

**Current Knowledge and Conservation Status of *Frasera gypsicola* Barneby (Gentianaceae),
the Sunnyside green gentian, in Nevada.**

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SUMMARY: *Frasera gypsicola* was first collected by Rupert Barneby and H. Dwight Ripley in the summer of 1941 near Sunnyside in Nye County, Nevada. The species was named and published by Rupert Barneby in 1942. Prior to 1994 *F. gypsicola* was known to occur in three sites in White River Valley in White Pine and Nye counties, and one site in Millard County, Utah. Because of its rarity in Nevada, it was classified as a category-2 candidate for listing under the Endangered Species Act, which requires that more information be obtained before a listing decision can be made. Field surveys were undertaken in Nevada during the summers of 1994 and 1995 to relocate historical populations, discover additional populations, and document the biology, ecology, and conservation status of the plant. This report summarizes the results of these surveys, reviews all previous knowledge of the species, and recommends conservation and recovery actions designed to prevent it from becoming a threatened or endangered species.

Field surveys in the summers of 1994 and 1995 yielded six new Nevada sites totaling about 33,300 plants covering about 180 acres. In Nevada, *Frasera gypsicola* is known from nine sites under federal, state and private management. A total of 69,800 plants on 793 acres has been documented. Potential habitat that has not been surveyed remains in White River Valley in Nevada and in Millard County, Utah. In Utah the species has not been relocated since Arthur Cronquist discovered the species in 1983 approximately 17 km north of Garrison in Millard County. The species occurs in the valley floor on white calcareous barrens, Rocky Mountain juniper, barberry, and rabbitbrush communities.

Listing *Frasera gypsicola* as threatened or endangered could be avoided by careful monitoring of known sites and minimizing impacts to known populations. The Sunnyside green gentian could possibly be removed from the candidate list by obtaining more information about the reproductive biology, and developing appropriate management plans and conservation agreements.

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I. CLASSIFICATION AND NOMENCLATURE

Scientific Name: *Frasera gypsicola* (Barneby 1942) D. Post

Original Publication: Barneby, R. C. 1942. An addition to the genus *Swertia*. *Leaflets of Western Botany* 3: 155-157.

Type Specimen: NEVADA, Nye County: locally abundant on gypsum flats in the valley of the White River near Sunnyside. Elev. 4950-5000 ft. *Ripley & Barneby* 4002 (holotype: CAS; isotypes: K, NY, POM).

Synonym(s): *Swertia gypsicola* Barneby (1942).

Vernacular Name(s): Sunnyside green gentian, Sunnyside elkweed.

Family: Gentianaceae (gentian family).

Major Groups:	Cronquist (1988)	Thorne (1992)
Class	Magnoliopsida (Dicotyledoneae)	Magnoliopsida (Angiospermae)
Subclass	Asteridae	Magnoliidae (Dicotyledoneae)
Superorder	---	Gentiananae
Order	Gentianales	Gentianales
Suborder	---	---

Review of Alternative Taxonomic Treatments: This species has been placed in both *Swertia* (Barneby 1942) and *Frasera* (Post 1958). According to Cronquist et al. (1984) more work needs to be conducted on all the species in the complex to determine the correct generic placement. He feels that *Frasera* in North America is distinguishable from the single species of *Swertia* found in North America (*Swertia perennis*) and probably comprises a natural, monophyletic group. No questions have been raised concerning the validity of *Frasera gypsicola*; there appear to be no taxonomic problems with the Sunnyside green gentian.

II. TAXON HISTORY

1941. *Frasera gypsicola* was first collected by Rupert Barneby and H. Dwight Ripley in the summer of 1941 near Sunnyside, Nevada.
1942. The species was initially described by Rupert Barneby (1942) in the genus *Swertia*. Placement in this genus was based on the monographic revision of the American species of *Swertia* by H. St. John (1941).
1958. A plant anatomy study by D. M. Post (1958) placed the species into *Frasera*.

1980. The only known population of *Frasera gypsicola* for several years was the type location near Sunnyside, Nevada (Harrison 1980).
1983. Arthur Cronquist discovered the species approximately 17 km north of Garrison in Millard County, Utah.
1984. Cronquist et al. (1984) treated the species as *Frasera* for *The Intermountain Flora*. In two recently published floras of California (*The Jepson Manual*, Hickman 1993) and Utah (*The Utah Flora*, Welsh et al. 1993) *Frasera* has been changed back into *Swertia*.
1985. Kathy Lindsey of the Ely District, Bureau of Land Management and Jerry Tiehm, a botanist from the New York Botanical Garden, found two new locations of the species in Nevada. One site, covering approximately 70 acres, is within 3 miles of the original location, and another population was found in the White River Swamp Cedar area, approximately 24 miles north of the Wayne Kirch Wildlife Management Area, where the first populations are located. This separate population is scattered over 478 acres.
1992. In July of 1992, Ron Kass, a private consultant, and Laurie Armstrong of the Richfield District, Bureau of Land Management searched for the species in Utah and were unable to relocate it.
1994. According to the updated synonymized checklist by John Kartesz (1994) *Frasera* is being used. For the purposes of this report, the species will be referred to as *Frasera gypsicola*.
- 1994-95. Six new sites were discovered in White River Valley in Nevada.

III. PRESENT LEGAL OR OTHER FORMAL STATUS

International: The Nature Conservancy (TNC) ranks sensitive taxa at state, national and global levels on a scale of 1 to 5, with 1 as the most vulnerable and 5 the most secure. *Frasera gypsicola* is ranked 1 by TNC at all levels (Morefield & Knight, 1992). Based on the findings of the field surveys for this report, the author concurs with this ranking.

Federal: *Frasera gypsicola* was until recently a category-2 candidate for listing as Endangered or Threatened under 16 U.S.C. 1531 *et seq.*, the Endangered Species Act as amended in 1988 (USDI Fish and Wildlife Service 1993, p. 51166).

State: *Frasera gypsicola* is listed by the State of Nevada as a Critically Endangered species under NRS 527.260-.300.

IV. DESCRIPTION

Non-technical: A pale green or whitish perennial with a short, wide root-crown from which arise many branches tightly pressed together. The leaves are always opposite, close together, and grass-like, 5 to 9 cm (2 to 3.6 in) long by 1.5 to 2.5 mm wide. The leaves form a depressed mound 1 to 2 dm (4 to 8 in) wide. The flowering stems have internodes 2 to 3 cm (0.8 to 1.2 in) long. The highest bracts of the inflorescence are ovate, minute, and membrane-margined. Flowers are four-parted on slender pedicels 2-12 mm long. The calyx teeth are 4 mm long and 1.5 to 2mm wide and membrane-margined. The

taper-pointed petals are 6 to 6.5 mm long by 2 mm wide, dull or shiny white, and freckled with indigo above the greenish linear-oblong gland on the lower half of the petal. The mature capsule is oblong and compressed, and 10 to 12 mm (0.4 to 0.5 in) long (Mozingo & Williams, 1980).

Technical: Perennial herb, 1-2 dm tall; **stems** usually many from a much-branched caudex, last year's stems remaining; **herbage** glabrous; **leaves** all linear, opposite, white-margined, short connate-sheathing, the basal leaves crowded, 3.5-8 cm long, erect, the upper 1.5-3.5 cm long, spreading to ascending, conduplicate; **inflorescence** a racemiform thyrses of opposite, 1- (3)-flowered cymes; calyx 3-4 mm long, broadly lanceolate, with white-scarious margins; **corolla** cream, flecked with dark spots, the lobes 5-8 mm long, lanceolate; **fovea** one on each and situated well above the base, small and circular, the rim with long white fimbriae all around; **crown** scales ca 2 mm long, lacerate; **stamens** ca 5 mm long, the anthers 1.4-1.7 mm long; **capsule** 10-12 mm long, oblong; **seeds** ca 5 mm long, elliptic, two to four, minutely tuberculate (Cronquist et. al., 1984)

Field Characters: *Frasera gypsicola* and *Frasera albomarginata* are found growing together, and can be easily distinguished in the field. The leaves of *F. gypsicola* are opposite, linear, 1-2.5 mm wide, and the inflorescence is a simple narrow thyrses. In *F. albomarginata* the leaves are in whorls of four, 5-8 mm wide and the inflorescence is a broad panicle 6 to 28 cm broad. *F. gypsicola* is a perennial with many stems from a much branched caudex, and *F. albomarginata* is a biennial with usually only one stem.

Frasera gypsicola may be separated from similar species by the following key:

- 1. Nectary pits 2 per corolla, leaves whorled, not white-margined*Frasera speciosa*
- 1' Nectary pits 1 per corolla, leaves opposite or whorled, white-margined
 - 2. Inflorescence a broad panicle, 5-30 cm broad
 - 3. Leaves in whorls of four, nectary pits two-lobed at apex.....*Frasera albomarginata*
 - 3' Leaves all opposite, nectary pits otherwise.....*Frasera paniculata*
 - 2' Inflorescence a simple, narrow thyrses, 1.5-2.5 cm broad
 - 4. Basal leaves narrowly oblanceolate 7-11 mm wide*Frasera pahutensis*
 - 4' Basal leaves linear 1.5-2.5 mm wide*Frasera gypsicola*

Photographs and Line Drawings: Photographs of the plant and habitats are found in Appendix 2, Figures 1-6. A line drawing (Mozingo & Williams 1980, p.146) is presented in Appendix 2, Figure 7. Another line drawing can be found in Cronquist et al. (1984, p.22).

V. SIGNIFICANCE OF TAXON

Natural: The species is found growing in extreme environmental conditions and has adapted to three unique habitats in the White River Valley: the white calcareous barrens; the saline bottom environment where it occurs in association with swamp cedar, a rare ecotype of Rocky Mountain juniper (*Juniperus scopulorum*); and Ruppel Boghole, an area of many springs where *Frasera gypsicola* is found in association with barberry (*Berberis fremontii*) and rabbitbrush (*Chrysothamnus nauseosus* or *Chrysothamnus* sp.) communities. In the white calcareous barrens the species is

withstanding heat in the summer, cold in the winter, long dry spells, and high incident light. At the Rocky Mountain juniper site the soils are periodically flooded and there are long periods of time in which water is standing. At the Ruppes Boghole site, the springs may be the major environmental factor influencing the occurrence of *Frasera gypsicola*. This species provides a unique opportunity to study the biology and ecology of a narrow endemic.

Human: No human uses are known for *Frasera gypsicola*. The species' ability to withstand extreme environmental conditions may make it attractive to horticulturists and nursery growers for use in rock gardens or xeric landscapes; the closely related native plant *Frasera speciosa* is commonly used in garden landscapes.

VI. GEOGRAPHIC DISTRIBUTION

Geographic Range: *Frasera gypsicola* is known from the White River Valley in Nye and White Pine counties, Nevada. In Utah, the species is known from Millard County. Figure 8, Appendix 2 shows the general distribution of the Sunnyside green gentian.

Precise Occurrences:

Historical site(s) rediscovered or recently known extant: Sites 3, 4, and 5 were rediscovered and resurveyed in 1994 for this report. These three sites consist of approximately 36,500 plants on about 615 acres. See Appendix I, Table 1: Sites 3, 4, and 5; Appendix 2, Figures 9,10.

New site(s) discovered: Sites 1, 2, 6, 7, 8, and 9 comprising about 33,300 plants on about 180 acres, were newly discovered and documented in 1994 and 1995 for this report. See Appendix I, Table 1: Sites 1, 2, and 6; Appendix 2, Figures 9,10.

Historical site(s) searched for but not rediscovered: None.

Other site(s) searched where not discovered: Sites A1-A34, comprising about 2,017 acres at an elevation between 4785 and 5845 feet, were surveyed for this report without encountering *Frasera gypsicola*. See Appendix I, Table 1: Sites A1-A34; Appendix 2, Figures 9-?.

Historical site(s) known or suspected to be erroneous reports: None.

Historical site(s) known or assumed extirpated: None.

Historical site(s) where present status unknown: The Utah population has not been relocated since Cronquist's discovery in 1983 (personal communication, Laurie Armstrong). There is probably more suitable habitat for *Frasera gypsicola* that has not been searched in the White River Valley east to the Utah border in White Pine and Nye counties, Nevada, and also in Millard County, Utah.

Potential site(s) meriting future field surveys: Areas in the vicinities of the known populations may yield new populations in White River Valley, Nevada. There may be a chance the species may be found in Lake Valley or Spring Valley in Nevada. The Soil Conservation Service in Elko, Nevada conducted a soil survey of the Rocky Mountain juniper community in Spring Valley and did not come across the Sunnyside green gentian.

Biogeography and Phylogeny: The genus *Frasera* is comprised of about 15 species which are known mostly from western North America (Cronquist et al. 1984). The locations of the nearest relatives to *Frasera gypsicola* are *Frasera pahutensis* in south-central Nevada and *Frasera albicaulis*, which occurs in northwest Nevada, southeast Oregon, and southwest Idaho. The phylogeny of *Frasera* is not well understood; *Frasera gypsicola* is probably a neoendemic that has evolved in relatively recent times to occupy harsh environments.

VII. HABITAT CHARACTERISTICS

Environment and Habitat Summary: (Appendix 2, Figures 3-6) In Nevada, *Frasera gypsicola* occurs on white calcareous barrens, in a saline bottom environment on the periphery and within an ecotype of Rocky Mountain juniper, and in association with a barberry community and a rabbitbrush community in an area of many springs. The elevations range from 5190 to 5500 feet. In Utah, the species was collected in a *Sarcobatus-Atriplex* community at an elevation of about 5610 feet. This population has not been relocated.

Physical Characteristics:

Physiography: The species occurs in the Great Basin Section of the Basin and Range physiographic province. The subdivision within the Great Basin Section is the Central Area which is characterized by valleys over 5000 feet in elevation (Hunt 1974).

The White River Valley is a remnant of a middle Pliocene to early Pleistocene Lake. The valley fill in White River Valley is between 1000 and 3000 feet (Smith 1976). Floristically, the species occurs in the Calcareous Mountains Section of the Great Basin Division (Holmgren 1972).

Climate: There are two weather stations in the White River Valley: the Lund Station and the Sunnyside Station. The following temperature and precipitation data were supplied by John James, State Climatologist for Nevada, based on climatic records from 1961 to 1990. At the Lund Station the annual mean temperature is 47.7°F and the annual average precipitation is 10.48 inches. In the winter the average minimum temperature is 13.2°F in January and the average maximum temperature in July is 88.7°F. At the Sunnyside Station the annual mean temperature is 49.7°F and the annual average precipitation is 9.58 inches. In the winter the average minimum temperature is 14.2°F in January and the average maximum temperature in July is 91.2°F.

Temperature and precipitation vary year to year. In 1994, the temperatures appeared higher with less precipitation than normal. Population fluctuations of the Sunnyside green gentian are probably related to fluctuations in the temperature and the amount of precipitation.

Geology: The species occurs in the Great Basin Section of the Basin and Range physiographic province. The subdivision within the Great Basin Section is the Central Area, which is characterized by having valleys that are over 5000 feet in elevation (Hunt 1974).

The White River Valley is a remnant of a middle Pliocene to early Pleistocene Lake. The valley fill in White River Valley is between 1000 to 3000 feet (Smith 1976). Floristically, the species occurs in the Calcareous Mountains Section of the Great Basin Division (Holmgren 1972).

Soils: Rupert Barneby and H. Dwight Ripley reported the soils to be gypsum when they first collected *Frasera gypsicola* in the Sunnyside area. According to John Fisher of the Soil Conservation Service, gypsum soils have not been documented in the area but there could be a low amount of gypsum in the soil.

Harrison (1980) collected soil samples from three known areas of *Frasera gypsicola* and collected soil from three similar sites where the plant does not grow to have them analyzed at Brigham Young University Soils Laboratory (Appendix I, Table 3). Upon comparison, he said there appeared to be no statistically significant difference in soil characteristics among the samples, although concentrations of constituent ions/elements (especially sulfur, phosphorus, magnesium, sodium) appear generally higher in the samples from *F. gypsicola* sites. All of these soil samples were taken from the Sunnyside area.

Four soil samples were collected in 1994 at known sites of *Frasera gypsicola* and tested at Utah State University Analytical Laboratories. A sample was collected from the surface down to approximately 10 inches in depth. The soil texture was not determined because the soil kept breaking down. The individual who conducted the tests resolved that most of the samples had less than 5 percent sand and consisted mostly of clay. He indicated he believes the soil may be a weathered shale; in the field the soil feels like a sand, but soil tests indicate there is a low percentage of sand.

The following is the result of the 1994 soil tests. The electrical conductivity is measured in mmhos/cm.

Site	%>2mm Rock	pH	ECe	%CaCO ₃
3	25.8	7.4	1.5	73.4
4	1.2	7.4	0.5	--
5	3.0	8.0	4.6	22.2
5	2.6	8.9	3.5	21.9

It is interesting to note that the soil is very high in lime at Site 3 (Sunnyside area, type location) compared to Site 5 (White River Swamp Cedar). In light of the wide variation, soil composition is probably not the main determining factor for where the species will grow.

Hydrology: The White River Valley exhibits exterior drainage, which is southward to the Colorado via the Muddy River. A number of thermal springs are found in the valley.

Geomorphology: Sites 1, 2, 3, 4, 7, 8, and 9 occur on stream terraces in the valley. Site 5 is positioned on a floodplain where there is a water table near the surface for short periods of time in the early spring. Site 6 occurs on the base of the valley slope where there are numerous springs.

Aspect and slope: Plants are growing in mostly open sites which have a flat to gentle slope. Aspect does not appear to be a primary habitat factor for *Frasera gypsicola*.

Biological Characteristics:

Community physiognomy: In the white calcareous barrens the plant composition is composed of a mixture of mound forming shrubs and herbs, and the barrens are surrounded by larger shrubs. The total plant cover ranges from 10 to 20 percent. Most of the plants are less than 3 dm in height (Appendix 2, Figure 3).

The Rocky Mountain juniper site is composed of scattered juniper with a shrub and herbaceous layer. The tree cover ranges from 1 to 3 percent. The shrub component comprises approximately 10 to 15 percent cover. The herbaceous layer, which is dominated by grass species, provides about 5 to 10 percent cover (Appendix 2, Figure 4).

At Site 6, the barberry community is composed of a shrub and herbaceous layer. The shrub cover is between 20 to 30 percent, and the herbaceous cover ranges from 5 to 10 percent. At the same site, the rabbitbrush community consists of a shrub layer ranging from 5 to 20 percent and a herbaceous layer providing typically five to 10 percent cover. In some areas of Site 6, the herbaceous cover is dominated by a grass layer ranging from 25 to 30 percent cover (Appendix 2, Figures 5 and 6).

Vegetation type: The species occurs on the white calcareous barrens in a desert shrub community at Sites 1, 2, 3, 4, 7, 8, and 9. At Site 5, the plants occur in association with scattered swamp cedar, a rare ecotype of Rocky Mountain juniper. *Frasera gypsicola* is found in association with a rabbitbrush community and a barberry community at Site 6.

Associated species: Appendix I, Table 2 provides a list of plant species observed at known sites of the Sunnyside green gentian. The most common shrubs include *Artemisia pygmaea*, *Artemisia tridentata*, *Chrysothamnus* sp. and *Sarcobatus vermiculatus*. Common grasses include *Elymus cinereus*, *Elymus elymoides*, *Sporobolus airoides*, and *Stipa hymenoides*. Some common forbs include *Comandra umbellata*, *Eriogonum shockleyi*, *Frasera*

albomarginata, *Hymenopappus filifolius*, *Lepidium nanum*, *Phlox tumulosa*, and *Physaria* sp..

Other endangered, threatened, and sensitive species: *Cryptantha welshii* is found with *Frasera gypsicola* at Sites 3, 4, and 5. *Phacelia parishii*, another C-2 candidate, occurs in the Sunnyside area of the White River Valley. *P. parishii* was not encountered during the 1994 field survey. For the names and status of other sensitive species occurring with or near *Frasera gypsicola*, contact the Nevada Natural Heritage Program.

Land Management: In Nevada *Frasera gypsicola* occurs on private, state, and BLM lands. Sites 1, 2, and 3 are on lands co-administered by both the state and the Bureau of Land Management (BLM). The state land is part of the Wayne Kirsch Wildlife Management Area. Site 4 is on private, state, and BLM lands. This site consists of nine distinct areas. Four areas are solely on federal land, two areas are on unfenced private land, two areas consist of public and private land, and the last area consists of state and private land (Lindsey 1985). The White River Swamp Cedar site and sites 7, 8, and 9 are located entirely on public land administered by the BLM. The Ruppess Boghole site is on private and BLM land.

The BLM manages its lands under the multiple use concept. The Ely District Office of the BLM is responsible for rare plants which occur on lands within their jurisdiction. The Wayne Kirch Wildlife Management Area is managed for waterfowl and fisheries. The Nevada Division of Forestry is responsible for rare plants on all state lands, which include the Wayne Kirch Wildlife Management Area. The private land is managed mainly for livestock use.

VIII. BIOLOGY

Population Summary: In Nevada, *Frasera gypsicola* is known from the White River Valley in Nye and White Pine counties. Seven of the populations with a total of over 33,300 plants occur on the white calcareous barrens in Nye County. The two populations in White Pine County occur in a Rocky Mountain juniper community in a saline bottom site and in an area of many springs in conjunction with a barberry community and a rabbitbrush community. Approximately 1500 plants were found at the Rocky Mountain juniper site and about 10,000 plants were found at the Ruppess Boghole spring site. Six populations were documented during the 1994 and 1995 surveys: Sites 1, 2, 6, 7, 8, and 9 and a portion of Site 4 were newly discovered. Potential habitat remains to be searched in White River Valley, Nevada, and in Millard County, Utah.

Demography: When *Frasera gypsicola* was first collected by Rupert Barneby and H. Dwight Ripley in July of 1941 they reported the species as locally abundant (Barneby 1942). Over 30 years later Jim Reveal visited the same site and observed that the population was not abundant. Furthermore, he felt the plants had not flowered that year (Pinzl 1978). Bertrand Harrison and Kaye Thorne (1979) surveyed the same area and found about 5000 plants. A visit by Kaye Thorne et al. (1980) documented 200+ plants in a 1600 square meter area. At the Swamp Cedar site Teri Knight (1986) located approximately 500 plants.

During the 1994 and 1995 field seasons the total number of individual plants of *Frasera gypsicola* found was approximately 69,800. The species is restricted to nine sites covering an area of about 793 acres. The following is a general demographic summary of each occurrence.

Site 1: This site in the Sunnyside area occupies approximately one acre. There were about 100 individual plants. On May 11, 1994, the plants were 100 percent vegetative. All plants appeared to be fully mature.

Site 2: This site of approximately two acres in the Sunnyside area consists of about 200 individual plants. On May 11, 1994, 100 percent of the plants were in a vegetative state. The age classes appeared to be 90 percent mature plants and 10 percent immature.

Site 3: This site in the Sunnyside area covers about 67 acres. Individual plants numbered about 15,000. On June 3, 1994, 40 percent of the plants were vegetative and 60 percent of the plants were budding. The age classes appeared to be about 85 percent mature, 10 percent first year, and 5 percent seedling.

Site 4: This Sunnyside site is the most extensive in the number of individual plants (20,000). Plants at this site occurred on approximately 70 acres and appeared to be about 65 percent vegetative, 30 percent budding, and 5 percent flowering in early June 1994. The age classes seemed to be 90 percent mature, 5 percent first year, and 5 percent seedling.

Site 5: At this site in the White River Swamp Cedar area about 1500 individual plants were dispersed over an area covering approximately 478 acres. In early June 1994, 70 percent of the plants were vegetative and 30 percent were budding. The age classes appeared to be 90 percent mature and 10 percent seedling.

Site 6: At the Ruppess Boghole site about 10,000 plants were found within 112 acres. During the mid-September 1994 survey, it appeared that about 50 percent of the plants had been chewed on by cattle. Approximately 95 percent of the plants were mature and 5 percent were immature.

Site 7: At the White River Valley site about 8,000 plants were found within 17 acres. During early September 1995 survey, approximately 95 percent of the plants were mature and 5 percent were immature.

Site 8: At the White River Valley site about 9,000 plants were found within 24 acres. During the early September 1995 survey, some plants had been chewed on by cattle. Approximately 95 percent of the plants were mature and 5 percent were immature.

Site 9: At the White River Valley site about 6,000 plants were found within 24 acres. During the early September 1995 survey, approximately 95 percent of the plants were mature and 5 percent were immature.

Phenology: In 1994 a few plants (less than 5 percent) were flowering as early as the first week of June. By the end of June most plants were in full flower, and some even in early fruit. Plants were most likely in full fruit by mid-July. This early flowering was probably influenced by the dry conditions this year. In 1978 Margaret Williams and Ann Pinzl reported plants of *Frasera gypsicola* were just beginning to bloom on June 27, 1978 at Site 3. Flowering generally occurs in June and July and fruits develop in July and August.

Reproduction and Dispersal: There has been no study of the reproductive biology of the species. It is assumed the species reproduces sexually. But plants do appear to grow in clones, which may indicate some asexual reproduction. Seed dispersal is most likely by wind or rain. Some plants are found growing in drainages which would support the role of rain in seed dispersal.

Insects that were collected on the flowers of *Frasera gypsicola* in mid-June of 1994 and that may play a role in pollination of the species include a number of unidentified insects in the families of *Braconidae*, *Tachinidae*, *Coenagrionidae*, and *Conopidae*. Identified insects include *Glenostictia megacera*, *Lasioglossum (Dialictus) sp.*, *Ammophila sp.*, and *Anthophora urbana*. The insects were identified by Wilford Hansen, Utah State University, and Terry Griswold, USDA, Bee Biology and Systematics, Utah State University.

Hybridization: None known.

Pathology: None known.

Predation: At Sites 6 and 9 plants had been chewed by cattle.

Competition: Overgrowth of large shrubs and/or dense vegetation cover may create intense competition for scarce resources, which could be detrimental to the continuing existence of the Sunnyside green gentian.

Other Interactions: None known.

IX. EVIDENCE OF THREATS TO SURVIVAL

Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range: At Site 1, the population is adjacent to a well-used dirt road on lands co-administered by the state and the BLM. If the road is widened, it will have a significant impact. No apparent threat was evident at Site 2. At Site 3, on the south side between the fence and the road, some disturbance from cattle was visible but it did not appear to be having a significant impact on the species or its habitat. Seismic exploration has been a threat to the plants at Site 4, but seismic companies have avoided sensitive areas in the past (Lindsey 1985). At Site 5 the main threat is the unauthorized cutting of juniper trees (Lindsey 1985). No recent cutting of junipers was observed during the 1994 survey. Cattle and horses occur in this area, but did not appear to be having an adverse effect on the species. At the Ruppes Boghole site (Site 6) cattle were observed grazing and trampling on the Sunnyside green gentian, which could possibly have an effect on the reproductive process of the species. At Site 9

plants were chewed and it appears cattle may have been feeding on the species. Possible impacts to the species in Nevada are potential land developments, seismic exploration, and livestock grazing and/or trampling. Off-road vehicle use, either for recreation, seismic activity, or agricultural use, could have a negative impact at all the sites.

Over-utilization for Commercial, Recreational, Scientific, or Educational Purposes: None known.

Disease or Predation: No sign of disease or predation was observed except at Sites 6 and 9, where plants had been chewed on by cattle.

Inadequacy of Existing Regulatory Mechanisms: No enforceable protective designations, conservation agreements, or approved management plans are known to exist for *Frasera gypsicola* or its habitat. Unless it is listed as Endangered or Threatened (50 CFR 17.61, 17.71) and occurs within federal jurisdiction, a plant has no formal protection under the federal Endangered Species Act (ESA), except for regulatory determinations by some federal land management agencies (Forest Service, BLM) that candidate species will be managed as if they were listed. No federal protection currently extends to plants under non-federal jurisdiction unless they are listed as Endangered and removing, cutting, digging up, damaging, or destroying them would be "*in knowing violation of any law or regulation of any state or . . . of a state criminal trespass law*" [ESA Sect. 9(a)2(B)], and unless that law extended to non-federal jurisdictions. It should also be noted that the Endangered Species Act, and federal regulations and policies implementing it, are in direct conflict with provisions of the 1872 mining law, and are therefore of uncertain protective value when mineral-related projects are involved.

Frasera gypsicola is listed as "Critically Endangered" under Nevada Revised Statute (NRS) 527.270. Such listing provides that ". . .no member of its kind may be removed or destroyed at any time by any means except under special permit issued by the state forester firewarden" on any lands in Nevada. The adequacy of this law, however, depends on informed and cooperative landowners, or on some form of deterrent enforcement. Such enforcement does not now exist. It also depends on the state forester firewarden's discretion in issuing or withholding permits, and in placing protective conditions on permits that are issued. To date, very few requests for such permits are known to have been denied. Nevada law does not require the continued survival of any plant species which it declares to be in danger of extinction.

USDI Bureau of Land Management policy provides that the agency "*shall carry out management, consistent with the principles of multiple use, for the conservation of candidate species and their habitats and shall ensure that actions authorized, funded, or carried out do not contribute to the need to list any of these species as Threatened or Endangered.*" If *Frasera gypsicola* occurred entirely on federal lands, BLM policy would further require that the candidate species be included as a priority species in land use plans, and that range-wide or site-specific management plans be prepared "*that identify specific habitat and population management objectives designed for recovery, as well as the management strategies necessary to meet those objectives*" (BLM Manual Section 6840).

Other Natural or Man-made Factors: Due to the limited distribution of *Frasera gypsicola*, the species may be vulnerable to climatic changes or extremes of heat, cold, or drought. Overgrowth of large shrubs and/or dense vegetation cover may create intense competition for scarce resources which could be detrimental to the continuing existence of the Sunnyside green gentian.

X. GENERAL ASSESSMENT AND RECOMMENDATIONS

General Assessment: *Frasera gypsicola* is known from only nine populations in Nevada, all in Nye and White Pine counties. These populations are found in the White River Valley: the Sunnyside area with five populations consisting of 43,300 plants; north of Sunnyside with two populations consisting of 15,000 plants; the Swamp Cedar area southwest of Lund with one population of about 1500 plants; and the Ruppes Boghole area south of Lund with approximately 10,000 plants. The total number of individual plants is approximately 69,800. The total acreage of all six sites is about 793. Although *F. gypsicola* was discovered by Arthur Cronquist in 1983 in Millard County, Utah, all attempts to relocate the plant in Utah have been unsuccessful. It is not known how many plants were observed in 1983.

On general observation, cattle do not appear to be having an impact on the species with the exception of Site 6 and 9, although a study specifically looking at cattle impacts may show otherwise. No other direct impacts or threats to the species were evident, although in the past there has been seismic exploration in the Sunnyside area. The main threats to the species may be livestock grazing and trampling, natural environmental fluctuations and land developments in the area.

Status Recommendations: *Frasera gypsicola* is now classified as a category-2 candidate for listing by the U.S. Fish and Wildlife Service, is listed as Critically Endangered by the State of Nevada, is considered critically imperiled by The Nature Conservancy, and is recommended on the Watch List (potentially vulnerable taxa in need of monitoring or further data to determine status) by the Northern Nevada Native Plant Society. Based on this survey, the author recommends that the federal status be retained as a category-2 candidate. Additionally, the BLM lands and state lands in the Sunnyside area and the BLM land in the White River Swamp Cedar and the Ruppes Boghole area should be designated as Areas of Critical Environmental Concern (ACEC). Neil McCleery (1980) of the Bureau of Land Management wrote a letter to the Nevada Division of Wildlife and proposed that an ACEC be designated in the Sunnyside area for the protection of *Frasera gypsicola* and six other sensitive species. In 1985 Kathy Lindsey recommended the public land in the Sunnyside area and the White River Swamp Cedar sites be designated as ACEC, but no designation has yet been made. The author recommends a conservation agreement between the BLM, U.S. Fish and Wildlife Service, and the Nevada Division of Wildlife to protect the species in the Sunnyside area. If no protection measures are taken, then it is recommended that the species be listed as a federally threatened species.

Critical Habitat Recommendations: If critical habitat were ever designated through the provisions of the Endangered Species Act, it should include all of sites 3, 4, 5, 6, 7, 8, and 9 (see Appendix 2, Figures 9-?). It is recommended that this critical habitat not be formally designated if it would subject *Frasera gypsicola* to increased threats to its survival.

Conservation and Recovery Recommendations:

1. A formal conservation agreement should be made between the Bureau of Land Management and the Nevada Division of Wildlife as well as other interested parties such as The Nature Conservancy, U.S. Fish and Wildlife Service, and the Northern Nevada Native Plant Society to ensure no further destruction of the species and its habitat.
2. All nine Nevada populations should be evaluated on an annual basis to monitor impacts or disturbances to the species.
3. A monitoring effort should be established to study the biology and ecology of the species at the Sunnyside site, the White River Swamp Cedar site, and the Ruppes Boghole site. Some suggested areas of study include soil requirements, seed production, age structure, genetic diversity, spatial distribution, seed dispersal, seed bank composition, plant community structure, and seed viability. Permanent plots should be established at the sites of study.
4. The effects of livestock grazing and/or trampling on *Frasera gypsicola* should be studied and any negative impacts minimized or eliminated.
5. A study should be undertaken to determine the nature and role of pollinators in the reproductive success of the species.
6. Efforts to inventory potential unsearched habitat for new populations of *Frasera gypsicola* should continue.
7. A phylogenetic study should be conducted to determine the relationship between *Frasera gypsicola* and other related species such as *Frasera pahutensis*.

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Quinn Canyon Range, Nevada (1978), BLM 1:100,000 Planimetric Series, Surface-Minerals Management Status.

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Sunnyside, Nevada (1969, photoinspected 1980) U.S.G.S. 1:24,000 Topographic Series.

Field Research: 10 May-12 May 1994, 30 May-3 June 1994, 6 June-10 June 1994, 20 June-23 June 1994, 14 September-15 September 1994, 16 May 1995, 14 June-17 June 1995, 4 September-7 September 1995.

Specimens:

Site Number and Name	Collector & Number	Date	Disposition
3. Sunnyside road north	<i>Ripley & Barneby 4002</i>	20 Jul 1941	K,NY,POM,RSA,UC +
	<i>Holmgren & Holmgren 8977</i>	18 Jun 1978	BRY, NY, RENO
	<i>Pinzl & Williams 1917</i>	27 Jun 1978	NSMC
	<i>Williams & Pinzl 78-106-2</i>	27 Jun 1978	RENO, UNLV
	<i>Harrison & Thorne 13180</i>	13 Jun 1979	BRY, RENO
	<i>Welsh & Thorne 389</i>	30 Jun 1980	BRY, RENO
4. Sunnyside Creek north	<i>Tiehm & Lindsey</i>	Jun 1985	NY, RENO
5. White River swamp cedars	<i>Tiehm & Lindsey 9773</i>	25 Jun 1985	NSMC
	<i>Knight & Elliott-Fisk 1538</i>	17 Aug 1986	NSMC

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Table 1. Actual and potential sites searched for *Frasera gypsicola* in east-central Nevada.

Site#	NV EO	Fig	Site Name, Map Quadrangle (yr), Legal Description	Est. Acres	Elevation Range (ft)	Est. Plants	Land Man- agement*
<u>SITES WHERE FRASERA GYPSICOLA IS PRESENT</u>							
1	004	9	Sunnyside road south, Sunnyside Quad, Nye Co., T7N R61E 36 SE of SW	1	5205	100	es
2	005	9	Adams-McGill Reservoir NE, Sunnyside Quad Nye Co., T6N R61E S1 NW of NW	2	5190	200	es
3	001	9	Sunnyside road north, Sunnyside Quad Nye Co., 7N R61E S36	67	5190-5215	15,000	es
4	002	10	Sunnyside Creek north, Sunnyside Quad Nye Co., 7N R62E S20SW; S19 SE; S30N½	70	5200-5215	20,000	eps
5	003	4,6, 10	White River swamp cedars, Lund Quad White Pine Co., T11N R61E S28/33/34	478	5395-5420	1,500	e
6	006	5,10	Rupes Boghole, Lund & Moorman Spring NE Quad White Pine Co., T10N R62E S6/7	112	5440-5500	10,000	ep
7	007	17	Sunnyside Creek west, Sunnyside Quad Nye Co., T7N R61E S26	20	5200-5220	8,000	e
8	008	17, 20	Moorman Spring SE, Moorman Spring SE Quad Nye Co., T8N R61E S2/11	19	5270-5280	9,000	e
9	009	18	Emigrant Springs SW, Moorman Spring SE Quad Nye Co., T9N R61E S25/26/35	24	5285-5305	6,000	e
9sites	---SUBTOTALS---			793	5190-5500	69,800	eps
<u>SITES SEARCHED WHERE NO FRASERA GYPSICOLA WAS FOUND</u>							
A1		9	White River Valley, Sunnyside Quad Nye Co., T7N R61E S36 NW/S25 SW	75	5180-5210		es
A2		9	White River Valley, Sunnyside Quad Nye Co., T6N R61E S1 NW	38	5190-5205		es
A3		9	White River Valley, Sunnyside Quad Nye Co., T6N R61E S2 SE	25	5190-5210		e
A4		9	White River Valley, Sunnyside Quad Nye Co., T6N R61E S11	33	5190-5210		es
A5		10	White River Valley, Gap Mountain Quad Nye Co., T6N R61E S22 NE	37	5180-5190		es
A6		11	White River Valley, Hot Creek Butte Quad Nye Co., T6N R61E S30 SE of NW	16	5250-5270		e
A7		11	White River Valley, Hot Creek Butte Quad Nye Co., T6N R61E S31	112	5150-5210		es
A8		11	White River Valley, Hot Creek Butte Quad Nye Co., T6N R61E S16 SW SW/S17 SE SE	19	5200-5210		s
A9		12	White River Valley, Sunnyside Quad Nye Co., T7N R62E S5/6	20	5265-5275		e

(continued)

Site#	NV EO	Fig	Site Name, Map Quadrangle (yr), Legal Description	Est. Acres	Elevation Range (ft)	Est. Plants	Land Man- agement*
A10		12	White River Valley, Sunnyside Quad Nye Co., T7N R62E S6 NE SW	13	5250-5260		e
A11		12	White River Valley, Sunnyside Quad Nye Co., T7N R61E S1 NW of SW/NW of SE	13	5230-5240		e
A12		12	White River Valley, Sunnyside Quad Nye Co., T7N R61E S3 SW of SE	8	5230-5250		e
A13		12	White River Valley, Moorman Spring SE Quad Nye Co., T8N R61E S25 SE	33	5255-5265		e
A14		12	White River Valley, Moorman Spring SE Quad Nye Co., T8N R62E S5 NW	40	5440-5470		e
A15		12	White River Valley, Moorman Spring SE Quad Nye Co., T9N R61E S33 NE	43	5295-5300		e
A16		13	Lake Valley, Pioche Quad Lincoln Co., T2N R67E S27	41	5515-5530		e
A17		13	White River Valley, Sunnyside Quad Nye Co., T7N R62E S16/17	30	5250-5280		e
A18		13	Railroad Valley, Blue Eagle Springs NE Quad Nye Co., T9N R57E S3 or 4	146	4820-4835		e
A19		13	Railroad Valley, Blue Eagle Springs NE Quad Nye Co., T9N R57E S9	103	4785-4795		e
A20		14	White River Valley, Moorman Spring Quad Nye Co., T9N R61E S17	84	5260-5270		e
A21		14	Spring Valley, Hogum Quad White Pine Co., T14N R67E Sec 21	114	5718-5720		e
A22		15	Spring Valley, South Bastian Spring Quad White Pine Co., T15N R67E S28/29/33	153	5660-5670		e
A23		15	The Cedars, Baking Powder Flat Quad White Pine Co., T12 R67E S2	51	5745-5845		e
A24		16	White River Valley, Moorman Spring Quad Nye Co., T9N R61E S32 SE	86	5280-5300		e
A25		16	White River Valley, Moorman Spring Quad Nye Co., T9N R61E S30/31	223	5295-5315		e
A26		17	White River Valley, Sunnyside Quad Nye Co., T7N R61E S15/22/23	13	5190-5230		e
A27		17	White River Valley, Sunnyside Quad Nye Co., T7N R61E S23/24/25/26	61	5190-5225		e
A28		18	White River Valley, Lund Quad Nye Co., T11N R62E S29/30	19	5430-5455		ep
A29		19	White River Valley, Moorman Spring NE Quad Nye Co., T10N R61E S23	31	5355		e

(continued)

Site#	NV EO Fig	Site Name, Map Quadrangle (yr), Legal Description	Est. Acres	Elevation Range (ft)	Est. Plants	Land Management*
A30	19	White River Valley, Moorman Spring SE Quad Nye Co., T8N R61E S27/34	31	5230-5260		e
A31	17, 20	White River Valley, Moorman Spring SE Quad Nye Co., T8N R61E S1/11/12	36	5250-5280		e
A32	20	Spring Valley, South Bastian Spring Quad White Pine Co., T16N R67E S33/34	172	5600-5610		e
A33	21	Spring Valley, Third Butte West Quad White Pine Co., T18N R67E S10/15	63	5557-5570		e
A34	21	Spring Valley, Third Butte West Quad White Pine Co., T18N R67E S7/8	35	5565-5575		e
34 sites		--- SUBTOTALS ---	2,017	4785-5845		es
43 sites		--- TOTAL SITES EXAMINED ---	2,810	4785-5845	69,800	eps

* Land Management: e = Ely district, BLM; p = private; s = state

Table 2. Plant species observed at known sites of *Frasera gypsicola*

Life Form Taxon	SITE NUMBERS FROM TABLE 1									
	Average Elevation (ft):	5205	5190	5208	5205	5408	5470	5210	5275	5295
	Sites:	1	2	3	4	5	6	7	8	9
Trees:										
<i>Juniperus scopulorum</i>						+				
Shrubs:										
<i>Artemisia pygmaea</i>		+	+	+	+			+	+	+
<i>Artemisia nova</i>			+							+
<i>Artemisia spinescens</i>								+		
<i>Artemisia tridentata</i>				+	+	+	+	+	+	
<i>Atriplex confertifolia</i>				+		+	+			
<i>Berberis fremontii</i>							+			
<i>Chrysothamnus albidus</i>						+				
<i>Chrysothamnus nauseosus</i>				+		+	+			
<i>Chrysothamnus parryi</i>				+				+	+	+
<i>Chrysothamnus sp.</i>		+		+		+	+	+		
<i>Ephedra nevadensis</i>			+					+	+	
<i>Eriogonum microthecum</i>								+	+	+
<i>Gutierrezia sarothrae</i>		+								
<i>Rhus trilobata</i>							+			
<i>Sarcobatus vermiculatus</i>			+			+	+			

(continued)

SITE NUMBERS FROM TABLE 1										
Life Form	Average Elevation (ft):									
Taxon	5205	5190	5208	5205	5408	5470	5210	5275	5295	
	Sites: 1	2	3	4	5	6	7	8	9	
<u>Shrubs (continued):</u>										
<i>Tetradymia canescens</i>			+		+	+	+	+		
<u>Succulents:</u> None										
<u>Graminoids:</u>										
<i>Aristida purpurea</i>								+		
<i>Distichlis spicata</i>						+				
<i>Elymus cinereus</i>						+	+			
<i>Elymus elymoides</i>			+	+				+	+	
<i>Hilaria jamesii</i>								+		
<i>Juncus balticus</i>						+	+			
<i>Spartina gracilis</i>						+				
<i>Sporobolus airoides</i>						+	+			
<i>Stipa comata</i>								+		
<i>Stipa hymenoides</i>	+							+	+	+
<u>Forbs:</u>										
<i>Abronia nana</i>				+						
<i>Allenrolfea occidentalis</i>						+				
<i>Asclepias cryptoceras</i>								+		
<i>Astragalus calycosus</i>								+		
<i>Astragalus toanus</i>						+	+			
<i>Chaenactis douglasii</i>				+				+		
<i>Comandra umbellata</i>	+		+	+						+
<i>Cordylanthus ramosus</i>								+	+	+
<i>Cryptantha flavoculata</i>		+								
<i>Cryptantha welshii</i>			+	+	+			+	+	+
<i>Enceliopsis nudicaulis</i>				+				+	+	+
<i>Erigeron compactus</i>		+						+	+	+
<i>Eriogonum ovalifolium</i>								+		
<i>Eriogonum shockleyi</i>			+	+	+	+	+	+	+	+
<i>Euphorbia sp.</i>			+					+	+	
<i>Frasera albomarginata</i>			+							
<i>Gilia sp.</i>								+		+
<i>Gilia congesta</i>							+			
<i>Halogeton glomeratus</i>							+			
<i>Hymenopappus filifolius</i>	+		+	+				+	+	+
<i>Iva axillaris</i>							+			
<i>Kochia americana</i>						+				
<i>Lepidium nanum</i>	+	+	+	+						+
<i>Leptodactylon caespitosum</i>				+					+	
<i>Leucelene ericoides</i>			+					+	+	+

(continued)

SITE NUMBERS FROM TABLE 1										
Life Form	Average Elevation (ft):	5205	5190	5208	5205	5408	5470	5210	5275	5295
Taxon	Sites:	1	2	3	4	5	6	7	8	9
Forbs (continued):										
<i>Linum perenne</i>								+		+
<i>Machaeranthera canescens</i>				+			+			
<i>Machaeranthera grindelioides</i>					+					
<i>Mentzelia</i> sp.				+						+
<i>Oenothera caespitosa</i>					+					
<i>Penstemon immanifestus</i>				+	+			+	+	
<i>Penstemon thompsoniae</i>			+							
<i>Phlox tumulosa</i>	+		+	+	+			+	+	+
<i>Physaria chambersii</i>	+	+	+	+	+			+	+	+
<i>Salsola</i> sp.							+			
<i>Stanleya pinnata</i>				+	+				+	
<i>Stephanomeria spinosa</i>			+	+			+		+	+
<i>Townsendia jonesii</i>			+	+				+	+	

Table 3. Characteristics of soils that support *Frasera gypsicola* and nearby soils that do not. *

LOCATION	pH	ppm SO ₄	ppm Cl	ppm P	ppm Ca	ppm Mg	ppm K	ppm Na	ECx10 ³
<i>Frasera</i> Site 1	7.4	---	---	6.2	---	---	371	---	2.2
<i>Frasera</i> Site 2	8.6	1459	10.4	7.1	6650	2640	414	200	0.63
<i>Frasera</i> Site 3	8.4	1326	10.8	1.5	4875	375	434	180	0.90
6 miles N of Hot Creek Camp	---	---	---	3.6	---	---	318	---	0.57
3 miles NW of Hot Creek Camp	7.9	1042	10.2	4.2	7275	389	437	71	0.52
0.5 miles NW of Hot Creek Camp	7.9	947	8.6	3.2	7400	306	189	54	0.45

LOCATION	% Sand	% Silt	% Clay	Soil Type
<i>Frasera</i> Site 1	57.4	21.1	21.5	Sandy clay loam
<i>Frasera</i> Site 2	36.6	28.0	35.4	Clay loam
<i>Frasera</i> Site 3	58.0	17.6	24.4	Sandy clay loam
6 miles N of Hot Creek Camp	42.4	23.6	34.0	Clay loam
3 miles NW of Hot Creek Camp	43.6	18.0	38.4	Clay loam
0.5 miles NW of Hot Creek Camp	34.0	21.6	44.4	Clay

* Values are in parts per million