

Rare Plant Monitoring and Database Development
Black Canyon of the Gunnison National Park
and Curecanti National Recreation Area
2012



Prepared for Black Canyon of the
Gunnison National Park

by

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Knowledge to Go Places

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Cover photo: Black Canyon viewed from the North Vista Trail.

Photo by Delia Malone

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Executive Summary

In 2012, the Colorado Natural Heritage Program (CNHP) surveyed known occurrences of three rare plant species in Black Canyon of the Gunnison National Park and Curecanti National Recreation Area for the purpose of selecting long-term monitoring sites for these species. Species targeted for monitoring included Gunnison milkvetch (*Astragalus anisus*), hanging garden sullivantia (*Sullivantia hapemanii* var. *purpusii*) and juniper tumble-mustard (*Thelypodopsis juniperorum*). Each species is endemic to Colorado and has a rarity ranking of either globally imperiled or globally vulnerable from the CNHP. Both proximate and indirect anthropogenic threats to these species are present and may diminish long-term survivability potential. Ongoing monitoring is important to informing management that may enhance species viability. To this end, two long-term monitoring sites were selected for each targeted species and monitoring protocols were developed that are easily replicable by National Park Service staff. These data will be used by Park staff to inform management strategies that improve survivability potential for *Astragalus anisus*, *Sullivantia hapemanii* var. *purpusii*, and *Thelypodopsis juniperorum*.

Table of Contents

Introduction	6
Methods.....	7
Results	9
Species Selected for Monitoring.....	9
Profiles of Targeted Monitoring Species.....	11
Gunnison milkvetch (<i>Astragalus anisus</i>).....	11
Hanging Garden Sullivantia (<i>Sullivantia hapemanii</i> var. <i>purpusii</i>).....	13
Juniper tumble-mustard (<i>Thelypodopsis juniperorum</i>)	17
Black Canyon Gilia (<i>Gilia penstemonoides</i>)	19
Monitoring Locations and Protocols.....	20
<i>Astragalus anisus</i>	20
<i>Sullivantia hapemanii</i> var. <i>purpusii</i>	23
<i>Thelypodopsis juniperorum</i>	34
<i>Gilia penstemonoides</i> (Alternate monitoring species).....	36
Discussion.....	36
References	38
Appendix I. List of Plant Species Observed at Monitoring Sites, 2012	40
Appendix II. Data Collection Form.	44
Appendix III. Completed Data Collection Forms.....	45

List of Figures & Tables

Table 1: Element Occurrence Records (EORs) documented in 2012 at Black Canyon of the Gunnison National Park (BLCA) and Curecanti National Recreation Area (CURE).....	9
Table 2: Targeted plant species and selected monitoring sites at Black Canyon of the Gunnison National Park (BLCA) and Curecanti National Recreation Area (CURE).....	10
Figure 1. Location of survey area in Colorado	7
Figure 2. <i>Astragalus anisus</i> in fruit.....	11
Figure 3. <i>Sullivantia hapemanii</i> var. <i>purpusii</i>	13
Figure 4. <i>Sullivantia hapemanii</i> var. <i>purpusii</i> at Chipeta Falls	15
Figure 5. <i>Sullivantia hapemanii</i> var. <i>purpusii</i> at Pine Creek.....	16

Figure 6. <i>Thelypodopsis juniperorum</i> and associated habitat.....	17
Figure 7. Closeup of <i>Thelypodopsis juniperorum</i> in flower.....	13
Figure 8. <i>Gilia penstemonoides</i> in flower.....	19
Figure 9. Location of <i>Astragalus anisus</i> monitoring site at Coopers Resort.....	22
Figure 10. Location of <i>Sullivantia hapemanii</i> var. <i>purpusii</i> monitoring site at Chipeta Falls.....	25
Figure 11. Overview – Chipeta Falls <i>Sullivantia hapemanii</i> var. <i>purpusii</i> monitoring site.....	26
Figure 12. Chipeta Falls; Top section – 25 clumps.	27
Figure 13. Chipeta Falls; Middle section – 20 clumps.....	27
Figure 14. Chipeta Falls; lower section – 5 clumps.	28
Figure 15. Location of <i>Sullivantia hapemanii</i> var. <i>purpusii</i> monitoring site at Pine Creek.....	29
Figure 16. Overview – Pine Creek Trail <i>Sullivantia hapemanii</i> var. <i>purpusii</i> monitoring site (upstream). .	30
Figure 17. Pine Creek Trail <i>Sullivantia hapemanii</i> var. <i>purpusii</i> monitoring site (upstream); Left section – 9 clumps.....	30
Figure 18. Pine Creek Trail <i>Sullivantia hapemanii</i> var. <i>purpusii</i> monitoring site (upstream); Right section – 6 clumps	31
Figure 19. Overview – Pine Creek Trail <i>Sullivantia hapemanii</i> var. <i>purpusii</i> monitoring site (downstream).	31
Figure 20. Pine Creek Trail <i>Sullivantia hapemanii</i> var. <i>purpusii</i> monitoring site (downstream); Left section – 6 clumps.	32
Figure 21. Pine Creek Trail <i>Sullivantia hapemanii</i> var. <i>purpusii</i> monitoring site (downstream); Middle section – 10 clumps.	33
Figure 22. Pine Creek Trail <i>Sullivantia hapemanii</i> var. <i>purpusii</i> monitoring site (downstream); Right section – 4 clumps.....	33

Introduction

Monitoring of rare plant populations on National Park Lands is needed to determine current viability and long-term population trends. Impacts to plants from human uses and climate change need to be assessed to enable sustainable management. In 2012, CNHP botanists visited historic occurrences of rare plant species in the Black Canyon of the Gunnison National Park and Curecanti National Recreation Area (hereafter BLCA/CURE) to assess condition of these populations and to select suitable sites for long-term monitoring (Figure 1). Despite limited field work by area botanists, as of 2011, the majority of known occurrences of rare plants (18 of 26), had not been revisited in over ten years (Beatty et al. 2004; CNHP 2010; Hogan et al. 2005; Hogan et al. 2009; Hogan et al. 2009). In addition, very few of these occurrences have information on population size and condition.

Species targeted for survey include Hanging Garden Sullivantia (*Sullivantia hapemanii* var. *purpusii*), Juniper tumble-mustard (*Thelypodopsis juniperorum*) and Gunnison milkvetch (*Astragalus anisus*). Each species is a Colorado endemic. One of these species, Hanging Garden Sullivantia, occupies steep canyon walls and cliff ledges. This species is only found locally in restricted ranges and is consequently vulnerable and thus ranked by the Colorado Natural Heritage Program (CNHP) as “G3T3S3” (globally- and state-vulnerable). Two others target species, Gunnison milkvetch and Juniper tumble-mustard, occupy upland habitats on the canyon rim. The entire global range of Gunnison milkvetch is contained within the upper Gunnison Basin, which has earned the species a ranking of G2G3S2S3 (globally imperiled and state vulnerable). Juniper tumble-mustard is ranked G2S2 (globally- and state-imperiled) as this species is known only from 16 locations in Montrose, Delta, and Gunnison counties, Colorado (NatureServe 2012).

Outcomes of this project will provide the National Park Service (NPS) with baseline data including up-to-date information on the location, population size, habitat, and threats to several of the rare plants that occur on BLCA/CURE lands. These location-specific data are essential in assessing range and abundance, predicting distribution, for identifying areas of critical habitat, and for monitoring population trends.

Results of this project will also provide NPS staff with a protocol for monitoring these rare plant species. Monitoring will enable adaptive management, allowing NPS to detect population trends that may require management intervention.

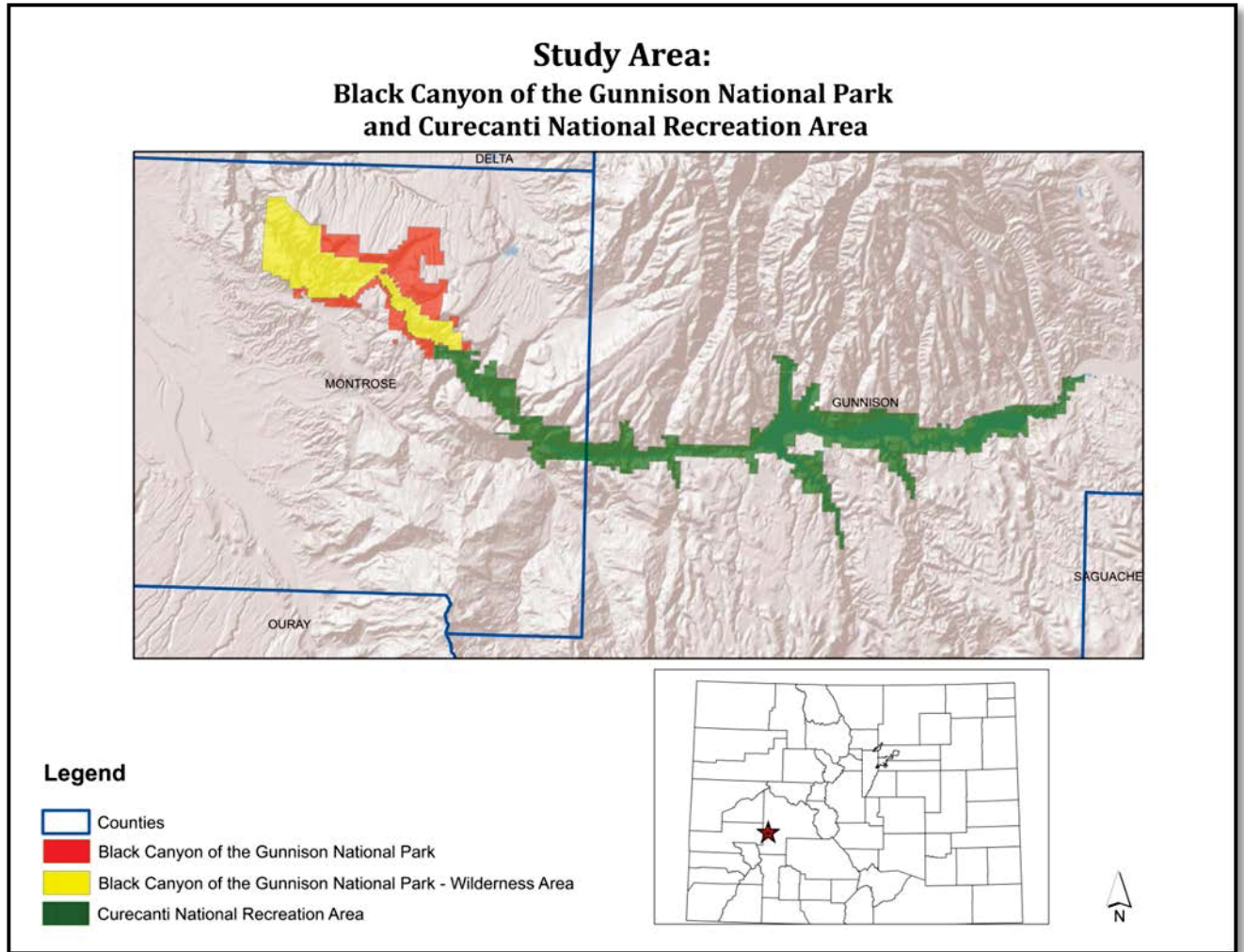


Figure 1. Location of survey area in Colorado

Methods

Three plant species were targeted for survey with the purpose of documenting current population abundance and condition and also to identify and establish permanent monitoring sites. These species included Hanging garden Sullivantia (*Sullivantia hapemanii* var. *purpusii*), Gunnison milkvetch (*Astragalus anisus*), and Juniper tumble-mustard (*Thelypodopsis juniperorum*). Known sites of these species were surveyed in May and June of 2012. In the event that suitable monitoring sites for target species could not be located we added a fourth species, *Gilia penstemonoides*, to the target list of species to be surveyed and monitored.

Natural Heritage Methodology was followed to document the occurrences which included collecting data on plant population parameters, location, and habitat characteristics. Population parameter information includes evaluating condition and determining the number of individuals at a site. Location data was collected using a GPS with UTM coordinates taken at each rare plant occurrence. Area occupied by populations was calculated using GIS. For larger

populations, a GPS unit was used to mark the perimeter of the population and create a polygon around the observed area.

Condition of plant populations was assessed by collecting data on phenology (percent of the plants that are vegetative, in flower, and in fruit at the time of survey); reproductive success (evidence of seed dispersal and establishment); age class structure; symbiotic or parasitic relationships (*e.g.*, pollinators present); and evidence of disease, predation or injury. Habitat information collected included descriptions of the surrounding landscape, dominant plant community and associated plant species, elevation, topographic position, slope, shape of slope, aspect, light exposure, soil texture, moisture gradient, and geomorphic landform.

Current threats and the likelihood of continued persistence of plant populations were assessed and documented at each occurrence. Occurrences were ranked according to NatureServe (2006) methodology which incorporates population size, condition/quality, and landscape context. By identifying threats and natural or unnatural disturbance (*e.g.*, effects on population viability due to mining, recreation, grazing, and/or exotic species), the data can inform sustainable management of the areas.

With these data, element occurrence records were updated or new element occurrence were created to reflect current population size and condition of the targeted plant species at each site. Also included in these records were habitat and environmental characteristics and condition, landscape context, locational information, and any potential threats to long-term viability. Additional plant species observed at each site visited in BLCA/CURE are listed in Appendix I.

Photo documentation for each surveyed site was used to establish a visual record and time stamp of plant population and habitat characteristics. Additional photo documentation of Hanging Garden Sullivantia sites was used to establish a baseline framework for long-term monitoring.

Long-term monitoring sites were selected based on ease of access, site comparability and site suitability. Monitoring plans were developed at two sites for each of the three target species, yielding a total of six monitoring locations. Details are provided in the Monitoring Locations and Protocols section on page 24.

Results

To identify potential monitoring sites, CNHP botanists visited known locations of the three targeted rare plants in the Black Canyon of the Gunnison National Park (BLCA) and Curecanti National Recreation Area (CURE) in May and June, 2012. In addition to visiting known locations, suitable habitat within BLCA and CURE was also visited. This resulted in a new occurrence of Hanging garden sullivania (*Sullivantia hapemanii* var. *purpusii*) at Chipeta Falls, and a new occurrence of Juniper tumble-mustard (*Thelypodopsis juniperorum*) near High Point. Additionally, two known occurrences of two of the targeted species (Hanging garden sullivania and Juniper tumble-mustard) were updated. The third target species, Gunnison milkvetch (*Astragalus anisus*) was not present in 2012 due to drought conditions, therefore we surveyed for an additional rare species, Black Canyon gilia (*Gilia penstemonoides*) (Table 1). These data will be entered into the CNHP BIOTICS data base during the fall and winter of 2012-13. Six sites, two sites for each of the three target species, were selected for permanent monitoring plots. The annual monitoring will be conducted by the Park Service. Monitoring protocols and maps were prepared for each species and baseline monitoring data were collected for two target species. Monitoring locations for each species are listed in Table 2.

Table 1. Element Occurrence Records (EORs) documented in 2012 at Black Canyon of the Gunnison National Park (BLCA) and Curecanti National Recreation Area (CURE).

Plant Species Scientific Name	CNHP Rarity Rank	New EORs	Updated EORs
<i>Astragalus anisus</i>	G2G3/S2S3	0	0
* <i>Gilia penstemonoides</i>	G3/S3	0	3
<i>Sullivantia hapemanii</i>	G3T3/S3	1	1
<i>Thelypodopsis juniperorum</i>	G2/S2	1	1

Species Selected for Monitoring

Plant species originally selected for monitoring included Gunnison milkvetch (*A. anisus*), hanging garden sullivania (*S. hapemanii* var. *purpusii*) and Juniper tumble-mustard (*T. juniperorum*). These species were selected based on their rarity ranking, vulnerability and presence in the Black Canyon of the Gunnison National Park/Curecanti National Recreation Area. Black Canyon gilia (*Gilia penstemonoides*) was added as an alternate in the event that suitable *A. anisus* sites could not be located in 2012.

Table 2. Targeted plant species and selected monitoring sites at Black Canyon of the Gunnison National Park (BLCA) and Curecanti National Recreation Area (CURE).

Monitoring Site	Plant Species Scientific Name	Base Line Data Collection
Hwy 50 at Cooper’s Resort (trampling-impacted)	<i>Astragalus anisus</i>	2011
Hwy 50 at Cooper’s Resort- (trampling –unimpacted)	<i>Astragalus anisus</i>	2011
North Vista Trail	<i>Thelypodopsis juniperorum</i>	2012
Decommissioned North Vista Trail	<i>Thelypodopsis juniperorum</i>	2012
Chipeta Falls	<i>Sullivantia hapemanii</i> var. <i>purpusii</i>	2012
Pine Creek Trail	<i>Sullivantia hapemanii</i> var. <i>purpusii</i>	2012
Pine Creek Visitor Center Road	<i>Gilia penstemonoides</i> *	NA
Curecanti Creek	<i>Gilia penstemonoides</i> *	NA

**Gilia penstemonoides* was not selected for monitoring in 2012.

Profiles of Targeted Monitoring Species

Gunnison milkvetch (*Astragalus anisus*)



Figure 2. *Astragalus anisus* in fruit.

Astragalus anisus is a small perennial plant in the pea family that reproduces only by seed, and devotes one or more years to vegetative growth before reproducing (Decker and Anderson 2005). *Astragalus anisus* is endemic to Colorado and to the upper Gunnison Basin. Here Gunnison milkvetch occupies Sagebrush Shrublands and Sagebrush Shrub Steppe ecological systems (Rondeau 2001). Habitat is characterized by rolling hills with dry, gravelly hillsides and flats with sandy clay soils overlying granitic bedrock. This species is usually found in fairly open sites where sagebrush shrubs do not form a closed canopy, but sometimes shelters under low sagebrush plants. Sites are characterized by the absence of trees, moderate shrub cover, moderate understory cover, and extensive bare ground (NatureServe 2012). This tendency of *Astragalus anisus* to prefer areas with a large percentage of bare ground indicates that it is likely not a strong competitor (Decker and Anderson 2004).

Astragalus anisus is fairly common within the Gunnison Basin, and population numbers are thought to be stable (Decker and Anderson 2004). However, due to its small global distribution, NatureServe and the Colorado Natural Heritage Program rank this species as G2G3S2S3 (globally and state imperiled). There are 35 occurrences in the CNHP database, four of which are in BLCA/CURE. Decker and Anderson (2004), list 83 locations but the CNHP considers many of these as sub-populations of single element occurrences.

In 2012, CNHP botanists visited two known locations of *Astragalus anisus* near Dillon Pinnacles and Red Creek. The survey date of May 13, 2012 was phenologically appropriate and coincided with the reported historical survey date in 1998, when 234 individuals were found in the two locations. In 2012 the climate was unusually warm and dry with spring rainfall lower than average (Western Regional Climate Center 2012). Surveys in 2012 at these sites documented only two very small plants with no flowers or fruit. Other regional *Astragalus* species, such as *A. microcymbus*, also failed to appear. We speculate that 2012 population abundances were most likely impacted by drought conditions and were not representative of population abundances in a more typical moisture year. These same sites were surveyed in 2011 when flowering and fruiting were abundant, likely from elevated winter precipitation (Kuhn 2011). Because this species' abundance appears to be tightly tied to precipitation and because some of the species' locations are vulnerable to anthropogenic trampling, monitoring *A. anisus* will be especially beneficial to informing management for long-term survival of BLCA/CURE populations.

The primary threat to *A. anisus* at this time (2012) is road building. Other threats are from off-road vehicle use, non-motorized recreation, non-native species invasion, grazing, residential development, fire suppression, resource extraction, and global climate change (NatureServe 2012). Additive effects of threats to the population may be compounded by this species' restricted range (Decker and Anderson 2004). Additionally, a lack of systematic tracking of population trends and conditions and a lack of knowledge about the species' basic life cycle also contribute to the possibility that one or more of these factors will threaten its long-term persistence (NatureServe 2012).

Of these threats, four are present in the BLCA/CURE, including non-motorized recreation, fire suppression, non-native species invasion and global climate change. Off-road non-motorized recreation that results in social trails can lead to trampling injury. Fire suppression, if it leads to an increase in sagebrush density, will have the effect of gradually eliminating suitable habitat for *A. anisus* (Decker and Anderson 2004). Invasions of non-native species such as *Bromus tectorum* can lead to increased erosion and increased competition for resources. Projections regarding Global Climate Change suggest that even under a medium emissions increase scenario (A1B) average temperatures will increase while precipitation will decrease in Colorado (ClimateWizard 2012). Because the habitat for *Astragalus anisus* is already xeric, lower soil moistures in the growing season induced by decreased precipitation could have serious impacts (Decker and Anderson 2004).

Because several of these threats are present in the BLCA/CURE, long-term monitoring of this species will be especially important to informing management. Additionally, element occurrence records for this species have very low viability ranks which provide even greater justification for monitoring, regardless that this species is somewhat common in the Gunnison Basin.

Hanging Garden Sullivantia (*Sullivantia hapemanii* var. *purpusii*)



Figure 3. *Sullivantia hapemanii* var. *purpusii* (photo by Janis Huggins).

Sullivantia hapemanii var. *purpusii* is a Colorado endemic that occupies moist inner canyon walls where seepage through cracks or spray from waterfalls provides water. Because this species is a Colorado endemic with only 45 known occurrences it has earned a rank of G3T3 S3 (globally and state vulnerable). Four of these occurrences are located in the BLCA/CURE (NatureServe 2012). These highly localized environments that provide habitat for *S.hapemanii* var. *purpusii* are found in canyonlands where perennial water sources provide a stable source of moisture within a surrounding arid environment, forming pocketed wetlands and allowing the draping of vegetation across wet cliff faces.

Two known locations of *Sullivantia* were visited in 2012 in BLCA/CURE. The first, at Chipeta Falls above Morrow Point Reservoir, was accessed by a Park Service boat on June 5. At this site plants occupy a vertical cliff face behind and adjacent to a waterfall. Water that sustains *Sullivantia hapemanii* at the Chipeta Falls site comes primarily from spray from the falls. The second site is located at the Pine Creek trail on cliffs that flank the Gunnison River. Pine Creek occurrences are dependent on water from seepage through cracks in cliff faces. At the Pine Creek trail site, two sub-populations were documented in the canyon. One site was within the area mapped by Hogan in 2003, and the other was 183 meters upstream of this site. No plants were found at the site previously mapped about 240 m downstream of the western-most occupied site. Documentation of abundance and distribution of plants at both the Chipeta Falls and Pine Creek sites was accomplished with binoculars, a spotting scope and photo documentation with GPS points.

Threats to *Sullivantia hapemanii* var. *purpusii* primarily come from hydrologic alteration. Because *S. hapemanii* var. *purpusii* typically occupies relatively inaccessible habitat this species is generally protected from proximate disturbances such as trampling or collecting. However, global climate change may threaten survivability due to climate drying. Intact hydrology is needed for the survival of the locations occupied by *Sullivantia hapemanii* var. *purpusii* (NatureServe 2012). *Sullivantia hapemanii* var. *purpusii* at the Chipeta Falls site is reliant on spray from the waterfall which is then dependent on sufficient streamflow; water at the Pine Creek trail site is reliant on seepage through cracks in the cliff faces which is likely dependent on sufficient precipitation infiltration from surrounding uplands.

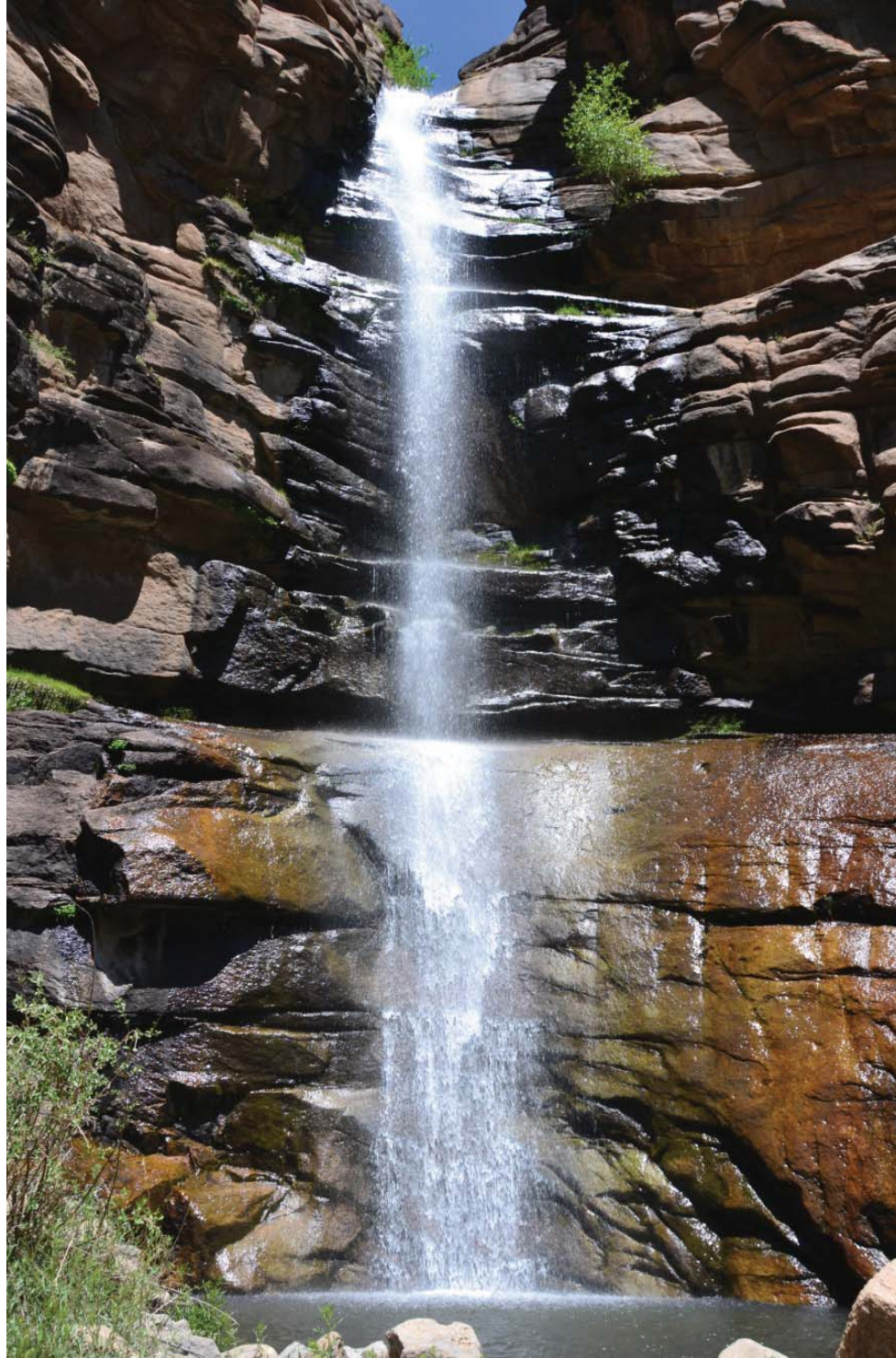


Figure 4. *Sullivantia hapemanii* site at Chipeta Falls.



Figure 5. *Sullivantia hapemanii* site at Pine Creek trail.

Juniper tumble-mustard (*Thelypodopsis juniperorum*)



Figure 6 (left). *Thelypodopsis juniperorum* and associated habitat.



Figure 7 (above). Closeup of *Thelypodopsis juniperorum* in flower.

Thelypodopsis juniperorum is a ruderal annual plant that reproduces exclusively by seed that is probably dispersed by wind or surface water runoff (Anderson 2004). This species completes its life cycle very early in the growing season, taking advantage of ephemeral environmental conditions, thereby reducing competition with other species.

Thelypodopsis juniperorum is a Colorado endemic, with 16 locations reported in Colorado in Montrose, Delta and Gunnison counties, and is ranked by CNHP as G2 S2 (globally and state imperiled). Its high level of endemism, small number of occurrences, and the vulnerability of its habitat suggest that *T. juniperorum* is imperiled (Anderson 2004). *Thelypodopsis juniperorum* is most commonly documented from pinyon-juniper woodlands but has also been documented in sage (*Artemisia* spp.) shrublands and Gambel oak-serviceberry and/or mountain mahogany (*Quercus gambelii*-*Amelanchier utahensis* – *Cercocarpus montanus*) shrublands (Anderson 2004).

In 2012, CNHP botanists searched for *Thelypodopsis juniperorum* on the North Vista Trail (both old/closed and open trails) to Green Mountain, and also the Warner Point Trail. Along the North Vista closed-trail we found 50 living and 8 dead (from 2011) plants that had flowered and produced fruit; this site is west of the area that was formerly mapped for *T. juniperorum*. Along the North Vista open trail we found 16 living and 2 dead (from 2011) plants that had flowered and produced fruit. No plants were found at the location documented in 2001 along the North

Vista Trail. This year's (2012) drought has likely impacted plant population abundance and distribution throughout the area. *Thelypodopsis juniperorum* probably has highly variable aboveground population numbers, which better reflect the quality of growing conditions in a given year than the effective population size (Anderson 2004). Thus the 2012 *T. juniperorum* population may not be representative of non-drought year populations.

Although these populations appear to be somewhat small they may still be viable. The minimum viable population size is not known for *Thelypodopsis juniperorum*, but even small populations may still be viable and of conservation importance (Soulé 1980). Colorado Natural Heritage Program considers occurrences of *T. juniperorum* containing ten or more plants as viable, but this threshold will be revised when a minimum viable population size is determined (Anderson 2004).

On the Warner Point trail, no living plants were found, however remains of plants from 2011 were found in several locations. These locations were documented to indicate areas where this annual plant may grow in the future. Previous occurrences located here indicate that habitat characteristics at this site are suitable for *T. juniperorum*. Absence of living plants may be due to the drought which may have inhibited seed germination. However, observations at Black Canyon of the Gunnison National Park suggest that *T. juniperorum* has a persistent seed bank that allows for recruitment of individuals during favorable years (Anderson 2004). Thus in higher moisture years, plants may again be seen here.

Plant survival at this on-trail sites may have also been impacted by trampling, although at distances greater than 50m from the trail, habitat conditions are undisturbed by trampling and conditions are suitable to support *T. juniperorum*. Further, fire appears to have been absent from this habitat for at least 50 years, which may be resulting in unsustainable habitat and stand characteristics.

Threats to *T. juniperorum*'s viability, in order of decreasing priority, include grazing, off-road vehicle use, non-native species invasion, fire suppression, energy development, residential development, pesticide use for range management, hiking, and global climate change. However, these threats are somewhat speculative due to a lack of information specific to *T. juniperorum*, thus assessment of threats to this species will be an important component of future inventory and monitoring work (Anderson 2004).

Observations from field surveys indicate three primary proximate threats may impact this species in the BLCA/CURE: hiking, fire suppression and historic grazing. Additionally, global climate change is predicted to significantly alter environmental conditions throughout the southwestern United States (USGCRP 2009).

Some level of natural disturbance might be beneficial to *Thelypodopsis juniperorum*. However, most anthropogenic disturbances that might occur in habitat for *T. juniperorum* are likely to result in habitat degradation (Anderson 2004). Fire regime alteration and the legacy of historic

grazing have altered the vegetation structure and composition of the habitat occupied by *T. juniperorum*. Global climate change is likely to have wide ranging effects in the near future. Projections suggest that average temperatures will increase while precipitation will decrease in Colorado (ClimateWizard 2009). Because the habitat for *Thelypodopsis juniperorum* is already xeric, lower soil moistures in the growing season induced by decreased precipitation could have serious impacts (Anderson 2004).

Black Canyon Gilia (*Gilia penstemonoides*)



Figure 8. *Gilia penstemonoides* in flower.

Gilia penstemonoides is a perennial plant species that grows in crevices, on narrow ledges, and on rimrock of vertical or near-vertical canyon walls (Spackman et al. 1997) in western and west-central Colorado. This species is likely a stress-tolerant species as indicated by its perennial life style and ability to withstand harsh environmental conditions.

However, *G. penstemonoides*

is also reliant on appropriate microsite conditions including moisture availability.

Gilia penstemonoides is ranked by CNHP as G3S3 (globally and state vulnerable) due to the small number of occurrences and small geographic distribution (NatureServe 2012). This species is a Colorado endemic with 28 known occurrences found in Montrose, Delta, Hinsdale and Mineral counties (two occurrences have been probably been eradicated by the filling of Blue Mesa Reservoir (NatureServe 2012)) (Beatty et al. 2004). However, the extensive but generally inaccessible cliffs in the BLCA/CURE provide potential habitat that has not been explored and which may harbor more populations of *G. penstemonoides*.

During field surveys in 2012, we also conducted surveys for *Gilia penstemonoides*, which could serve as a monitoring species in the event that suitable monitoring sites for targeted species could not be found. Surveys included historic sites as well as new locations. We searched for *Gilia* at a historically documented location at the end of the Park Service road to the Morrow Point Dam. No plants were found here and it appears that the cliffs where *Gilia* historically occurred have been dynamited and mesh installed since 1998 when the plants were documented last at this site.

Surveys along the Curecanti Creek trail, west and northwest of Lookout Point, yielded three sub-populations with a total of 17 plants. Another population was found along the road to the Pine Creek Visitor Center, 0.8 miles from the highway, with 55 individuals.

Because most populations of *Gilia penstemonoides* occupy inaccessible cliff face habitats the species is generally protected from direct anthropogenic impacts such as trampling, collecting or grazing. Rather, threats to *G. penstemonoides* primarily ensue from non-native plant invasion, global climate change and development activities such as road and reservoir building and campground development.

Although no specific information exists concerning the influence of environmental conditions or ecological factors on reproduction in *Gilia penstemonoides*, environmental fluctuations, such as available moisture, length of growing season, and temperature fluctuations could potentially affect growth, seed maturation, germination, and seedling survival of this species (Beatty et al. 2004). Global climate change is likely to have wide ranging effects in the near future. Projections from the IPCC suggest that average temperatures will increase while precipitation will decrease in this region of Colorado (ClimateWizard 2009).

Monitoring Locations and Protocols

Sites that are comparable and suitable for long-term monitoring and those that were relatively easy to access were selected from the locations visited in BLCA/CURE. Monitoring protocols were designed to be easily replicable by NPS personnel and be appropriate to site characteristics; for instance at *Sullivantia hapemanii* var. *purpusii* sites, technical climbing to enable counting, could result in damage to the habitat and to the population, so spotting scopes and photo documentation is used instead to enable monitoring.

A monitoring plan was designed to include two sites for each of the three targeted species for a total of six monitoring sites. Paired sites were selected to enable: 1) determining if species viability is being impacted by direct anthropogenic disturbance (such as trampling or collecting) and; 2) to enable distinguishing between changes in viability that are due to direct impacts such as trampling, from changes due to indirect impacts such as those related to climate change. Site suitability was based on selecting sites that would result in the least monitoring disturbance; for instance sites with steep slopes were not selected because trampling disturbance during monitoring may harm both the habitat and the plants.

A data collection form was developed and is provided in Appendix II. Monitoring protocols for each species are provided in the following section.

Astragalus anisus

Paired monitoring sites are located on the hillsides above Highway 50, near Cooper's Resort (Figure 9). For each pair of sites, locations were selected to be as comparable as possible with regard to habitat and environmental conditions with only one variable, the potential presence or absence of direct anthropogenic disturbance. One site is located in an area that experiences

trampling; the other site is located outside of the trampling-impacted area. Due to drought conditions in 2012, only the baseline site selection was completed, utilizing locational information gathered during 2011 surveys when *A. anisus* was abundant. Planned monitoring sites will be located to encompass *A. anisus* occurrences and will be one hectare in size. Each monitoring site will contain four monitoring plots, each 400 sq m (20m x 20m). Additionally, because many herbaceous plants are sensitive to disturbance, we suggest monitoring changes in relevant habitat characteristics within the monitoring site, as outlined below.

Astragalus anisus monitoring protocol:

Location: Highway 50 at Cooper's Resort.

GPS positions (NAD 83, Zone 13):

Monitoring site 1 at Cooper's Resort North (no trampling): northing 4264419;
easting 323388

Monitoring site 2 at Cooper's Resort South (trampling): northing 4263652;
easting 323299

Habitat: Sagebrush shrublands. Plants are usually found in fairly open sites where sagebrush shrubs do not form a closed canopy, but sometimes *A. anisus* grows under low sagebrush plants.

When: May through June (Flowering/Fruiting occurs May through June)

Frequency: Yearly

How: Thoroughly search each plot for *A. anisus*, flagging each plant with survey flags.

After searching and flagging, count individuals while picking up flags and recording the numbers of individuals in each of the categories on the field form including:

Phenology; Age class; Numbers of individuals affected by disease, predation, herbivory, injury and type; Numbers of individuals with symbiotic relationships and type, and parasitic relationships and type.

Habitat condition monitoring: Describe each of the categories in the field form including:

Edaphic characteristics; Dominant species; Disturbance including trampling – including photo points of each instance of trampling with corresponding GPS points and photo aspect to document impact; Weed cover – including photo points of each weed occurrence with corresponding GPS points and photo aspect to document weed cover.

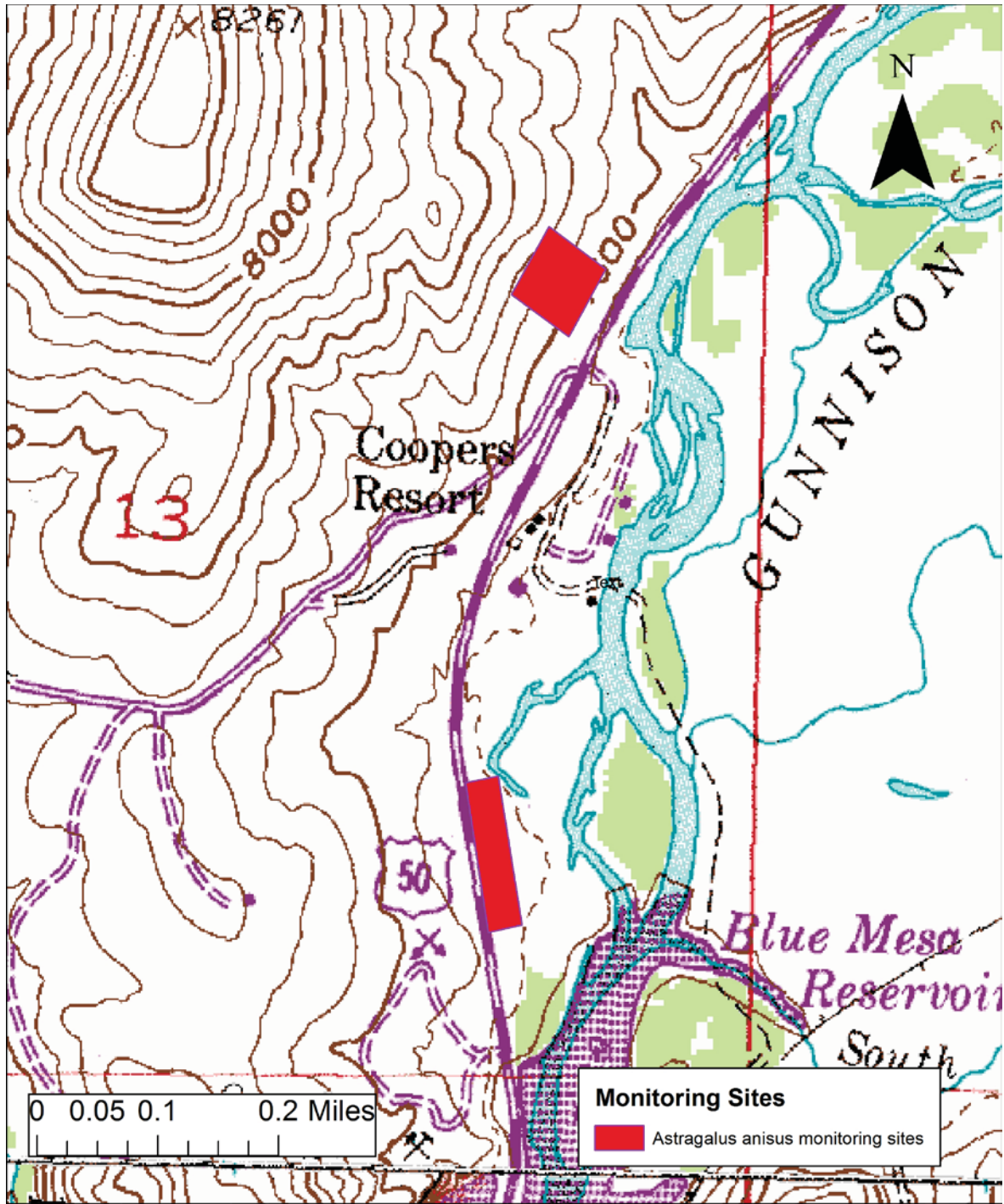


Figure 9. Location of *Astragalus anisus* monitoring site at Coopers Resort.

Sullivantia hapemanii* var. *purpusii

Monitoring sites were identified and mapped at Chipeta Falls and at Pine Creek Trail (Figures 10 and 15: *Sullivantia hapemanii* var. *purpusii* monitoring site locations). Due to the nature and position of the habitat occupied by *S.hapemanii* (vertical cliff faces) and the growth form (clumping), spotting scopes, photo documentation and counting clumps is used as the basis for long-term monitoring. Low intensity monitoring - presence/absence, rank abundance, and/or photo points - appears adequate for known occurrences, due to low threats (NatureServe 2012).

Detailed photographs with GPS position and aspect were taken at each site in 2012. Locations of all individual plants or clumps of plants were identified, counted and then marked on photographs of each site (Chipeta Falls Figures 11-14; Pine Creek Trail Figures 16-22). Ongoing monitoring of the Chipeta Falls site will be accomplished using a spotting scope to compare current abundance, distribution and condition of plants with photographs of 2012 plant abundance, distribution and conditions. Ongoing monitoring of the Pine Creek Trail site will be accomplished from the trail using binoculars and comparing 2012 baseline photographs with current abundance, distribution and condition.

Sullivantia hapemanii var. *purpusii* monitoring

Location: Site 1 - Chipeta Falls

GPS position (NAD 83, Zone 13): northing 4258668.860059; easting 290887.182758

Moist canyon walls and wet cliffs where seepage through cracks or spray from waterfalls provides water.

When: June 15-July 15.

Frequency: Yearly.

Chipeta Falls: determine location of monitoring point from GPS coordinates; using a spotting scope and 2012 photographs for comparison, thoroughly search each of three sections (upper, mid, lower) of the cliff face for plants. Count individual clumps in each section and record the number of individual clumps in each of the following categories on the field form including:

Phenology; Age class; Numbers of individuals affected by disease, predation, herbivory, injury and type; Numbers of individuals with symbiotic relationships and type, and parasitic relationships and type.

Habitat condition monitoring: Describe each of the categories in the field form including:

Hydrologic characteristics – stream flow measured in cfs; Disturbance including trampling or climbing – including photo points of each instance of trampling with corresponding GPS points and photo aspect to document impact; Weed cover – including

photo points of each weed occurrence with corresponding GPS points and photo aspect to document weed cover.

Location: Site 2 – Pine Creek Trail (2 sub-populations)

GPS positions (NAD 83, Zone 13):

Upstream site: northing 4258768.442578; easting 294590.161717

Downstream site: northing 4258772.922982; easting 294396.793861

Moist canyon walls and wet cliffs where seepage through cracks provides water.

When: June 15-July 15.

Frequency: Yearly.

How: Using binoculars and 2012 photographs for comparison, thoroughly search each section of the cliff face for plants. Count individual clumps in each section and record the number of individual clumps in each of the categories on the field form including:

Phenology; Age class; Diameter of clumps; Numbers of individuals affected by disease, predation, herbivory, injury and type; Numbers of individuals with symbiotic relationships and type, and parasitic relationships and type.

Habitat condition monitoring: Describe each of the categories in the field form including:

Hydrologic characteristics – free water and soil moisture; Disturbance including trampling or climbing – including photo points of each instance of trampling with corresponding GPS points and photo aspect to document impact; Weed cover – including photo points of each weed occurrence with corresponding GPS points and photo aspect to document weed cover.

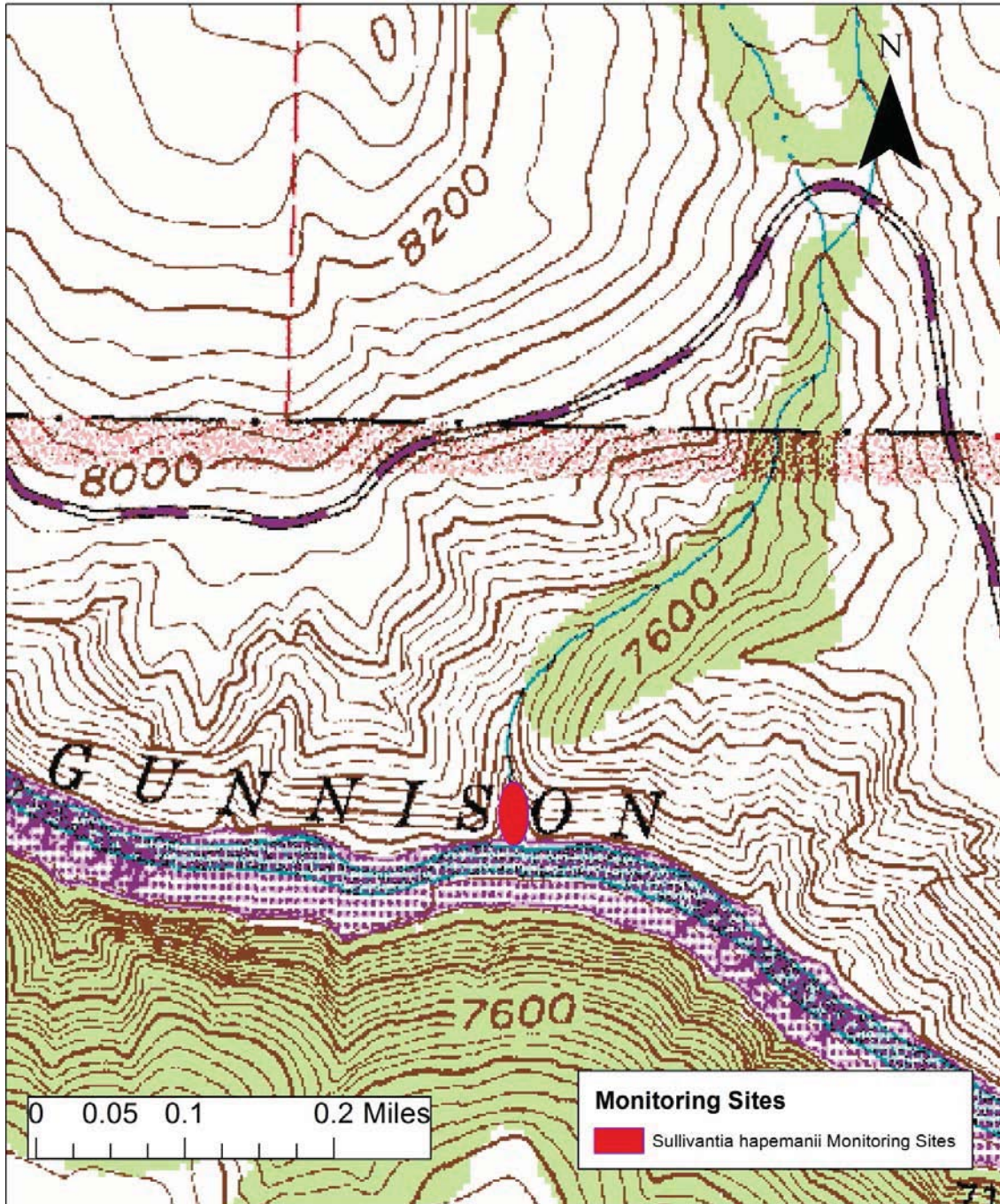


Figure 10. Location of *Sullivantia hapemania* var. *purpusii* monitoring site at Chipeta Falls.

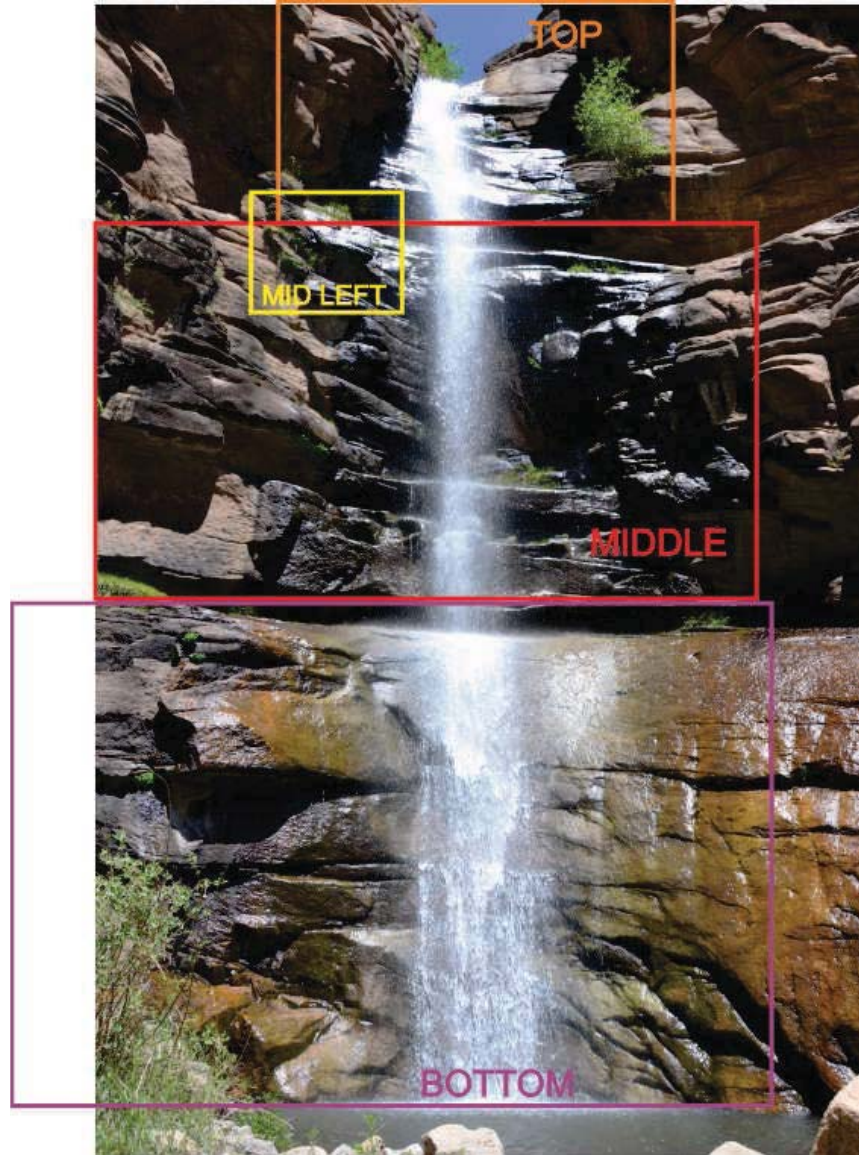


Figure 11. Overview – Chipeta Falls *Sullivantia hapemanii* var. *purpusii* monitoring site.

UTM coordinates (NAD 83, Zone 13): Northing 4258668.860059 Easting 290887.182758

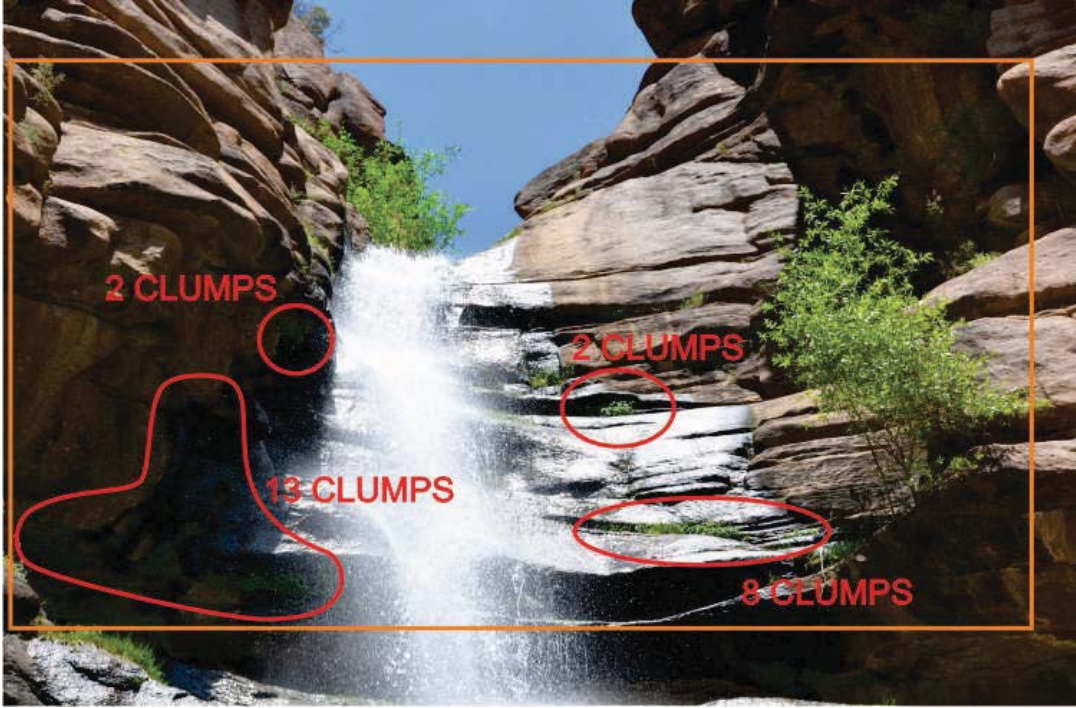


Figure 12. Chipeta Falls; Top section – 25 clumps.

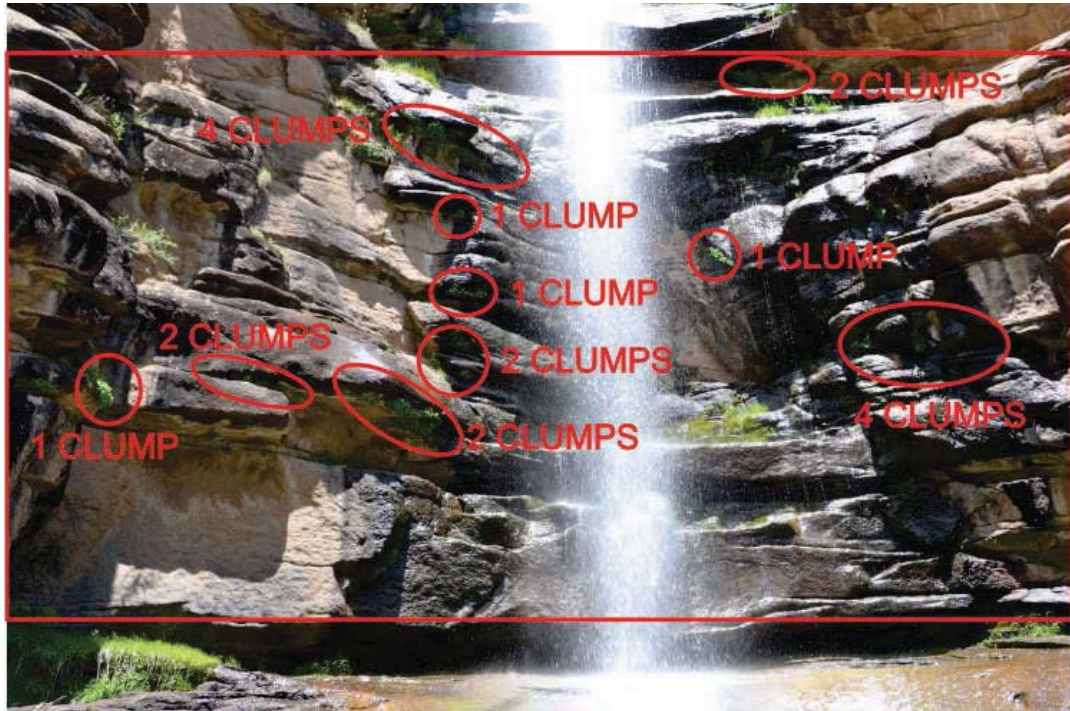


Figure 13. Chipeta Falls; Middle section – 20 clumps.



Figure 14. Chipeta Falls; lower section – 5 clumps.



Figure 15. Location of *Sullivantia hapemanii* var. *purpusii* monitoring site at Pine Creek.



Figure 16. Overview – Pine Creek Trail *Sullivantia hapemanii* var. *purpusii* monitoring site (upstream).

GPS location (NAD 83, Zone 13): northing 4258768.442578; easting 294590.161717



Figure 17. Pine Creek Trail *Sullivantia hapemanii* var. *purpusii* monitoring site (upstream);

Left section – 9 clumps.



Figure 18. Pine Creek Trail *Sullivantia hapemanii* var. *purpusii* monitoring site (upstream);

Right section – 6 clumps.

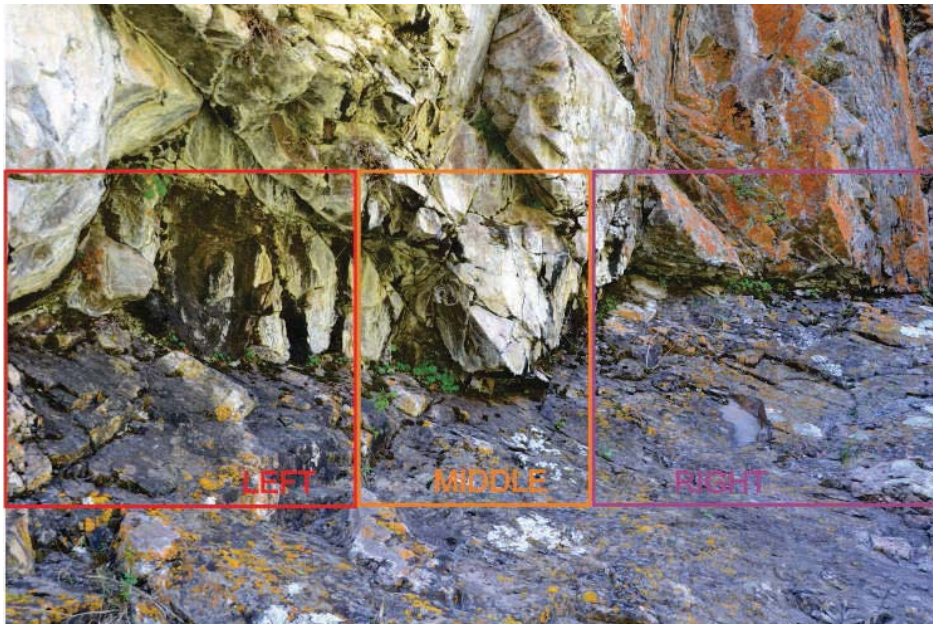


Figure 19. Overview – Pine Creek Trail *Sullivantia hapemanii* var. *purpusii* monitoring site (downstream).

GPS location (NAD 83, Zone 13): northing 4258772.922982; easting 294396.793861



Figure 20. Pine Creek Trail *Sullivantia hapemanii* var. *purpusii* monitoring site (downstream); Left section – 6 clumps.

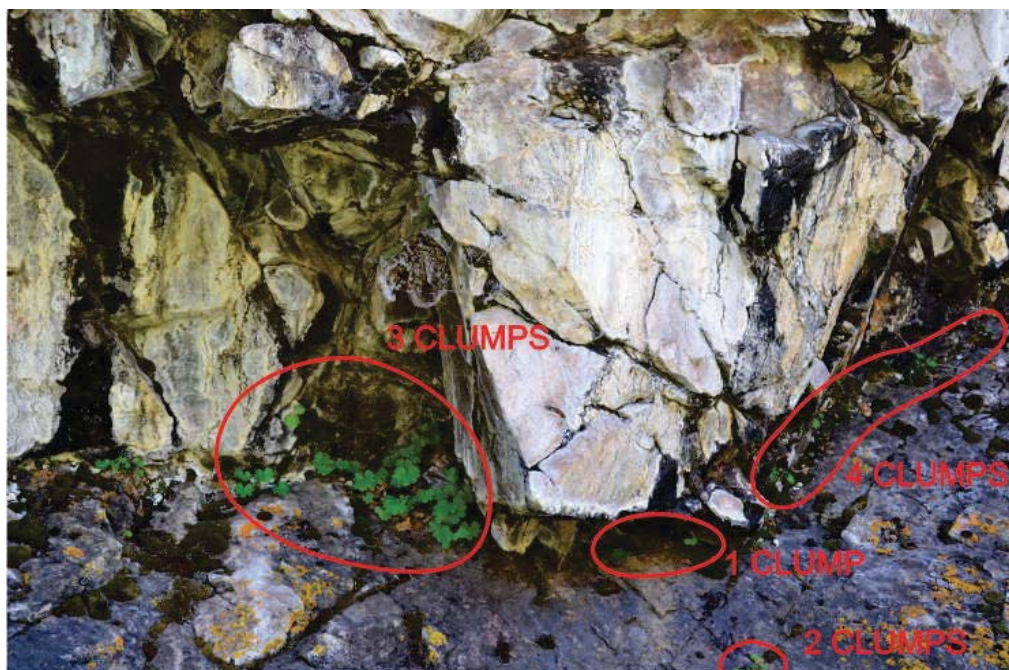


Figure 21. Pine Creek Trail *Sullivantia hapemanii* var. *purpusii* monitoring site (downstream); Middle section – 10 clumps.



Figure 22. Pine Creek Trail *Sullivantia hapemanii* var. *purpusii* monitoring site (downstream); Right section – 4 clumps.

Thelypodopsis juniperorum

Paired monitoring sites were located and mapped along the established North Vista trail and also along a nearby de-commissioned trail (Figure 23: Location of *T. juniperorum* monitoring sites). Occurrences of *T. juniperorum* that are located along the active trail potentially experience trampling while those located on the de-commissioned trail, do not. Monitoring sites were designed to parallel these trails while encompassing documented occurrences as well as potential habitat. Each monitoring site is a 20m wide corridor along the trail, extending 10m in width on each side of the trail. Although *T. juniperorum* occurrences are not distributed along the entire length of the trails, appropriate habitat is present throughout the length of the trails and seeds may be present. Thus the entire lengths of both trails are used as monitoring corridors. Additionally, because many annuals are sensitive to disturbance, we suggest monitoring changes in relevant habitat characteristics.

Thelypodopsis juniperorum monitoring protocol

Location: Active and de-commissioned North Vista trails to Green Mountain

GPS positions (NAD 83, Zone 13):

Active North Vista trail: northing 4274405.193; easting 264363.856 (trailhead)

Decommissioned North Vista trail: northing 4274447.527; easting 264427.356 (trailhead)

When: mid-May through mid-June at peak flowering

Frequency: Yearly. It is an annual species, so resampling of monitoring plots will be necessary every year (Anderson 2004).

How: Slowly walk along the trail monitoring corridor, thoroughly searching the entire corridor for *T. juniperorum*, flagging each plant with survey flags.

After searching for and flagging plants along the entire monitoring corridor, walk back down the trail, counting individuals while picking up flags and recording the numbers of individuals in each of the categories on the field form including:

Phenology; Age class; Numbers of individuals affected by disease, predation, herbivory, injury and type; Numbers of individuals with symbiotic relationships and type, and parasitic relationships and type.

Habitat condition monitoring: Describe each of the categories in the field form including:

Edaphic characteristics; Dominant species and percent cover; Disturbance including trampling – including photo points of each instance of trampling with corresponding GPS points and photo aspect to document impact; Weed cover – including photo points of

each weed occurrence with corresponding GPS points and photo aspect to document weed cover.

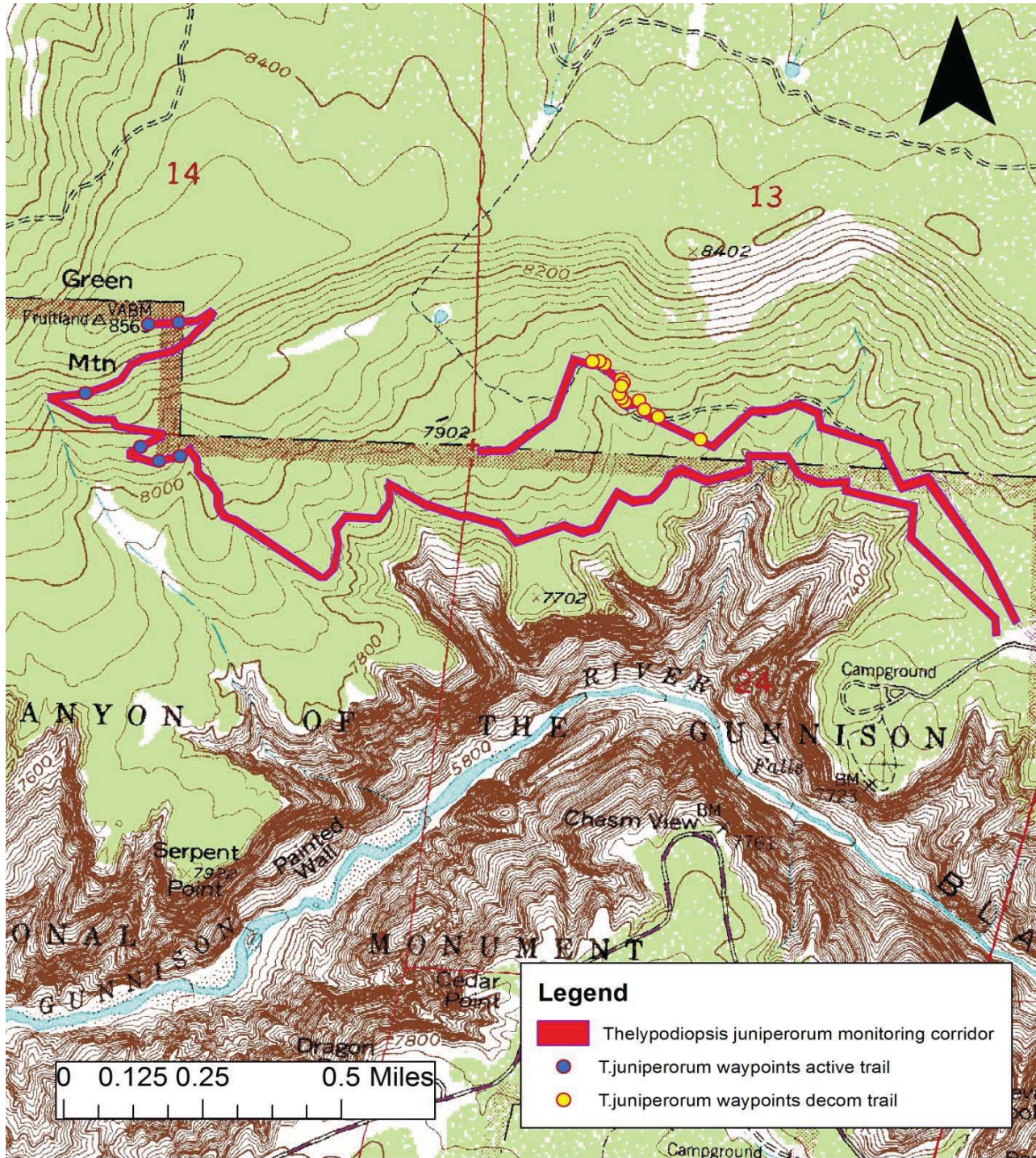


Figure 23. Location of *Thelypodopsis juniperorum* monitoring site at North Vista Trail.

***Gilia penstemonoides* (Alternate monitoring species)**

Gilia penstemonoides monitoring

Location: Curecanti Creek and Pine Creek Visitor Center Road

GPS points Curecanti Creek (NAD 83, Zone 13):

- 1) Northing 4259532.71468; easting 288727.35673
- 2) Northing 4259546.454316; easting 288662.955106
- 3) Northing 4258954.576018; easting 288921.673675

GPS points Pine Creek Visitor Center: northing 4257979.313714; easting 295473.898171

When: Peak flowering (flowering June 5-July 15)

Frequency: Yearly

How: Hike along Curecanti Creek to locate three sub-populations. Search along road to the Pine Creek visitor center to locate populations with binoculars and spotting scope.

Phenology; Age class; Numbers of individuals affected by disease, predation, herbivory, injury and type; Numbers of individuals with symbiotic relationships and type, and parasitic relationships and type.

Habitat condition monitoring: Describe each of the categories in the field form including:

Dominant species and percent cover; Disturbance including trampling/climbing – including photo points of each instance of disturbance with corresponding GPS points and photo aspect to document impact; Weed cover – including photo points of each weed occurrence with corresponding GPS points and photo aspect to document weed cover.

Discussion

During 2012 the Colorado Natural Heritage Program re-visited known locations of three globally vulnerable or imperiled plant species that occur in Black Canyon of the Gunnison National Park and Curecanti National Recreation Area: Gunnison milkvetch (*Astragalus anisus*), hanging garden Sullivantia (*Sullivantia hapemanii* var. *purpusii*) and juniper tumble-mustard (*Thelypodopsis juniperorum*). Surveys identified suitable sites for long-term monitoring and collected information on the location, population size, habitat, and threats to two of these species: *S. hapemanii* var. *purpusii* and *T. juniperorum*. The third species, *A. anisus*, appeared only infrequently in 2012, likely due to drought conditions. Thus, monitoring sites are based on 2011 surveys. Monitoring sites were also located for an additional species, *Gilia penstemonoides*.

Native plant species have evolved with, and are adapted to, a natural range of environmental conditions such as moisture level and disturbance regimes such as fire and soil erosion. Alteration of these ecological regimes to conditions beyond the natural range of variability can impact species survivability. Long-term monitoring of population and habitat characteristics can inform adaptive management to enhance species viability.

Habitat resilience to perturbation or disturbance is increased when ecological processes are intact. In the face of global climate change, the maintenance of ecosystem structure and function through the conservation of healthy native habitats will serve to ameliorate impacts such as decreased stream flows and reduced soil moisture that result from a changing climate and that are essential for the survivability of these plant species. Monitoring information will enable staff at BLCA/CURE to more effectively manage, monitor and protect these globally vulnerable and imperiled plant species

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Appendix I. List of Plant Species Observed at Monitoring Sites, 2012

*=non-native

Sullivantia hapemanii site at Pine Creek

Trees

Acer glabrum

Acer negundo

Juniperus scopulorum

Populus angustifolia

Pseudotsuga menziesii

Shrubs

Amelanchier utahensis

Artemisia tridentata ssp. *tridentata*

Chrysothamnus nauseosus

Cornus sericea

Holodiscus dumosus

Padus virginiana

Paxistima myrsinites

Philadelphus microphyllus

Purshia tridentata

Ribes cereum

Ribes inerme

Ribes wolfii

Rosa woodsii

Rubus idaeus

Sambucus racemosa

Symphoricarpos rotundifolius

Graminoids

Achnatherum hymenoides

Carex geyeri

Poa pratensis

Forbs

Actaea rubra

Androsace septentrionalis

Antennaria rosea

Artemisia ludoviciana

Boechera sp.

Chamerion danielsii

Cilaria austromontana

Clematis occidentalis

Descurainia pinnata

Erigeron leiomeris

Heterotheca villosa

Heuchera parvifolia

Humulus lupulus

Lepidium sp.

Maianthemum amplexicaule

Mertensia ciliata

Potentilla sp.

Rubus idaeus

**Rumex sp.*

Ferns

Solidago sp.

Cystopteris fragilis

**Taraxacum officinale*

**Verbascum thapsus*

Sullivantia hapemanii var. purpusii site at Chipeta Falls:

Trees

Forbs

Populus angustifolia,

Cardamine cordifolia

Juniperus scopulorum

**Cirsium arvense*

Pseudotsuga menziesii

Heuchera parvifolia

Shrubs

Mimulus spp.

Cornus sericea,

Heracleum spondylium

Holodiscus discolor

Humulus lupulus

Philadelphus microphyllus,

Rudbeckia ampla

Potentilla fruticosa,

Sedum integrifolium

Ribes cereum.

Urtica gracilis

Salix spp.

**Verbascum thapsus*

**Tamarix ramosissima*

Ferns and Mosses

Graminoids

Cystopteris fragilis

**Bromus tectorum*

Marchantia spp

Red Creek site of previously documented *Astragalus anisus* (not found in 2012)

Trees

Artemisia tridentata ssp. wyomingensis

Populus angustifolia

Chrysothamnus nauseosus

Shrubs and Cacti

Chrysothamnus viscidiflorus

Amelanchier utahensis

Ephedra viridis

Artemisia frigida

Opuntia polyacantha

Pediocactus simpsonii

Purshia tridentata

Rhus trilobata

Rosa woodsii

Symphoricarpos oreophilus

Tetradymia canescens

Yucca harrimanniae

Graminoids

Achnatherum hymenoides

Bouteloua gracilis

Leymus cinereus

Poa secunda

Hesperostipa comata

Koeleria macrantha

Forbs

***Thelypodopsis juniperorum* site on North Vista Trail**

Tree

Pinus edulis

Juniperus osteosperma

Shrubs

Quercus gambelii

Amelanchier utahensis

Cercocarpus montanus

Gutierrezia sarothrae

Graminoids

Achnatherum hymenoides

Achillea lanulosa

Antennaria rosea

Artemisia ludoviciana

Balsamorhiza sagittata

Cirsium tracyi

Erigeron concinnus

Eriogonum umbellatum

Eriogonum racemosum

Erysimum capitatum

Gutierrezia sarothrae

Kochia americana

Phlox longifolia

Physaria acutifolia

Psilochenia occidentalis

Festuca arizonica

Forbs

Astragalus lentiginosus,

Balsamorhiza sagittata,

Chaenactis spp.

Delphinium spp.

Ipomopsis aggregata,

Lupinus argenteus

Oxytropis sericea

Physaria vitulifera

Gilia penstemonoides site at Curecanti Trail

Trees

Pseudotsuga menziesii

Picea pungens

Shrubs

Artemisia frigida

Betula occidentalis

Holodiscus discolor

Philadelphus microphyllus

Quercus gambelii

Graminoids

**Bromus tectorum*

Forbs

Heterotheca villosa.

Saxifraga austromontana

Heuchera parvifolia

Ferns

Cheilanthes feei

Appendix II. Data Collection Form

Black Canyon of the Gunnison Rare Plant Monitoring Data Collection Form

Date _____ Surveyor(s) _____

Species _____ Site name _____

Site Location (UTM): _____

Photo numbers and GPS location: _____

Total number of plants (*Astragalus anisus* and *Thelypodopsis juniperorum* sites only): _____

Total number of individual clumps (*Sullivantia hapemanii* var. *purpusii* sites only): _____

Phenology: Number vegetative _____ Flowering _____ Fruiting _____

Age class: Number of seedlings _____ Immature _____ Mature _____

Numbers of individuals affected by: Disease _____ Predation _____ Herbivory _____ Injury _____

Symbiotic relationships noted _____

Parasitic relationships noted _____

Habitat condition monitoring:

Edaphic characteristics (*Astragalus anisus* and *Thelypodopsis juniperorum* sites only):

Soil moisture: _____ Soil Texture: _____ Soil Properties: _____

Hydrologic characteristics (*Sullivantia hapemanii* var. *purpusii* sites only):

Stream flow in cfs (Chipeta Falls site) _____

Free water (Pine Creek site): Yes _____ No _____

Soil moisture (Pine Creek site): Yes _____ No _____

Stand dominant species or community associations: _____

Percent cover of: trees _____ shrubs _____ herbaceous graminoids/forbs _____

Disturbance noted: _____

Disturbance severity: High: ___ Medium: ___ Low: ___ Photo Number and GPS

Points: _____

(Include photo points of each trampling instance with GPS points and aspect to document impact.)

Weed cover: Species _____ Percent cover: _____ Photo number and GPS Points: _____

Appendix III. Completed Data Collection Forms

Black Canyon of the Gunnison Rare Plant Monitoring Data Collection Form

Date: 6/6/2012 _____ Surveyor(s): Malone, D. G. and Lyon, P.

Species: *Thelypodopsis juniperorum* Site name: North Vista Trail (active)

Site Location (UTM): north 4274405.193/east 264363.856.

Photo numbers and GPS location:

Black Canyon 102: 4274951.29876/261999.320034

Black Canyon 107 and 109: 4274933.106521/261937.318228

Total number of plants counted within monitoring plot: ___16_____

Total number of individual clumps (*Sullivantia hapemanii* var. *purpusii* Pine Creek site only): ___NA_____

Phenology: Number vegetative ___0___ Flowering ___2___ Fruiting ___14___

Age class: Number of seedlings ___0___ Immature ___0___ Mature ___16_____

Numbers of individuals affected by: Disease ___0___ Predation ___0___ Herbivory ___0___ Injury ___0___

Symbiotic relationships noted: none observed _____

Parasitic relationships noted: none observed _____

Habitat condition monitoring:

Edaphic characteristics (*Astragalus anisus* and *Thelypodopsis juniperorum* only):

Soil moisture: xeric ___ Texture: fine sandy loam ___ Properties: well drained, dense (>90% cover) litter layer of Pinyon needles, minimal organic matter (<5%) _____.

Hydrologic characteristics (*Sullivantia hapemanii* var. *purpusii* only):

Stream flow in cfs (Chipeta Falls site) ___NA_____

Free water (Pine Creek site): Yes ___NA___ No ___NA___

Soil moisture (Pine Creek site): Yes ___NA___ No ___NA___

Stand dominant species: *Pinus edulis* -*Juniperus osteosperma*/*Quercus gambellii*-*Amelanchier utahensis*

Percent cover of: trees ___35%___ shrubs ___35%___ herbaceous ___20%_____

Disturbance noted: trail-related trampling_____

Disturbance severity: High: _____ Medium: _____ Low: X_____

Photo number and GPS points: Black Canyon 106: 4274951.29876/261999.320034

(Include photo points of each trampling instance with GPS points to document impact.)

Weed cover: Species none observed Percent cover: NA Photo Points: NA

(Include photo points of each weed occurrence with GPS points to document weed cover.)

Black Canyon of the Gunnison Rare Plant Monitoring Data Collection Form

Date: 6/4/2012 _____ Surveyor(s): Malone, D.G., Lyon, P. and Brummer, L.

Species: *Thelypodopsis juniperorum* Site name: **Decommissioned North Vista Trail**

Site Location (UTM): north 4274447.527/east 264427.356.

Photo documentation - photo numbers and GPS location of photos:

Black Canyon 004-006: 4275179.014697/263277.628857

Black Canyon 013: 4275088.548728/263344.818326

Black Canyon 016:4275065.738929/263384.971491:

Black Canyon 022: 4274998.293421/263507.177178

Total number of plants (*Astragalus anisus* and *Thelypodopsis juniperorum* sites only): 50 _____

Total number of individual clumps (*Sullivantia hapemanii* var. *purpusii* sites only): ____ NA _____

Phenology: Number vegetative __0__ Flowering __23__ Fruiting __27__

Age class: Number of seedlings __0__ Immature _____ Mature __50__

Numbers of individuals affected by: Disease __0__ Predation __0__ Herbivory __50__ Injury __0__

Symbiotic relationships noted: *Formicidae* species herbivory typical on all *T. juniperorum* plants _____

Parasitic relationships noted: none observed _____

Habitat condition monitoring:

Edaphic characteristics (*Astragalus anisus* and *Thelypodopsis juniperorum* only):

Soil moisture: xeric . Soil Texture: fine sandy loam. Soil Properties: well drained; 90% litter cover 2 cm deep; 10% organic matter.

Hydrologic characteristics (*Sullivantia hapemanii* var. *purpusii* only):

Stream flow in cfs (Chipeta Falls site) ____ NA _____

Free water (Pine Creek site): Yes ____ NA _____ No ____ NA _____

Soil moisture (Pine Creek site): Yes ____ NA _____ No ____ NA _____

Stand dominant species: *Pinus edulis*-*Juniperus osteosperma*/*Quercus gambelii*-*Amelanchier utahensis* _

Percent cover of: Trees: 21 % ____ Shrubs: 28% ____ Herbaceous species (graminoids/forbs): 21% ____

Disturbance noted: none observed _____

Disturbance severity: High: ____ Medium: ____ Low ____ Photo number and GPS Points: NA ____

(Include photo points of each trampling instance with GPS points and aspect to document impact.)

Weed cover: Species - none observed ____ Percent cover: __NA__ Photo number and GPS Points: NA

Black Canyon of the Gunnison Rare Plant Monitoring Data Collection Form

Date: 6/5/2012 _____ Surveyor(s): Malone, D.G., Lyon, P.

Species: *Sullivantia hapemanii* var. *purpusii* Site name: **Chipeta Falls**

Site Location (UTM): _____ 4258668.860059/290887.182758 _____

Photo numbers and GPS location: Black Canyon 041-043 and 058, 061,066 -
4258668.860059/290887.182758 _____

Total number of plants (*Astragalus anisus* and *Thelypodopsis juniperorum* sites only): _____ NA _____

Total number of individual clumps (*Sullivantia hapemanii* var. *purpusii* sites only): _____ 50 _____

Phenology: Number vegetative _____ 39 _____ Flowering _____ 11 _____ Fruiting _____ 0 _____

Age class: Number of seedlings: _____ not known _____ Immature: _____ not known _____ Mature: _____ not known _____

Numbers of individuals affected by: Disease _____ 0 _____ Predation _____ 0 _____ Herbivory _____ 0 _____ Injury _____ 0 _____

Symbiotic relationships noted: none observed _____

Parasitic relationships noted : none observed _____

Habitat condition monitoring:

Edaphic characteristics (*Astragalus anisus* and *Thelypodopsis juniperorum* only):

Soil moisture: _____ NA _____ Soil Texture: _____ NA _____ Soil Properties:
_____ NA _____.

Hydrologic characteristics (*Sullivantia hapemanii* var. *purpusii* only):

Stream flow in cfs (Chipeta Falls site) _____ yes – to be measured in future years _____

Free water (Pine Creek site): Yes _____ NA _____ No _____ NA _____

Soil moisture (Pine Creek site): Yes _____ NA _____ No _____ NA _____

Stand dominant species or community associations: Cliff habitat near the waterfall is characterized by mosses and liverworts and moisture-loving herbaceous species and a few shrubs. Common species here include *Cardamine cordifolia*, *Cystopteris fragilis*, *Sedum integrifolium*, *Heuchera parvifolia* and *Ribes cereum*. Dry cliff faces are characterized by *Holodiscus discolor* and *Philadelphus microphyllus*, growing in cracks in the rocks. Habitat at the beach at the bottom of the cliffs is characterized by mixed shrubs and

forbs including *Cornus sericea*, *Rudbeckia ampla*, *Salix spp.*, *Heracleum lanatum*, *Urtica gracilis*, and *Humulus lupulus*.

Percent cover of: Trees 0 Shrubs <5% Herbaceous species (graminoids/forbs) >10% <20%

Disturbance noted: trampling on “beach” below waterfall where *S. hapemanii* var. *purpusii* is located.

Disturbance severity: High: Medium: Low: X

Photo Number and GPS Points: Black Canyon 066 - 4258668.860059/290887.182758 _____

(Include photo points of each trampling instance with GPS points to document impact.)

Weed cover: Species: *Tamarix* spp. and *Cirsium arvense* Percent cover: 5%

Photo number and GPS Points: Black Canyon 077 - 4258668.860059/290887.182758 _____

Black Canyon of the Gunnison Rare Plant Monitoring Data Collection Form

Date: 6/7/2012 _____ Surveyor(s): Malone, D.G. and Lyon, P.

Species: *Sullivantia hapemanii* var. *purpusii* Site name: **Pine Creek Trail**

Site Location (all location info in NAD 83, Zone 13):

Upstream site - Northing: 4258723.522 Easting: 294574.038

Downstream site - Northing: 4258742.176 Easting: 294389.094

Photo numbers and GPS location:

Black Canyon 136 and 172-174 Northing: 4258723.522 Easting: 294574.038

Black Canyon 149-151 Northing: 4258742.176 Easting: 294389.094

Total number of plants (*Astragalus anisus* and *Thelypodopsis juniperorum* sites only): NA

Total number of individual clumps (*Sullivantia hapemanii* var. *purpusii* sites only):
35 _____

Phenology: Number vegetative 34 Flowering 1 Fruiting 0

Age class: Number of seedlings 0 Immature 17 Mature 18

Numbers of individuals affected by: Disease _____ Predation _____ Herbivory _____ Injury _____

Symbiotic relationships noted: none observed _____

Parasitic relationships noted: none observed _____

Habitat condition monitoring:

Edaphic characteristics (*Astragalus anisus* and *Thelypodopsis juniperorum* only):

Soil moisture: NA Soil Texture: NA Soil Properties: NA

Hydrologic characteristics (*Sullivantia hapemanii* only):

Stream flow in cfs (Chipeta Falls site) NA

Free water (Pine Creek site): Yes X No _____ *surface water emerges from seeps

Soil moisture (Pine Creek site): Yes X No _____ *fine moist sand stabilized with mosses in cliff crevices

Stand dominant species or community associations: Rocky vertical cliff habitat alternates with high gradient slopes where soils have developed. Hillslope habitat is characterized by *Pseudotsuga*

menziesii/Acer glabrum woodlands. Cliff habitat species include *Cheilanthes feei*, *Cystopteris fragilis*, *Erigeron leiomerus*, *Heuchera parvifolia*, *Holodiscus discolor* and *Philadelphus microphyllus*. A narrow riparian zone occurs at the base of the cliffs. Dominant plant species here include *Populus angustifolia*, *Cornus sericea* and *Maianthemum stellatum*.

Percent cover of Trees :__0__ Shrubs:_5%_ Herbaceous species (graminoids/forbs): _____

Disturbance noted: none observed _____

Disturbance severity: High: __Medium: __Low: __ Photo Number and GPS

Points: __NA_____

(Include photo points of each trampling instance with GPS points and aspect to document impact.)

Weed cover: Species: none observed __ Percent cover: __NA_ Photo number and GPS Points:

__NA_____

Black Canyon of the Gunnison Rare Plant Monitoring Data Collection Form

Date: _____ Surveyor(s): _____

Species: *Astragalus anisus* Site name: **Cooper's Resort North (no trampling)**

Site Location (NAD 83, Zone 13): northing 4264419; easting 323388 _____

Photo numbers and GPS location: _____

Total number of plants (*Astragalus anisus* and *Thelypodopsis juniperorum* sites only): _____

Total number of individual clumps (*Sullivantia hapemanii* var. *purpusii* sites only): _____ NA _____

Phenology: Number vegetative _____ Flowering _____ Fruiting _____

Age class: Number of seedlings _____ Immature _____ Mature _____

Numbers of individuals affected by: Disease _____ Predation _____ Herbivory _____ Injury _____

Symbiotic relationships noted: _____

Parasitic relationships noted : _____

Habitat condition monitoring:

Edaphic characteristics (*Astragalus anisus* and *Thelypodopsis juniperorum* only):

Soil moisture: _____ Soil Texture: _____ Soil Properties: _____

Hydrologic characteristics (*Sullivantia hapemanii* var. *purpusii* only):

Stream flow in cfs (Chipeta Falls site) _____ NA _____

Free water (Pine Creek site): Yes _____ NA _____ No _____ NA _____

Soil moisture (Pine Creek site): Yes _____ NA _____ No _____ NA _____

Stand dominant species or community associations: _____

Percent cover of: trees _____ shrubs _____ herbaceous species (graminoids/forbs) _____

Disturbance noted: _____

Disturbance severity: High: _____ Medium: _____ Low: _____ Photo Number and GPS Points: _____

(Include photo points of each trampling instance with GPS points and aspect to document impact.)

Weed cover: Species _____ Percent cover: _____ Photo number and GPS Points: _____

Black Canyon of the Gunnison Rare Plant Monitoring Data Collection Form

Date: _____ Surveyor(s) _____

Species: *Astragalus anisus* Site name: **Cooper's Resort south (trampling impacted)**

Site Location (UTM): northing 4263652; easting 323299 _____

Photo numbers and GPS location: _____

Total number of plants (*Astragalus anisus* and *Thelypodopsis juniperorum* sites only): _____

Total number of individual clumps (*Sullivantia hapemanii* var. *purpusii* sites only): NA _____

Phenology: Number vegetative _____ Flowering _____ Fruiting _____

Age class: Number of seedlings _____ Immature _____ Mature _____

Numbers of individuals affected by: Disease _____ Predation _____ Herbivory _____ Injury _____

Symbiotic relationships noted: _____

Parasitic relationships noted : _____

Habitat condition monitoring:

Edaphic characteristics (*Astragalus anisus* and *Thelypodopsis juniperorum* only):

Soil moisture: _____ Soil Texture: _____ Soil Properties: _____

Hydrologic characteristics (*Sullivantia hapemanii* var. *purpusii* only):

Stream flow in cfs (Chipeta Falls site) _____

Free water (Pine Creek site): Yes _____ No _____

Soil moisture (Pine Creek site): Yes _____ No _____

Stand dominant species or community associations: _____

Percent cover of: Trees _____ Shrubs _____ Herbaceous species (graminoids/forbs) _____

Disturbance noted: _____

Disturbance severity: High: _____ Medium: _____ Low: _____ Photo Number and GPS Points: _____

(Include photo points of each trampling instance with GPS points and aspect to document impact.)

Weed cover: Species _____ Percent cover: _____ Photo number and GPS Points: _____