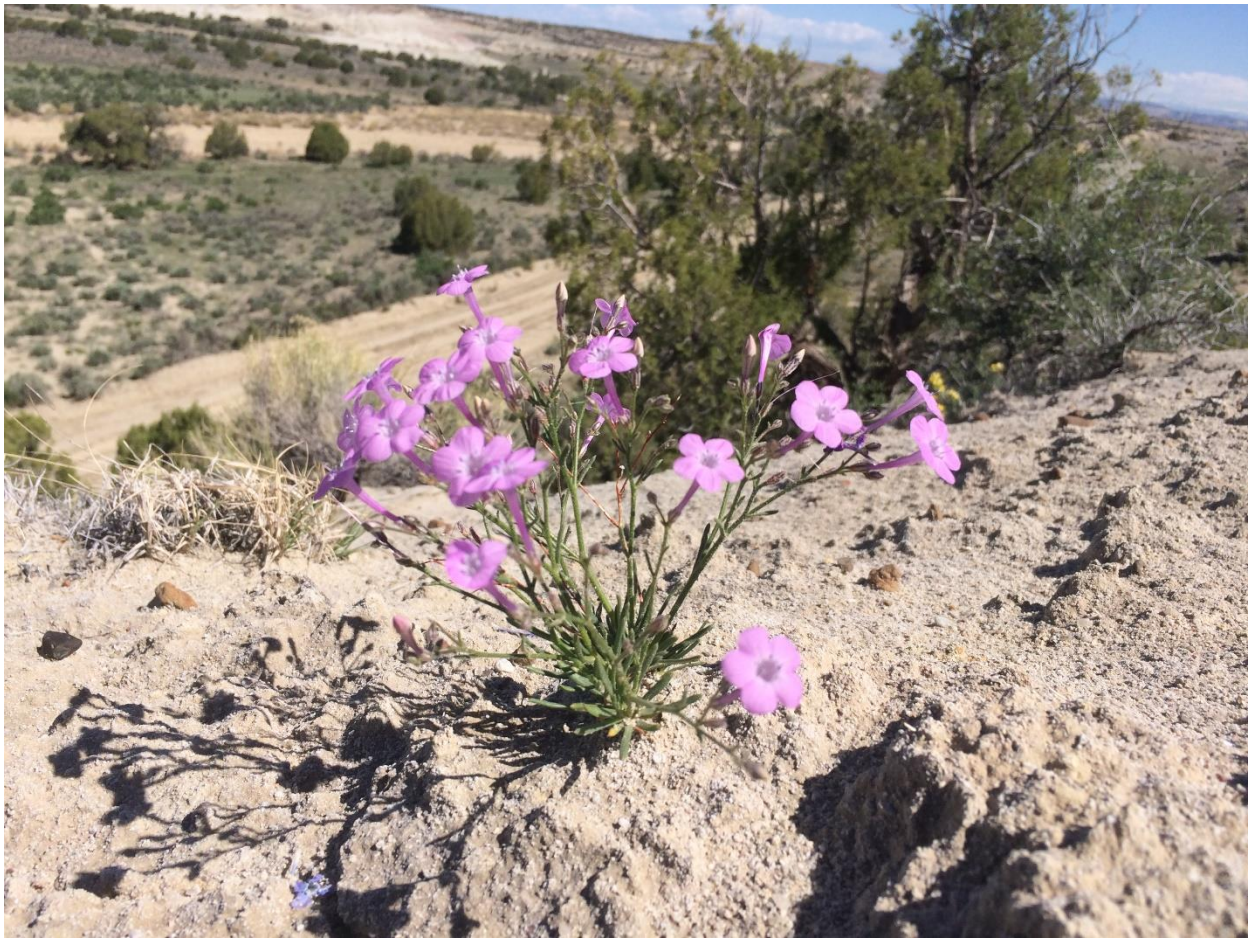
2019 Monitoring Report:
Aztec Gilia (*Aliciella formosa*)
Farmington Field Office New Mexico



Lauren Bansbach, Melissa Bacigalupa, Mike Beitner
Nathan Redecker, Zoe Davidson
New Mexico Bureau of Land Management
301 Dinosaur Trail Santa Fe, NM 87508

Conservation Status: High Risk of Extinction

The current conservation status of *Aliciella formosa* is dire. Across its range, *Aliciella formosa* has dramatically declined (≥85%; net loss of 386 out of 452 plants), both since early monitoring efforts by New Mexico State Botanists in the 1990s and recent monitoring efforts by the BLM. The precise cause of the decline is unknown, but it is highly likely that habitat fragmentation is related. This species has no conservation protections and 99% of known occurrences are within 1,000 feet of a road.

Management Recommendations:

To prevent further decline and possible extinction, future management decisions and actions should avoid all *Aliciella formosa* occurrences by at least a 200m buffer.

Priority conservation actions for this species should include:

- Continue demographic trend monitoring.
- Follow the mitigation hierarchy as directed by CEQ 40 CFR 1508.20.
- Designate protected habitat.
- Collect seed throughout the species range using Center for Plant Conservation protocol.
- Research population-level genetics to assess possibility to artificially augment populations.

Introduction

Aztec Gilia, *Aliciella formosa* (Greene ex A. Brand) J.M. Porter, is a perennial forb in the Polemoniaceae family endemic to loose eroded soils of the Nacimiento formation of the upper San Juan River Basin at elevations from 5,500 to 6,360 feet. Thus far, it has only been documented in San Juan County, New Mexico, though its population likely extends into southern Colorado. *Aliciella formosa* has trumpet-shaped pinkish-purple to pale blue lavender flowers that bloom in from April to June. It is primarily pollinated by hawk moths, bee flies, and hummingbirds (personal observations, 2019 rare plant crew). The *Aliciella* genus is named for botanist and naturalist, Alice Eastwood; '*formosa*' is Latin for 'beautiful.' A species with similar flowers, *A. haydenii*, is clearly distinguished by its wide, pinnately lobed basal leaves. In contrast, *A. formosa* has small linear, pointed-tip leaves. These two species are also separated by soil substrate; while *A. formosa* is restricted to the Nacimiento Formation, *A. haydenii* is endemic to barren Mancos shale formations on the mesas of the Mancos River watershed (including Mesa Verde National Park). Associated species for *A. formosa* include vegetation typical of the San Juan Basin badlands: pinyon, juniper, bitterbrush, serviceberry, mountain mahogany, rabbitbrush, yucca, Mormon tea, needle and thread grass, galleta grass, and several cactus and forb species.

Aliciella formosa is listed as Endangered in New Mexico (NMAC 19.21.2) and is a BLM Sensitive Species. A comprehensive report (2018) by Daniela Roth, New Mexico State Botanist, details the conservation status of this species from the early 1990s through 2017, noting overall decline in numbers within previously documented range. No new populations have been located and there are no protected sites

for this species. Interestingly, in 2003 an Area of Critical Environmental Concern was proposed to protect this species was instead designated as an off-highway vehicle recreation area.

The primary threat to this species is habitat destruction and fragmentation from oil and gas drilling in the San Juan Basin. The Nacimiento formation rests above reservoirs for oil that have been under production since the early days of oil extraction. Approximately 2,000 additional wells are predicted for the northern San Juan Basin (vicinity of Bloomfield and Aztec) where *A. formosa* occurs. In addition to direct habitat disturbance, dust from vehicle traffic in oil fields can interfere with photosynthesis and pollination. *Aliciella formosa* grows in loose, erodable soils, and thus any soil disturbance results in airborne dust that can settle in flowers and result in reduced visits by pollinators and reduced fertilization success. Since habitat fragmentation is abundant throughout the range of this species, associated forb communities that support the pollinators of *Aliciella formosa* are also fragmented and have likely decreased in local abundance. Other threats to the species include damage from livestock trampling, recreational biking, and off-highway vehicle use. Another potential threat is predation by a native microlepidopteran moth larvae that bores into the caudex of *A. formosa* individuals.

Demographic Trend Monitoring

Monitoring Questions

Regular monitoring of rare plant populations can detect downward trends in a species and identify degradation of important rare plant habitat that would otherwise go unnoticed. For *Aliciella formosa,* long-term demographic data can also illuminate several unknowns about its life history and ecology:

- What is the average and maximum lifespan of a single *A. formosa* individual?
- Does reproductive output within a local population (i.e. a single transect or pair of adjacent transects) correlate to germination the following year(s)?
- Does density of *A. formosa* (# individuals per m^2) fluctuate based on abiotic factors such as timing and quantity of precipitation?
- Does long-term trend within a plot or cluster of plots correlate with local density of oil wells, roads, and other habitat fragmentation from energy infrastructure?

Monitoring Objectives

1. Establish permanent monitoring plots across the known range of the species.
2. Monitor plots annually. Collect individual demographic data on all plants within plots.
3. Revisit at least 50% of Element Occurrence records for *Aliciella formosa* every 1 to 3 years, or as reasonable, to provide supplemental presence/absence data across the known range of the species.
4. Assess monitoring data annually to determine status and trend (increasing, decreasing, stable) across all plots monitored and compile other life history data such as average lifespan of individuals and proportion of plants reproducing across the range of the species. Summarize key findings in annual reports.

Monitoring Threshold

If *Aliciella formosa* declines by 10% or more across all monitoring plots and the number of individuals does not recover or continues to decline for 3 years, then conservation measures and/or research into

the decline are justified. Continued long-term monitoring will help refine this threshold and provide insight into the biology and demography of this species. Since the average lifespan of an individual *Aliciella formosa* plant is unknown and this species reproduces exclusively by seed, a loss of 1/10th of the population would likely be detrimental to its persistence in the long-term.

Importantly, the 2019 monitoring data have drastically exceeded this threshold; across all plots, *Aliciella formosa* declined by 85%. Individual plots declined by 68 to 100%. Clearly, emergency conservation measures for the species are warranted. See the 'Conservation' section for more detail.

Monitoring Applications

Long-term demographic data can inform management decisions and conservation measures of *Aliciella formosa*. Our monitoring design uses an array of belt census transects across the known range of the species. Plots are intentionally placed where plants occur in order to collect long-term demographic data on individuals. Since these plots span the range of the species, inferences can be made about its overall status and trend when plot data is aggregated and analyzed together. For example, to determine the overall decline of the species across all monitoring plots, we can total all tagged individuals across all plots, count the total that have died, and calculate the overall percent decline. If populations remain stable, then basic conservation measures like conventional seed banking are appropriate. If populations show declining trend over time, then research into the cause of the decline and *ex situ* conservation strategies are warranted. Furthermore, demographic data can be used to inform U.S. Fish & Wildlife decisions if *Aliciella formosa* is proposed for listing under the Endangered Species Act.

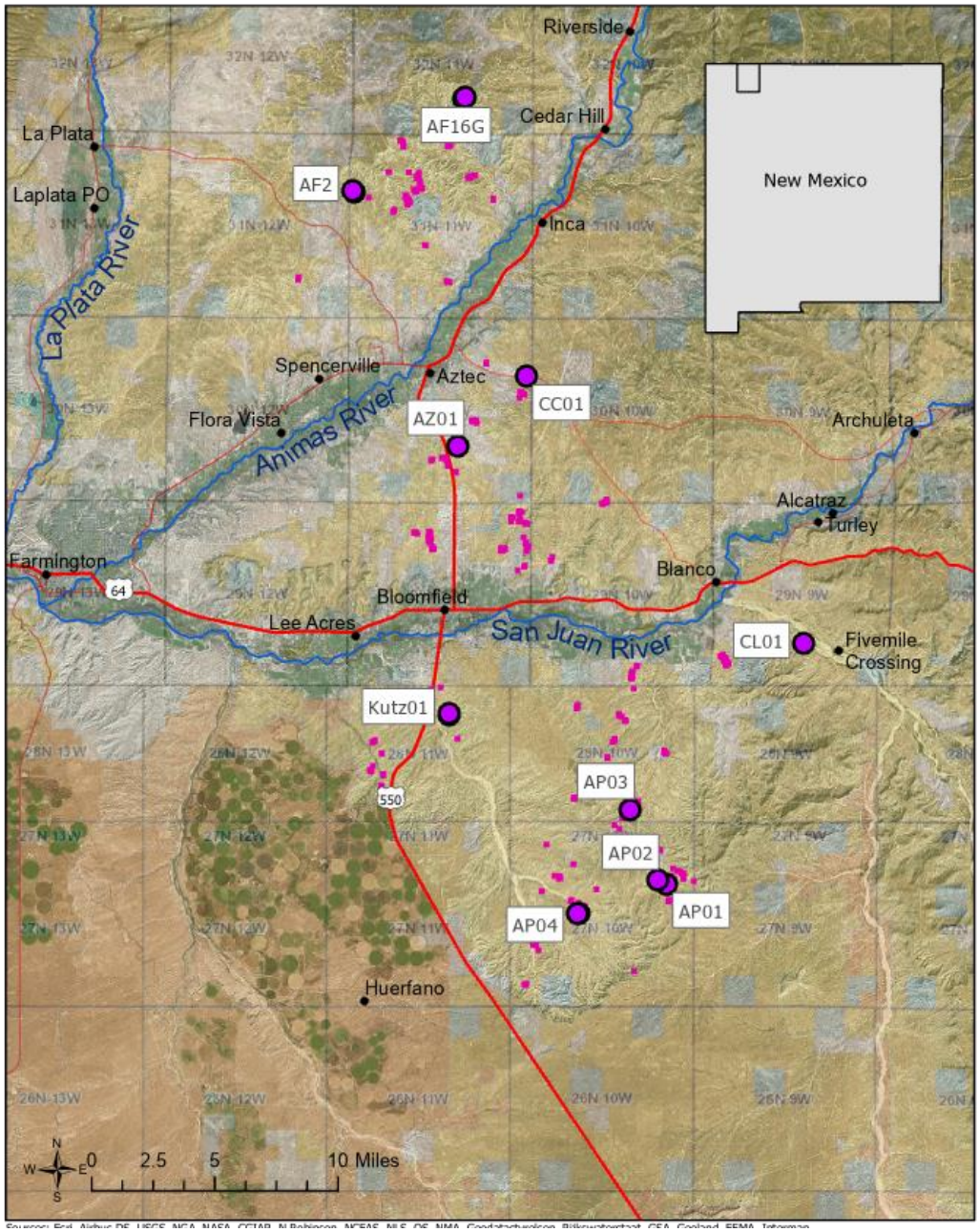
Monitoring Locations

In July and August of 2017, 10 permanent plots were established to monitor the long-term demographic trends of *Aliciella formosa* (Table 1). Plots are located across three general geographic areas: 4 plots near Aztec within the Animas River drainage, 1 plot near Blanco within the Cañon Largo drainage, and 5 plots within the Kutz Canyon / Angel Peak area (Map 1). All plots are rectangular census belt transects of varying length/width depending on each localized cluster of *A. formosa* individuals (Table 1). Within the plot area, every individual *A. formosa* is marked with a uniquely numbered round metal tag attached to a 6” nail, pushed into the soil approximately 10cm from the base of the plant. The belt transect design helps minimize trampling in the loose, fragile soils where *A. formosa* grows, and provides a reliable method to relocate plants year after year. All tags have precise coordinates in relation to the transect tape and are oriented to the plant in systematic way, either in the +/- y direction (parallel to transect tape), or in the +/- x direction (perpendicular to transect tape). Any ambiguous plants have a detailed note that is carried over from

Plot	2017 Dates	2019 Dates	Plot Dimensions	Plot Area (m^2)
AF16G	11-Jul	6-May	30m x 3m	180
AF2	12-Jul	7-May	30m x 3m	180
AP01	7-Aug	15-May	10m x 5m	100
AP02	7-Aug	15-May	20m x 5m	200
AP03	8-Aug	15-May	20m x 3m	120
AP04	9-Aug	15-May	15m x 3m	90
Kutz01	9-Aug	7-May	15m x 3m	90
CL01	10-Aug	7-May	15m x 3m	90
CC01	15-Aug	6-May	10m x 3m	60
AZ01	17-Aug	14-May	15m x 3m	90

Table 1. Dates *Aliciella formosa* plots were established (2017) and monitored in 2017 and 2019 and plot dimensions.

the datasheet year after year. Plots are re-visited annually, all existing tags read, and the plot area thoroughly surveyed for new seedlings. Demographic data collected on every individual includes whether the plant is alive, standing dead (i.e. plant is dead and tissue is still visible), or missing (presumed dead and no tissue is visible), a count of the number of buds, flowers, and fruits, and a yes/no to all presence of insect and mammal herbivory. These data provide a long-term measure of reproductive output and herbivory, as well as rates of mortality and recruitment.



Map 1. Monitoring locations for *Aliciella formosa* (purple circles) and occurrence records (pink dots).

Preliminary Monitoring Results

Mortality

From 2017 to 2019, the number of live *Aliciella formosa* individuals has dramatically declined across all plots measured (Table 2). Across all plots from 2017 to 2019, mortality rate ranged from 68-100%, with an average of 89%. Note: plots were not visited in 2018. Table 2 shows that among the original 452 number of plants tagged in 2017, only 66 plants were still alive in 2019. The other 386 plants were either standing dead (appearing as brown, desiccated twigs upon a lump of the original root mass) or missing completely and thus also presumed dead.

Table 2. Mortality of plants from status as alive and tagged in 2017 to missing or standing dead in 2019.

Summary from 2017 to 2019				
Plot	2017 total plants tagged	2017 plants still alive in 2019	2017 plants that died by 2019	% mortality
AF16G	87	28	-59	-68%
AF2	72	5	-67	-93%
AP01	18	1	-17	-94%
AP02	23	2	-21	-91%
AP03	33	2	-31	-94%
AP04	79	14	-65	-82%
AZ01	43	0	-43	-100%
CC01	35	2	-33	-94%
CL01	38	12	-26	-68%
Kutz01	24	0	-24	-100%
TOTAL	**452**	**66**	**-386**	

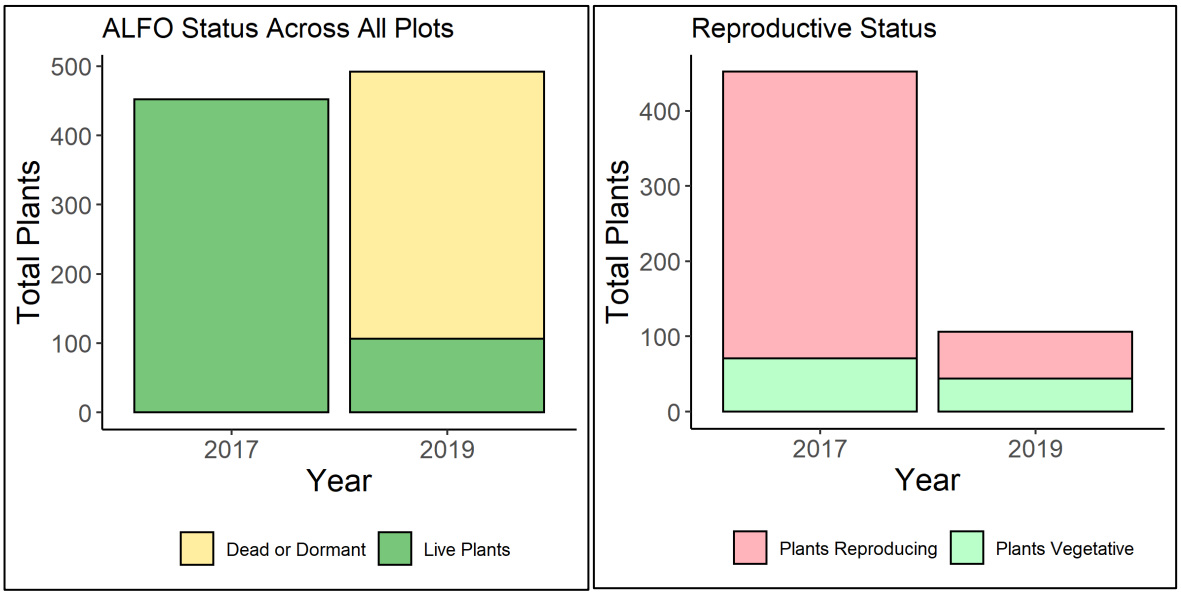


Figure 1. *Aliciella formosa* live/dead status and reproductive status across 10 monitoring plots from 2017 and 2019. Plots were not monitored in 2018.

Recruitment

While 40 new plants were tagged in 2019 (Table 3), 31 of these were very tiny seedlings at one plot (AZ01) where none of the original 43 tagged plants were still alive. While this could be a pulse of regeneration in this local population, the crew noted that seedling identification is generally difficult, and the tagged seedlings are not 100% certain to be *Aliciella formosa*.

Reproductive Output and Phenology

In 2017, reproductive data was collected as the presence (1) or absence (0) of flowers and fruits (Table 3). No data for buds were collected in 2017, perhaps because the plants were well-past bud stage in July/August. In 2019, reproductive data was collected as the total count of buds, flowers, and fruits. Aborted structures were not measured in 2017 and none were observed in 2019. This measurement will be discontinued due to lack of relevancy to the Polemoniaceae family and inability to clearly distinguish aborted buds, flowers, or fruits for this species.

In 2017 and 2019, an average of 86% and 62% of plants were reproductive across all plots, respectively (Table 4, Figure 1). Despite a massive decrease in live plants (452 plants in 2017 to 106 in 2019), a large percentage of the total are still reproductive. Many of the 2019 individuals that were reproductive were highly prolific; average number of structures per reproductive plant ranged from 13 to 201 (Table 5). While 2017 data do not include total number of reproductive structures, future years of counting buds/flowers/fruits may reveal trends in overall reproductive effort in response to abiotic factors such as precipitation.

Herbivory

In 2017, no insect damage was documented, and only two plants at two different plots were observed with mammal damage (AF16G and Kutz01). However, no notes were included to explain the extent or

severity of damage. In 2019, two plants at CL01 were observed with insect damage: one noted “aphids” (this plant had 71 buds, 4 flowers, and 17 fruits) and the other noted “diseased or insect eggs” (this plant had 2 buds). Overall, herbivory does not seem to impact this species. Herbivory data for both insects and mammals will continue to be collected to monitor any unexpected browse by mammals or damage by insects.

Threats

Broadly, habitat fragmentation related to oil and gas drilling are the greatest threats to *Aliciella formosa*. During the 2019 field season, several direct threats within plots were documented. Tire tracks were observed across the middle of two plots (AZ01 and Kutz01). Soil disturbance from human footprints through one plot (AP03) was also noted.

AZ01 tire tracks through plot

Kutz01 tire tracks through plot

AP03 footprints through plot

Conservation and Future Monitoring

As of 2019, the overall status and trend of *Aliciella formosa* appears grim. Daniela Roth’s 2018 report documented significant declines across permanent plots from the early 1990s to 2017, and the 10 plots established by the BLM in 2017 have shown extensive mortality. Continued annual monitoring of this species is essential to understand if this trend is a temporary dip in the population or a species-wide decline. Given the high rates of mortality, it is possible that *Aliciella formosa* faces extinction unless further conservation measures artificially augment populations.

In 2019, a BLM-USGS collaboration was initiated to model suitable habitat for *Aliciella formosa* and two other edaphic endemic species (*Sclerocactus cloverae* and *Townsendia gypsphila*) in the San Juan Basin. From April to September 2020, a two-person crew supervised by John Kendall in the Farmington Field Office will conduct extensive presence/absence surveys for both species across all potential habitat on BLM-managed land.

Priorities for the 2020 monitoring season include re-visiting all 10 plots, re-visiting historic occurrence records, and building new monitoring plots. New plot locations will be selected randomly from existing occurrence records. 2020 monitoring will also include an insect pollinator survey at all plots to document local diversity. A possible future project includes the placement of phenology cameras facing robust individuals of *A. formosa* to document daily phenology throughout the growing season. This

method would non-invasively capture a full phenology dataset, including dates of first bud/flower/fruit and length of flowering. A video from merged images would also serve as a creative outreach tool.

The most effective conservation strategies for *Aliciella formosa* are to avoid all additional disturbance to occurrences and develop a research plan for future conservation measures. All future management decisions within the Farmington Field Office should avoid every occurrence of *Aliciella formosa* by a minimum of 200m. This would help prevent further fragmenting of habitat and help limit additional dust exposure. Given the dramatic decline of this species over the past 30 years and no evidence of its recovery, *ex situ* conservation may be the only method to help prevent possible extinction of this species. *Aliciella formosa* was petitioned for listing in 2012 under the Endangered Species Act, but a 90-day finding by the U.S. Fish & Wildlife determined that the petition did not present substantial information to warrant listing (77 FR 24908).

Table 3. Total number of live, new, and dead plants, as well as number of plants with buds, flowers, and fruits at each plot for 2017 and 2019. Note: a single plant may have buds, flowers, and fruits all present at once.

Plot	2017				2019						
	Buds	#Plants with Flowers	#Plants with Fruits	Live Plants	# Plants with Buds	# Plants with Flowers	# Plants with Fruits	Live Plants	New Plants	Standing Dead	Plant Gone
AF16G	-	43	74	87	24	22	15	28	0	43	18
AF2	-	37	57	72	3	3	3	5	0	59	0
AP01	-	11	13	18	1	1	1	3	2	10	0
AP02	-	23	20	23	3	2	3	5	3	18	3
AP03	-	30	29	33	2	2	2	2	0	21	0
AP04	-	59	47	79	15	12	12	18	4	33	32
AZ01	-	39	33	43	0	0	0	31	31	1	0
CC01	-	28	28	35	2	1	1	2	0	30	0
CL01	-	27	12	38	12	10	7	12	0	19	0
Kutz01	-	19	20	24	0	0	0	0	0	15	0
TOTAL	**-**	**316**	**333**	**452**	**62**	**53**	**44**	**106**	**40**	**249**	**53**

Table 4. Proportion (%) of *Aliciella formosa* individuals with buds, flowers, and fruits for 2017 and 2019. Note 2017 monitoring occurred in July/August (post-budding) whereas 2019 monitoring occurred in May. Percent reproductive includes all individuals that had at least 1 reproductive structure, regardless of phenology.

Plot	2017				2019				
	%Bud	%Flower	%Fruit	% Reproductive	%Bud	%Flower	%Fruit	% Reproductive	**Difference**
AF16G	0	49	85	86%	86	79	54	86%	0%
AF2	0	51	79	82%	60	60	60	60%	-22%
AP01	0	61	72	89%	33	33	33	33%	-56%
AP02	0	100	87	100%	60	40	60	60%	-40%
AP03	0	91	88	91%	100	100	100	100%	9%
AP04	0	75	59	78%	83	67	67	83%	5%
AZ01	0	91	77	91%	0	0	0	0%	-91%
CC01	0	80	80	80%	100	50	50	100%	20%
CL01	0	71	32	74%	100	83	58	100%	26%
Kutz01	0	79	83	88%	0	0	0	0%	-88%
AVERAGE	**0**	**75**	**74**	**86%**	**62**	**51**	**48**	**62%**	**-24%**

Table 5. Total number of buds, flowers, and fruits at each plot for 2019.

Plot	Total # Buds	Total # Flowers	Total # Fruits	Live Plants	Avg. # reproductive structures per plant
AF16G	1091	240	129	28	52
AF2	400	78	62	5	108
AP01	376	92	83	3	184
AP02	113	24	77	5	43
AP03	62	23	62	2	74
AP04	85	35	115	18	13
AZ01	0	0	0	31	0
CC01	268	73	60	2	201
CL01	454	90	80	12	52
Kutz01	0	0	0	0	0
TOTAL	2849	655	668	106	39

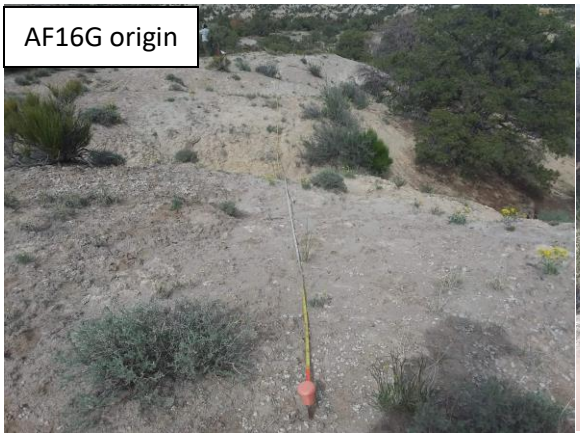
References

Roth, D. and Sivinski, R. 2018. Status Report for Aztec Gilia (*Aliciella formosa*), San Juan County, New Mexico. Report for U.S. Fish & Wildlife Service Region 2, Albuquerque Field Office.

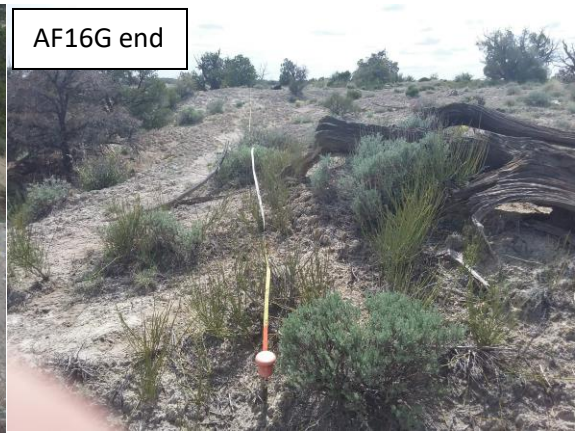
U.S. Fish & Wildlife Service. 2012-04-26. Endangered and Threatened Wildlife and Plants; 90-Day Finding on a Petition to List *Aliciella formosa*. Document Citation: 77 FR 24908. Document Number: 2012-10049.

Appendix I. *Aliciella formosa* plot photos from 2019 monitoring.

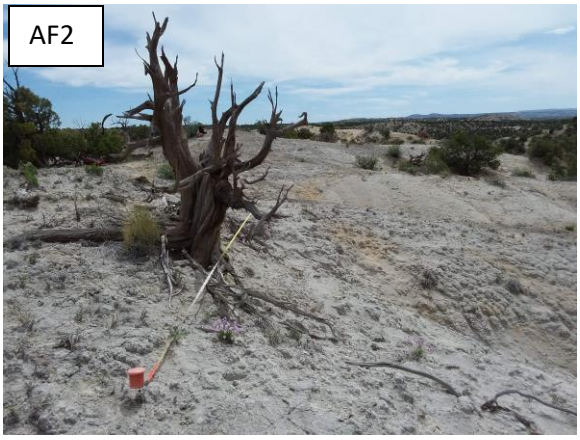
AF16G origin



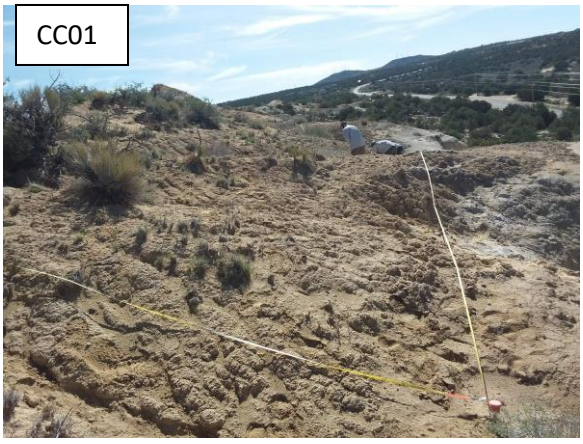
AF16G end



AF2



CC01



AZ01

Kutz01

AP01

AP02

AP03

AP04

Note: CL01 missing plot photos from 2019.

Appendix II. Supplemental photos.

Figure 2. Potential *Aliciella formosa* seedling at AZ01

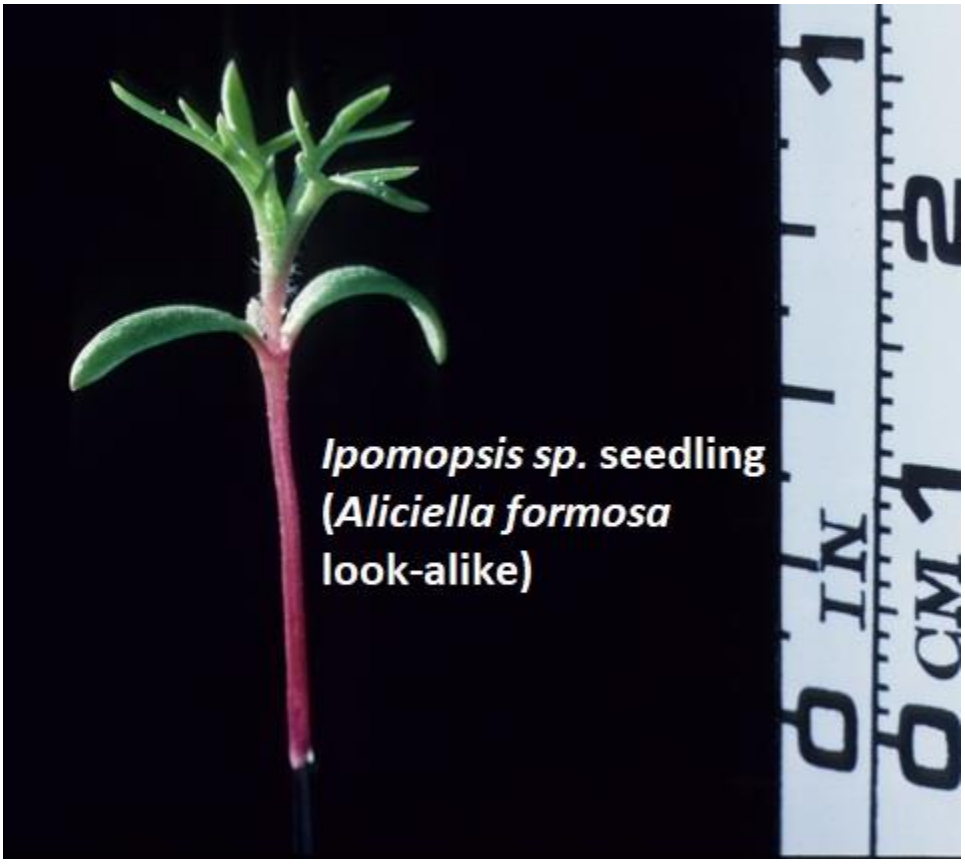


Figure 3. Seedling of *Ipomopsis* sp. that appears similar to *Aliciella formosa* seedling. Leaves of *A. formosa* are simple; leaves of *Ipomopsis* sp. are divided.