

***Lesquerella fremontii* Rollins & Shaw
(Fremont's bladderpod):
A Technical Conservation Assessment**



**Prepared for the USDA Forest Service,
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Species Conservation Project**

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COVER PHOTO CREDIT

Lesquerella fremontii (Fremont's bladderpod). Photograph by Stephanie Mills. Used with her permission.

SUMMARY OF KEY COMPONENTS FOR CONSERVATION OF *LESQUERELLA FREMONTII*

Status

Lesquerella fremontii (Fremont's bladderpod) is endemic to the east slope of the Wind River Range and Sweetwater Plateau of Fremont County, Wyoming. It is designated a sensitive species by the Rocky Mountain Region of the USDA Forest Service. The NatureServe Global rank for this species is G2, imperiled throughout its range. It is ranked S2, imperiled in Wyoming, by the Wyoming Natural Diversity Database. Half of all of the precisely-located occurrences (four of eight) are on the Shoshone National Forest in part or in full. This tally includes the largest known population, which has a total population number that greatly exceeds all the other known populations combined.

Primary Threats

Lesquerella fremontii is found on calcareous substrates of sparsely vegetated slopes and ridges in a limited geographic area. Its limited distribution compounds the effects of direct threats, which include road construction, quarrying, and off-road vehicle use. Oil and gas development, grazing, trampling, and weed competition are also identified as potential threats. Field surveys conducted at the largest of the eight extant *L. fremontii* occurrences in 1994 that generally documented much greater extent and numbers than previously known, failed to relocate two low elevation populations on BLM lands that were subject to drought conditions at the time. The effects of a large wildfire that burned through a portion of the largest population in 2002 are unknown. There is no evidence of extirpation, except in a small portion of a population that was removed as part of highway construction.

Primary Conservation Elements, Management Implications and Considerations

Lesquerella fremontii is a local endemic restricted to the east side of the Wind River Range and continuous Beaver Rim of the Sweetwater Basin in Fremont County, Wyoming. It is found on sparsely-vegetated slopes of bunchgrasses, cushion plants, *Artemisia tripartita* (threetip sagebrush), and scattered *Pinus flexilis* (limber pine). One of the eight extant populations is protected in the Fitzpatrick Wilderness Area on the Shoshone National Forest. Two more populations are protected on Areas of Critical Environmental Concern (ACECs) administered by the Bureau of Land Management. However, the population in the Beaver Rim ACEC could not be relocated during 1994 drought conditions, and the Red Canyon ACEC harbors only six of 27 subpopulations. The Red Canyon ACEC subpopulations are part of the Limestone Mountain population complex that has greater numbers of *L. fremontii* plants than all other populations combined, some of which extend onto Shoshone National Forest and which burned in a large wildfire in 2002. There is no available information on population trends or species' life history. Maintaining the population viability of *L. fremontii* begins with maintaining its habitat. Most populations are on accessible multiple-use lands and are potentially vulnerable to habitat loss and degradation.

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INTRODUCTION

This assessment is one of many being produced to support the Species Conservation Project of the Rocky Mountain Region (Region 2) of the USDA Forest Service (USFS). *Lesquerella fremontii* (Fremont's bladderpod) is the focus of an assessment because it is a sensitive species in the Rocky Mountain Region. Within the National Forest System, a sensitive species is a plant or animal whose population viability is identified as a concern by a regional forester because of significant current or predicted downward trends in abundance or in habitat capability that would reduce its distribution. A sensitive species may require special management, so knowledge of its biology and ecology is critical.

Goal

Species conservation assessments are produced as part of the Species Conservation Project to provide forest managers, research biologists, and the public with a thorough discussion of the biology, ecology, conservation status, and management of certain species based on available scientific knowledge. The assessment goals limit the scope of the work to critical summaries of scientific knowledge, discussion of broad implications of that knowledge, and outlines of information needs. The assessment does not seek to develop specific management recommendations. Instead it provides the ecological background upon which management must be based and focuses on the consequences of changes in the environment that result from management (i.e., management implications). Species assessments may be used to develop forest plans, restoration programs, and management strategies on USFS lands (Blankenship et al. 2001).

Scope

This species assessment examines the biology, ecology, conservation status, and management of *Lesquerella fremontii* throughout Wyoming, which contains the species' entire range. Its total distribution lies entirely within the USFS Rocky Mountain Region, and is present on the Shoshone National Forest and on sites outside of the national forest boundary in Wyoming. In producing the assessment, refereed literature, non-refereed literature, herbarium documentation, and other sources were reviewed. They represent over 20 years of collections and information compilation on *L. fremontii* as a Wyoming plant species of special concern, and research beginning with the monograph by Reed Rollins and Elizabeth Shaw (1973). In addition to compiling all

of the existing information, the current distribution data were used with Geographic Information System (GIS) base layers to assess potential distribution. A summary of the potential distribution model results is incorporated in this report.

Treatment of Uncertainty

Science represents a rigorous, systematic approach to obtaining knowledge. Competing ideas regarding how the world works are measured against observations. However, because our descriptions of the world are always incomplete and our observations are limited, science focuses on approaches for dealing with uncertainty. A commonly accepted approach to science is based on a progression of critical experiments to develop strong inference (Platt 1964). However, it is difficult to conduct experiments that produce clean results in the ecological sciences. Often, observations, inference, good thinking, and models must be relied on to guide our understanding of ecological relations. These scientific tools are to be used in concert with the most complete species status data to produce a robust analysis. The data and analyses presented in this assessment address all information and records produced as documentation of the distribution and biology of *Lesquerella fremontii* in the Rocky Mountain Region. The strength of evidence for particular interpretations or ideas is noted, and alternative explanations are described when appropriate.

Publication on the World Wide Web

To facilitate their use in the Species Conservation Project, the species assessments are being published on the World Wide Web site of the Rocky Mountain Region. Placing the documents on the Web makes them available to agency biologists and the public more rapidly than publishing them as reports. More importantly, it facilitates their revision, which will be accomplished based on guidelines established by the Rocky Mountain Region.

Peer Review

Assessments developed for the Species Conservation Project have been peer reviewed prior to release on the Web. This assessment of *Lesquerella fremontii* was reviewed through a process administered by the Center for Plant Conservation, employing at least two recognized experts on this or related taxa. Peer review was designed to improve the quality of communication and to increase the rigor of the assessment.

MANAGEMENT STATUS AND NATURAL HISTORY

Management Status

Federal status

Lesquerella fremontii was proposed as Endangered by the Smithsonian Institution on the first list of proposed Endangered and Threatened plants of the United States, a list that was accepted as a petition under the Endangered Species Act (USDI Fish and Wildlife Service 1975, Ayensu and DeFilipps 1978). At that time, it was only known from the type collection. Subsequent surveys and documentations of additional populations provided the basis for prompting the USDI Fish and Wildlife Service (USFWS) to drop the species to Category 3C in 1985 (USDI Fish and Wildlife Service 1985). *Lesquerella fremontii* is listed as sensitive by the USFS Rocky Mountain Region (USDA Forest Service 1995, 2003) and by the Bureau of Land Management - Wyoming State Office (USDI Bureau of Land Management 2001).

Heritage program ranks

Lesquerella fremontii was on the first Wyoming endangered plant species list that accompanied the published flora (Dorn 1977), precursor to the state ranking system for plants in Wyoming. It is currently ranked G2, indicating that it is imperiled throughout its range. It is ranked S2, or imperiled in Wyoming (NatureServe 2002, Keinath et al. 2003). There is no legislation or management policy in the state that accompanies this ranking status.

Existing Regulatory Mechanisms, Management Plans, and Conservation Strategies

In the Rocky Mountain Region, *Lesquerella fremontii* occurs on USFS land administered by the Shoshone National Forest. Of the twelve occurrences, the locations of eight are precisely known, and of those, four are located in part or in full on the Shoshone National Forest. All Shoshone National Forest occurrences are on lands managed for multiple-use, except for the Arrow Mountain population that occurs within the Fitzpatrick Wilderness Area. The Arrow Mountain area has also been evaluated for its research natural area characteristics (Jones and Fertig 1999). Occurrences outside of national forest boundaries are on public lands managed for multiple-use, except the Beaver Rim occurrences located within the Beaver Rim

Area of Critical Environmental Concern (ACEC), and parts of the occurrence in the Limestone Mountain area on the Red Canyon ACEC. In addition, a small portion of that occurrence is on the Red Canyon Preserve of The Nature Conservancy.

There are no other laws, regulations, management plans, or conservation plans that address *Lesquerella fremontii* apart from its sensitive species status, which confers some protection from human-caused activities and developments. As a sensitive species, *L. fremontii* populations on the Shoshone National Forest are considered when evaluating project proposals and management plans. Potential impacts to a population were identified in a highway construction project review (K. Houston personal communication 2003), and expanded surveys with GIS mapping were conducted to inform the review (Scott and Scott 2003).

Biology and Ecology

Classification and description

Systematics and synonymy

All previous taxonomic treatments and synonymy involving this species are summarized below:

Lesquerella fremontii Rollins & E. A. Shaw, Genus *Lesquerella* in N. America: 228 (1973). HOLOTYPE: U.S.A. Wyoming: "Fremont Co., Wind River Mts., 5 miles east of Atlantic City, calcareous gravel ridge, 8,200 ft.," *H. D. D. Ripley and R. C. Barneby 8931* (CAS); (ISOTYPES: NY, US). The common name of *L. fremontii* is Fremont's bladderpod or Fremont bladderpod, pertaining to the county in which it occurs.

Members of the *Lesquerella* genus were first separated from other members of the genus *Vesicaria* in the family Brassicaceae by Sereno Watson in 1888, and the first monograph on the genus was published by Payson (1922). The genus is identified by its stellate pubescence, yellow flowers, and small silicles (Hitchcock et al. 1964). Its name commemorates the American bryologist Leo Lesquereux (1805-1889). Rollins (1993) recognizes 95 species in the genus *Lesquerella*, all native to North and South America. It is second only to *Draba* in the number of North American species (Rollins 1993). Twelve species and two varieties of *Lesquerella* occur in Wyoming (Dorn 2001). Rollins and Shaw (1973) considered *L. fremontii* to be most closely related to *L. macrocarpa*, another Wyoming endemic. Both species are placed in the *L. prostrata-*

L. occidentalis group, based on their inflated fruits. Members of this group are geographically isolated. Chromosome data are not available, and chromosome numbers range widely in the genus, from diploid and aneuploids to polyploids (Rollins 1993).

Over 20 species in the genus *Lesquerella* have been studied for possible cultivation as an oil-seed crop in the United States. Oils in the seeds and the fruit of *L. fendleri*, a native of arid regions of the southwestern United States, have been found to be rich in hydroxy fatty acids. These acids are similar in quality to those currently available only from imported castor oil. These oils can be used in the production of resins, waxes, plastics, lubricants, soaps, and cosmetics. Residual meal from the seeds also makes a protein-rich livestock feed supplement (Senft 1992). *Lesquerella fremontii* may also contain commercial-grade oils and could provide useful genetic material for developing improved crop strains.

History of the species

The earliest documented specimen of *Lesquerella fremontii* was collected by C. J. Bayer from “Washakie National Forest” (now the Shoshone National Forest) in May 1911. No additional label information is available, and the location of the collection site is unknown (Rocky Mountain Herbarium records). A second herbarium specimen collected by R. W. Deland from “Lander, Wyoming” on 15 May 1936 in the “Wind River Basin” also lacks specific location data (Rocky Mountain Herbarium records). These two historic records are unmappable.

Lesquerella fremontii was collected in the South Pass area of southwestern Fremont County, Wyoming in 1947. The species went unrecognized for 26 years, when it was described as a new taxon by Rollins and Shaw (1973). The type locality of *L. fremontii* has not been relocated since its discovery by Ripley and Barneby in June 1947. Originally, the type location was reported as “5 miles east of Atlantic City” on a “calcareous gravel ridge, 8,200 ft.” The habitat and elevation at this location, however, do not match the description on the specimen label. Barneby later corrected the location data on the specimen as “3 miles north of Atlantic City at 8,200 ft.” (Lichvar and Dorn 1980). This would place the type locality in the vicinity of the Columbia-Geneva Mine, southwest of Limestone Mountain on the Shoshone National Forest. Referring back to the original site description and the species’ habitat requirements, Scott and Scott (2003) postulated that the type locality lies “approximately 61 degrees northeast of Atlantic City, at a distance of about five miles, very near the 8,000

ft. contour a little north of Beaver Creek on Big Horn Dolomite.” This location corresponds quite closely with that of the collection made in 1979 by Robert Dorn (2917). However, further evaluation of alternate collection areas and their geology is warranted before concluding that the Dorn collection site is a relocation of the type location. The type specimens were originally determined as *L. multiceps* or as *L. prostrata*, which do occur in southwestern Wyoming but on the western side of the Continental Divide (Rollins and Shaw 1973).

Surveys for *Lesquerella fremontii* from 1977 to 1993 resulted in the discovery of nearly one dozen locations in the southeastern Wind River Range and Beaver Rim area of Wyoming (Jones 1989, Fertig 1992). Systematic surveys were conducted by Walter Fertig in 1994 for a Bureau of Land Management status report on the species (Fertig 1995a). In these surveys, many of the one dozen locations were confluent or very close to each other and might be more appropriately recognized as subpopulations. Fertig recognized five geographically isolated populations presumed to be reproductively isolated by the distances between them (generally greater than 3 miles). Two of these populations could not be relocated during drought conditions in 1994 (Fertig 1995a). Surveys of *L. fremontii* in 1994 focused on calcareous rock outcrops in the lower montane zone of the southeastern Wind River Range and South Pass area of western Fremont County, Wyoming. They produced detailed documentation of the Limestone Mountain occurrence, spanning a distance of over 8 miles. Unsuccessful searches were conducted along the western slope of Beaver Rim and on Table Mountain south of Lander. Surveys of low elevation ridges and slopes on the east flank of the Wind River were also unsuccessful, possibly due to drought. (Fertig 1995a) In 1995, additional field surveys by Walter Fertig and Stephanie Mills documented three new populations: one in the Fossil Hill meadows of the Washakie Ranger District, one in the Arrow Mountain area in the Fitzpatrick Wilderness Area of the Wind River Ranger District, and one at Mount 7347 at the west end of Table Mountain. Recently, more detailed mapping of *L. fremontii* subpopulations was completed in the Sinks Canyon area by Richard and Beverly Scott (Scott and Scott 2003), further expanding on one of the original five populations. These represent the eight extant population records.

The largest set of *Lesquerella fremontii* voucher specimens is maintained at Rocky Mountain Herbarium (RM) and much of the RM distribution data is posted electronically on the Atlas of the Vascular Plants of Wyoming (University of Wyoming-Rocky Mountain Herbarium 1998).

Non-technical description

Lesquerella fremontii is a pubescent, perennial, taprooted herb with one to several decumbent or prostrate stems 5 to 15 cm long. The petiolate basal leaves are 1.5 to 4 cm long, with elliptic to orbicular blades, covered by stellate hairs. Stem leaves are generally longer and narrower. The flowers are 6 to 8 mm long with four yellow petals. The fruits are elliptical, 4 to 7 mm long, and inflated or slightly flattened at a right angle to the partition. At maturity, the fruits are borne on recurved stalks. The walls of the fruit are pubescent on both the outer and inner surfaces (**Figure 1** and **Figure 2**; Rollins and Shaw 1973, Clark and Dorn 1979, Rollins 1993, Fertig 1994, Fertig et al. 1994, Fertig 1995a, Fertig 2000).

Lesquerella fremontii is distinguished from similar species primarily by fruit characteristics (**Table**

1). *Lesquerella macrocarpa* has inflated fruits that are sparsely hairy on the outer wall and glabrous on the inner surface. *Lesquerella multiceps* and *L. prostrata* have somewhat inflated fruits on pedicels that are sigmoid- or upward-curved. *Lesquerella carinata* and *L. paysonii* differ by having more strongly flattened fruits. Vegetative rosettes of *L. fremontii* superficially resemble those of *Townsendia spathulata* but are smaller (Fertig et al. 1994, Fertig 1995a).

Distribution and abundance

There are twelve known occurrences of *Lesquerella fremontii*, two of which are unmappable, two of which have unresolved location questions, and eight of which are based on recent information that includes precise location (**Table 2**; **Figure 3**). Of these last eight, two could not be relocated on BLM lands in the 1994 drought year. If these two are presumed to be

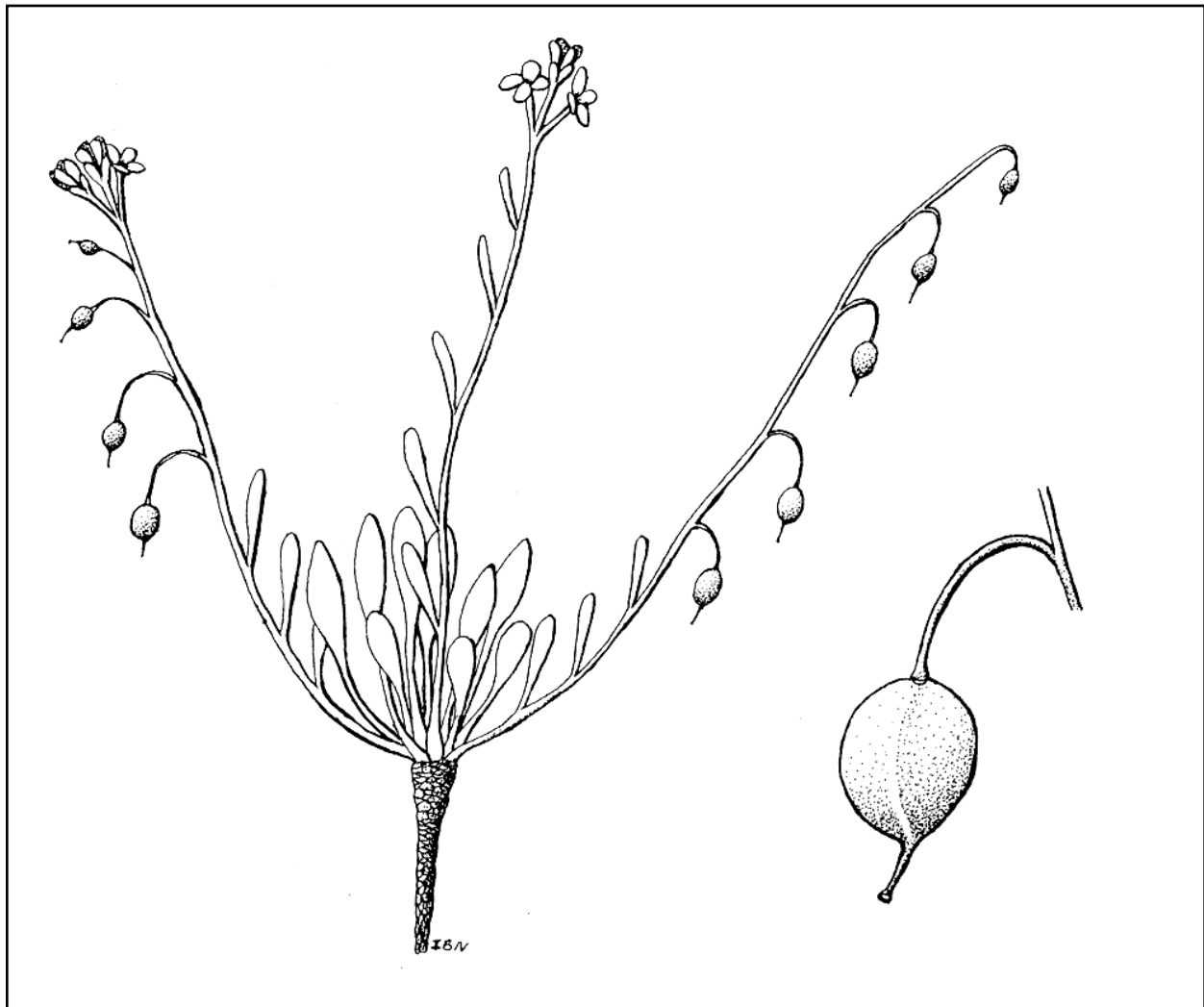


Figure 1. Illustration of *Lesquerella fremontii*, by Isobel Nichols; used with permission.



Figure 2. Photograph of *Lesquerella fremontii*, by Bonnie Heidel; used with permission.

extant, then there are eight extant occurrences, four of which occur on Shoshone National Forest in part or in full (Fertig 1995a). All eight extant populations are on the eastern side of the Wind River Range, and most are in the vicinity of Limestone Mountain and Sinks Canyon on the Washakie Ranger District of the Shoshone National Forest. The Arrow Mountain occurrence is in the northern Wind River Range on the Wind River Ranger District. The Wind River Indian Reservation lies between the northern Arrow Mountain occurrence and the southern occurrences, and *L. fremontii* surveys have not been conducted on the intervening reservation lands. Two other known occurrences of *L. fremontii* are found along Beaver Rim, approximately 20 miles east of the Wind River Range, on lands administered by the Lander Field Office of the BLM. Except for the northern Wind

River occurrence, the entire known range of the species falls within an area 30.5 miles long by 14 miles wide (Fertig 1995a).

There are no genetic data available for documenting gene exchange to define populations of *Lesquerella fremontii*, but the eight occurrences are located over three miles apart from one another on unrelated landforms and discontinuous sections. By contrast, there are partially isolated clusters within a mile or less of one another on the same landform or directly related landform that are treated as part of the same occurrence, and these are referred to as subpopulations in this document. Prior to 1994, eight occurrences were recognized in the Limestone Mountain area, but intensive surveys in 1994 showed

Table 1. Distinguishing characteristics of *Lesquerella fremontii* and other *Lesquerella* species.

Taxon	Basal leaf blade shape	Fruit cross section	Stem orientation	Fruit orientation
<i>L. fremontii</i>	orbicular to elliptic	not inflated; usually slightly flattened at a right angle to partition	prostrate or decumbent	secund
<i>L. macrocarpa</i>	orbicular to elliptic	inflated	prostrate or decumbent	not secund
<i>L. ludoviciana</i>	linear	inflated	usually erect	not secund
<i>L. arenosa</i>	linear to oblanceolate	inflated	usually erect	secund
<i>L. carinata</i>	rhombic to elliptic	quadrangular and strongly keeled	prostrate to ascending	not secund
<i>L. paysonii</i>	rhombic to oblanceolate	strongly flattened at a right angle to partition	decumbent	not secund
<i>L. prostrata</i>	subhastate to ovate	inflated	prostrate	sigmoid or upward-curved
<i>L. multiceps</i>	ovate to elliptic	inflated	prostrate	sigmoid or upward-curved

that six of these were essentially confluent and could be lumped into one extensive occurrence with 27 subpopulations (Fertig 1995a).

There are three historic and three recent collection records of *Lesquerella fremontii* with imprecise location information, and the interpretation of these records affects the tally of occurrences. They have been treated as separate occurrences in cases when they may represent discrete populations. First, the type locality has not been relocated since its discovery by Ripley and Barneby in June 1947. As previously discussed, it has been treated as a separate occurrence in the vicinity of the Columbia-Geneva Mine, although it is possible that it corresponds with the Beaver Creek collection by Robert Dorn. Additional review of geology maps and surveys is needed to evaluate these alternatives. Two collections were made prior to collection of the type specimen, and they represent unmappable records, collected in 1911 and 1936. The 1911 collection was made on “Washakie National Forest”, with no other location information. The Washakie National Forest later became the Washakie District of the Shoshone National Forest and could correspond with any of the four extant occurrences on the forest or represent a separate location. The 1936 collection was collected from the “Wind River Basin”, and *L. fremontii* is not otherwise known from the Wind River Basin, possibly indicating that it occurs at lower elevations than have been otherwise documented. It represents the earliest flowering plant record (May 15) in which *L. fremontii* has been collected, and it is a relatively robust specimen.

The recent collection records of *Lesquerella fremontii* with imprecise location information include two 1981 collections by Reed Rollins from the southeast

Wind River Mountains “near Wyoming State Highway 28, 24 miles southwest of Lander” (Rocky Mountain Herbarium records). Based on road miles, these collections are probably in the vicinity of Limestone Mountain as determined by RM staff. Therefore, they are treated as parts of the Limestone Mountain population. Finally, a 1980 collection by R.W. Lichvar has ambiguous label data. The specimen label cites the location as “ca 5 miles west of Limestone Mountain”, but the accompanying legal description gives the location as being over 100 miles to the west, well out of the known range of the species. A change in the legal description from 120W to 101W corresponds with an area approximately 5 miles west of Limestone Mountain in the Shoshone National Forest as interpreted by RM staff. Additional survey work is needed to confirm this edit to the collection label information.

Models of the potential distributions of BLM sensitive plant species in the state, including *Lesquerella fremontii*, were prepared for the Wyoming BLM (Fertig and Thurston 2003). In the resulting *L. fremontii* model, its potential distribution covered over 1,349 square kilometers of potential habitat, representing approximately 0.5% of the state’s area (**Figure 4**). In identifying potential distribution, it can be useful to identify the available environmental attributes that correlate most closely with a species’ current distribution. For *L. fremontii* these attributes are: 1) land cover, including mainly *Populus tremuloides* (aspen), *Juniperus scopulorum* (Rocky Mountain juniper), and *Artemisia tridentata* ssp. *vaseyana* (mountain big sagebrush) communities, and 2) bedrock geology, including limestone and dolomite units. Climate variables, particularly high July precipitation values and low July temperature values, also contributed to the

Table 2. *Lesquerella fremontii* occurrences and habitat characteristics in Fremont County, Wyoming (USFS Region 2). Information includes occurrence number and site name, land ownership, estimated population number and extent, elevation range, habitat description, and list of associated species.

Occurrence number/Site name	Management Area/Ownership	Estimated abundance	Estimated extent (hectares)	Elevation (feet)	General habitat description	Associated species
001 Beaver Creek and Dilabaugh Buttes	Bureau of Land Management-Lander (BLM-Lander); State of Wyoming; Private?	Not available (NA)	Not available (NA)	6,900 to 7,600	Crevices of limestone slabs and partially vegetated northwest-facing slopes of butte on rocky, sandy soil.	<i>Astragalus</i> spp., <i>Townsendia</i> spp.
002 Limestone Mountain area (includes Freak and Young mountains)	Shoshone National Forest; BLM-Lander (Red Canyon Area of Critical Environmental Concern); The Nature Conservancy; Private	50,000 (to 100,000) in 27 subpopulations in Shoshone National Forest	131.0	7,100 to 9,015	Montane meadows in cushion plant communities on deep, mesic calcareous soils covered by a thin layer of limestone, shale, or sandstone gravel. Typically on south or west facing slopes of 0 to 40 degrees. Also in cracks of limestone bedrock outcrops. Occasionally on gopher mounds.	<i>Artemisia tripartita</i> , <i>Artemisia tridentata</i> , <i>Balsamorhiza incana</i> , <i>Senecio canus</i> , <i>Sedum lanceolatum</i> , <i>Hymenoxys acaulis</i> , <i>Arenaria hookeri</i> , <i>Antennaria umbrinella</i> , <i>Phlox hoodii</i> , <i>Festuca idahoensis</i> , <i>Castilleja flava</i> , <i>Draba oligosperma</i> , <i>Townsendia spathulata</i>
003 Fairfield Hill	Shoshone National Forest	2,000 in two subpopulations	86.6	8,080 to 9,370	On limestone benches and bluff in slightly protected meadow (not in rimrock). Infrequent to absent where total vegetation canopy cover is greater than 30% and litter ground cover is greater than 30%. Soils shallow and dry, derived from limestone. Aspect southwest to southeast, slope 0-45%.	<i>Artemisia tridentata</i> , <i>A. tripartita</i> , <i>Pinus flexilis</i> , <i>Sedum lanceolatum</i> , <i>Draba oligosperma</i> , <i>Purshia tridentata</i> , <i>Elymus spicatus</i> , <i>Astragalus miser</i> , <i>Balsamorhiza incana</i> , <i>Phlox hoodii</i> , <i>P. multiflora</i> , <i>Lomatium cous</i> , <i>Mertensia viridis</i> , <i>Eriogon compositus</i> , <i>Senecio canus</i> , <i>Zigadenus venenosus</i> , grasses
004 Mount 7347 (ridge above Crooked Creek)	BLM Lander; The Nature Conservancy; Private	3,000 in two subpopulations	56.6	7,200 to 7,814	Bare patches of sandy-loam calcareous soil with surface layer of limey-sandstone gravel of the Bighorn Dolomite or Phosphoria Formations. Habitat typically on open flats or northeast to southwest-facing upper slopes.	<i>Artemisia tripartita</i> , <i>A. tridentata</i> , <i>Elymus spicatus</i> , <i>Townsendia spathulata</i> , <i>Antennaria umbrinella</i> , <i>Veronica biloba</i> , <i>Mertensia viridis</i> , <i>Balsamorhiza incana</i> , <i>Astragalus miser</i> , <i>Potentilla ovina</i> , <i>Cymopterus terebinthus</i> , <i>Phlox multiflora</i> , <i>Draba oligosperma</i>
005 Columbia-Geneva Mines	Shoshone National Forest; BLM Lander	Historic; location in question	NA	8,2000	Calcareous gravel ridge.	Not reported

Table 2 (concluded).

Occurrence number/Site name	Management Area/Ownership	Estimated abundance	Estimated extent (hectares)	Elevation (feet)	General habitat description	Associated species
006 “5 miles west of Limestone Mt”	Shoshone National Forest	Recent; location in question	NA	7,500	Gravelly limestone knoll.	Not reported
009 Beaver Rim above Cottonwood Creek	BLM Lander (Beaver Rim Area of Critical Environmental Concern)	NA	1.6	6,800	Not reported.	Not reported
012 Beaver Rim above Silver Creek	BLM Lander	NA	NA	7,200 to 7,300	Limestone and sandstone outcrops and sagebrush-covered slopes.	<i>Artemisia</i> spp.
013 Fossil Hill and Indian Ridge	Shoshone National Forest	1,500+ in four subpopulations	158.4	7,800 to 8,800	Limestone outcrops along ridges. Population ends where geologic formation changes from shallow limestone to deeper granitic glacial till. Prefers thin, dry, limestone soils. Slope 0-40%, aspect southwest to south to northeast.	<i>Artemisia tripartita</i> , <i>A. tridentata</i> , <i>Elymus spicatus</i> , <i>Purshia tridentata</i> , <i>Phlox hoodii</i> , <i>Balsamorhiza sagittata</i> , <i>B. incana</i> , <i>Mertensia viridis</i> , <i>Lomatium couis</i> , <i>Senecio canus</i> , <i>Zigadenus elegans</i> , <i>Physaria saximontana</i> , <i>Koeleria macrantha</i> , <i>Potentilla ovina</i> , <i>Townsendia spathulata</i>
014 Circle Peak at south end of Arrow Mountain	Shoshone National Forest (Fitzpatrick Wilderness)	Several hundred	2.9	11,100	Cushion plant community with vegetative cover of 20 to 25% on dry, open, gentle south-facing slopes of sandy clay-shale soil with brownish limestone-sandstone gravel colluvium on the surface. Mostly restricted to semi-bare microsites in which the soil has been eroded due to slumping mass movement downslope. Absent from adjacent turf stripes with high vegetative cover (averaging 80%).	<i>Phlox pulvinata</i> , <i>Minuartia obtusiloba</i> , <i>Silene acaulis</i> , <i>Aquilegia jonesii</i> , <i>Lloydia serotina</i> , <i>Senecio canus</i> , <i>Braya humilis</i> , <i>Saussurea weberi</i> , <i>Arnica angustifolia</i> , <i>Campanula uniflora</i> , <i>Thalictrum alpinum</i> , <i>Androsace chamaejasme</i> var. <i>carinata</i>
015 Lander, “Wind River Basin”	Public	Historic; unmappable	NA	5,400	Not reported	Not reported
016 “Washakie National Forest”	Shoshone National Forest	Historic; unmappable	NA	7,300	Not reported	Not reported
TOTAL of 12 occurrences		56,800 to 107,200	437			

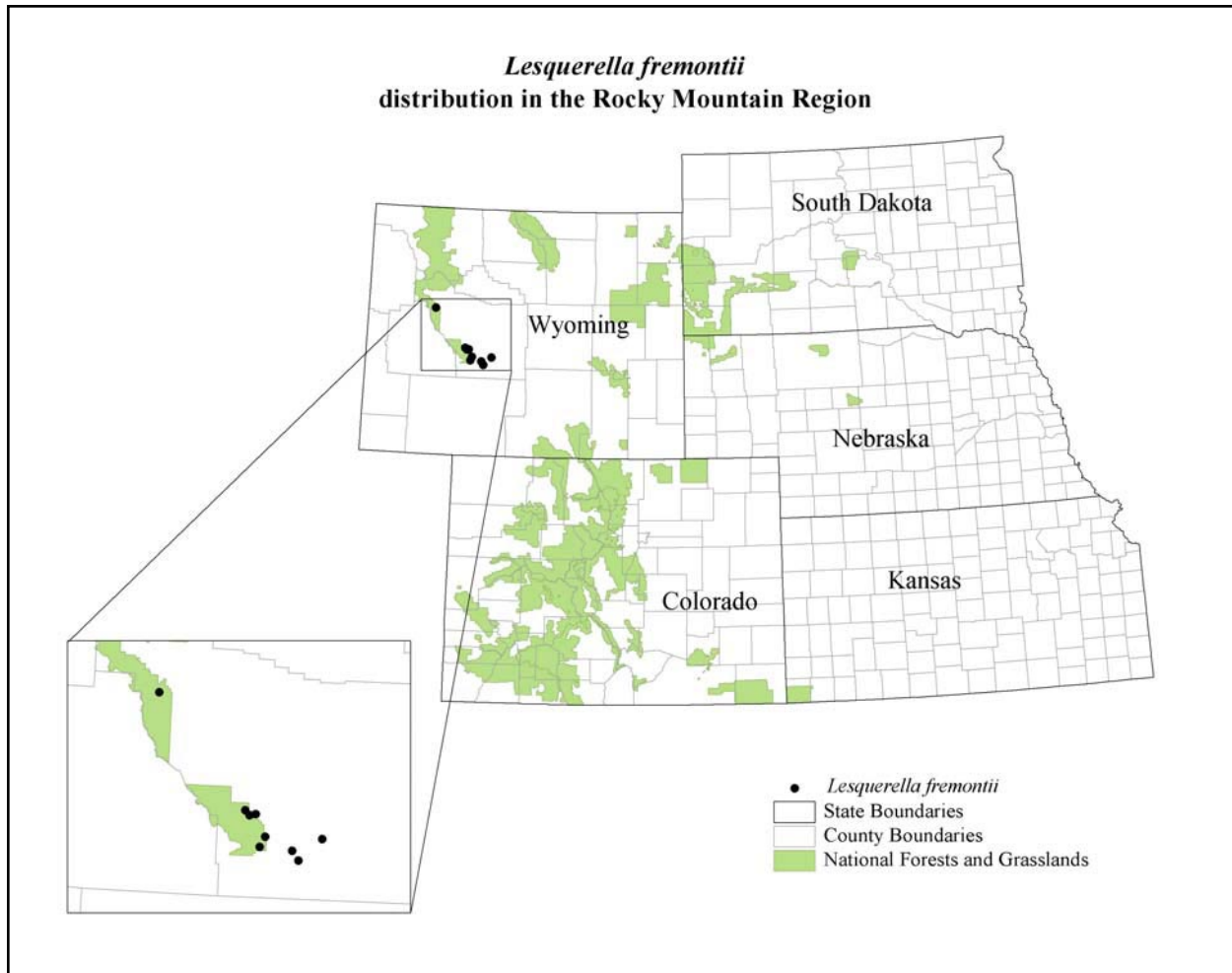


Figure 3. Distribution of *Lesquerella fremontii* in the Rocky Mountain Region.

model. This analysis suggests that there is additional habitat in the Rocky Mountain Region, and that there may be suitable habitat where there are no known populations, e.g. in the Big Horn Mountains. The largest area of potential habitat is mapped on the east side of the Wind River Range, lying in the Shoshone National Forest and in the Wind River Indian Reservation. Large areas of suitable environments were also mapped on the west side of the Big Horn Mountains. Small, widely-scattered areas of potential habitat are also mapped in the Absaroka Range on the Shoshone National Forest, in the Laramie and Medicine Bow ranges on the Medicine Bow National Forest, and in small areas adjoining the Seminole, Shirley, Pedro, and Granite mountains outside of national forests. To date, no populations have been located outside of the Wind River Range, despite very extensive floristic surveys across most of Wyoming (Hartman 1992).

Population sizes are highly variable, ranging in magnitude from several hundred plants to at least 50,000 plants (**Table 2**; Fertig 1995a). In the largest population, demographic plot data documented higher densities than those based on casual observation, suggesting that ocular population estimates may be conservative because of the difficulty of discerning this low-growing, drab-colored species when it is not flowering. Based on an observed density of 9.5 plants per square meter at one monitoring site, the total population on Limestone Mountain may be closer to 100,000 plants (Fertig 1995a). Population size estimates are not available for two of the eight extant occurrences, but the estimated Limestone Mountain population complex is at least 85 to 95 percent of all known species' numbers. The Limestone Mountain population complex spans lands managed by the Shoshone National Forest, the BLM, The Nature Conservancy, and private lands; and the

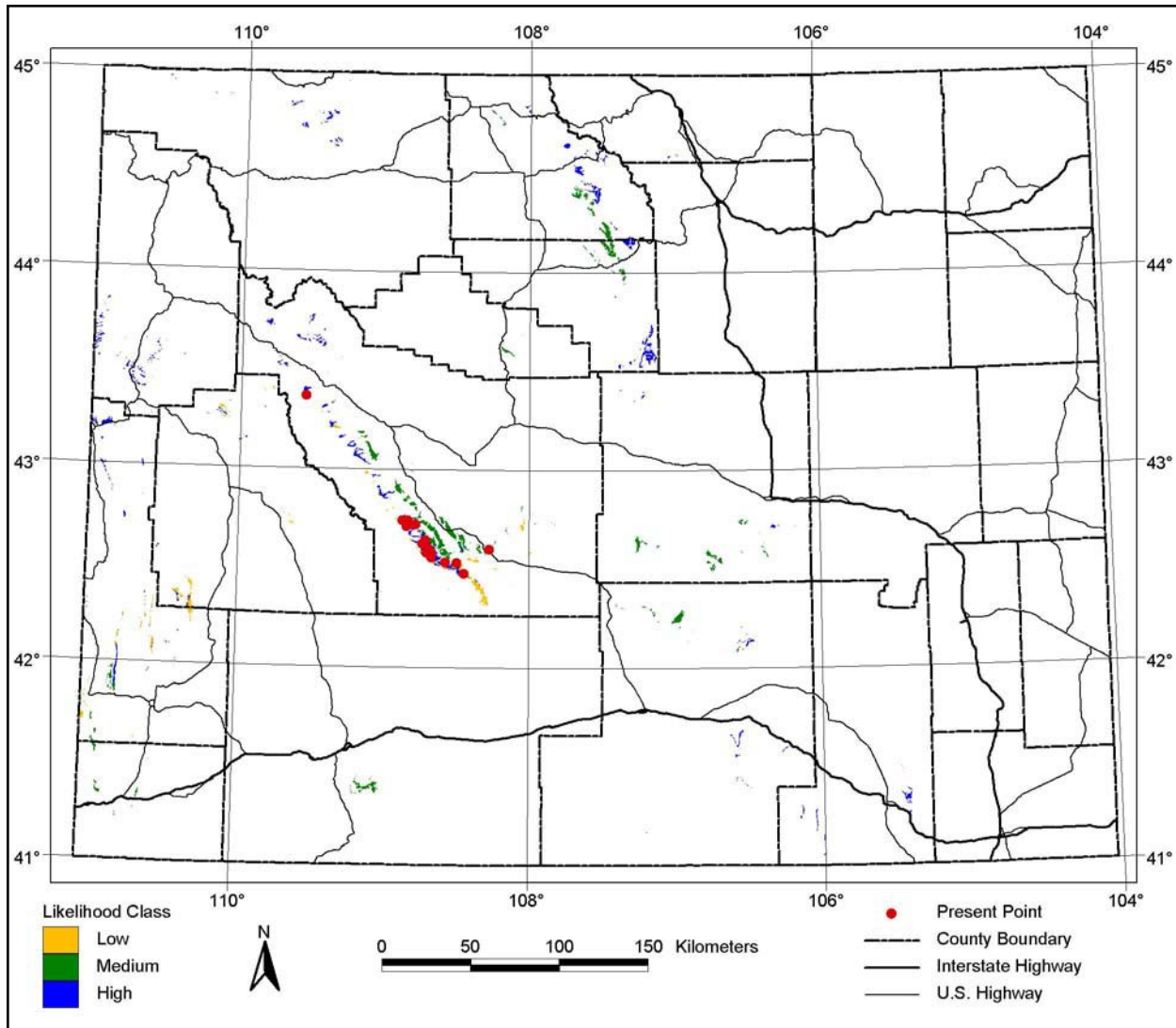


Figure 4. Potential distribution of *Lesquerella fremontii* in Wyoming (Fertig, W. and R. Thurston. 2003. Modeling the Potential Distribution of BLM sensitive and USFWS Threatened and Endangered Plant Species in Wyoming (http://uwadmnweb.uwyo.edu/WYNDD/Reports/pdf_fertig/FinalReport_03BLMmodeling.pdf). Report prepared for the BLM – Wyoming State Office by WYNDD – University of Wyoming, Laramie, WY).

largest proportion of its subpopulations (12 of the 27) are located on Shoshone National Forest.

Local patterns of *Lesquerella fremontii* distribution are typically clumped and non-random, as observed in systematic surveys and determined in baseline monitoring transects involving three subjectively-placed belt transects of 30 m x 1 m (Fertig 1995a). *Lesquerella fremontii* plants are often recurrent across a topographic gradient or in interrupted patches along continuous topographic patterns. Densities vary from much less than 1 to 9.5 plants per square meter (Fertig 1995a). It is likely, but has not been reported, that density is linked to habitat.

Population trend

Trend data are not available for any of the *Lesquerella fremontii* occurrences, but overall trend was characterized as probably stable (Fertig 2000).

A small number of plants along Wyoming State Highway 28 on the south slopes of Limestone Mountain (on the Shoshone National Forest; now considered to be a subpopulation of the Limestone Mountain occurrence) were extirpated following expansion of the highway in the 1980s. *Lesquerella fremontii* plants were last observed at this site in June 1979 and could not be relocated during visits in 1992 and 1994 (Fertig 1995a).

No suitable habitat remains in the immediate vicinity of the roadcut, where a large segment of slope was removed. This particular site is on state lands. Recent efforts to map and survey *L. fremontii* on Fossil Hill and Indian Ridge of the Shoshone National Forest (Element Occurrence Record 013) using Global Positioning System (GPS) technology have been conducted as a baseline for highway planning (Scott and Scott 2003). *Lesquerella fremontii* was characterized as “common on the upper roadcuts” of switchbacks and described in general as an early seral species that colonizes open, rocky surfaces that are poorly vegetated. Precise locations were documented with GPS technology as a baseline for future trend analysis.

Two populations could not be relocated in the drought conditions of 1994, and both of them are at low elevations on BLM lands. Re-survey was recommended in non-drought years (Fertig 1995a), but a subsequent survey has not been conducted. Potential explanations were not discussed for the 1994 survey results, but they include mortality or desiccation of *Lesquerella fremontii* such that plants could not be distinguished.

Three baseline demographic monitoring plots were established in 1994 on BLM lands, and it was recommended that follow-up monitoring should be conducted yearly to determine trend and to broaden the baseline data (Fertig 1995a). Establishment of additional monitoring transects was also recommended. There has not been subsequent monitoring.

Habitat

Lesquerella fremontii is a calciphile, restricted to substrate originating from Paleozoic limestone or limestone derivatives, particularly the Big Horn Dolomite. It also occurs on the Gallatin Limestone and the Madison Limestone (Fertig 1995a, Scott and Scott 2003). It is infrequently present on the Gros Ventre Shale, Flathead Sandstone, and Quaternary Till deposits, all with limestone or dolomite components or influences (Scott and Scott 2003). This is consistent with the generalization that many *Lesquerella* species occur on calcareous soils (Payson 1922), and with the potential distribution model for *L. fremontii* in which bedrock geology was identified as a consistent environmental factor in predicting potential distribution throughout its range (Fertig and Thurston 2003). The known occurrences of *L. fremontii* range in elevation from 2,075 to 3,641 m (6,800 to 11,100 ft.), from high desert ridges to subalpine elevations (**Table 2**).

Lesquerella fremontii often occurs on sparse ridges and slopes with scattered *Pinus flexilis* (**Figure 5** and **Figure 6**). Soils are often gravel-covered and contain gravel or coarser rocky material in the soil profile. *Lesquerella fremontii* typically occurs on gentle to steep (0 to 30+ degrees) west or south-facing slopes facing the prevailing wind. It is less commonly found on north and east-facing slopes (**Figure 7** and **Figure 8**) or in the shallow depressions or saddles between ridgecrests. The landscape photo in **Figure 8** shows the overall setting of Young Mountain with small areas of *L. fremontii* at mid-slope positions below the north-facing cliff, and the most extensive subpopulation lying out of view over the crest on south-facing slopes. Occasionally, *L. fremontii* can be found in narrow, soil-filled cracks in calcareous boulders or bedrock.

Lesquerella fremontii occurs in open, sparsely-vegetated habitat with low vegetative cover (typically below 50 percent, but occasionally as high as 80 percent) such as dry meadows, cushion plant communities, sparse steppe, or almost unvegetated slopes. The plant communities consist mostly of small forbs, cushion plants, and bunchgrasses, sometimes with *Artemisia tripartita* and they are present, at least in part, in the *Festuca idahoensis*/*Agropyron smithii* habitat type (Idaho fescue/western wheatgrass habitat type) and the *Artemisia tripartita*/*Festuca idahoensis* habitat type (threetip sagebrush/Idaho fescue habitat type; Tweit and Houston 1980). Scattered *L. fremontii* plants can occasionally be found in semi-shade of *Pinus flexilis*, *Artemisia tridentata* ssp. *vaseyana*, or *Artemisia tripartita* (threetip sagebrush), but in general, *L. fremontii* does not appear under heavy shade. The model for mapping potential habitat of *L. fremontii* (Fertig 2003) singled out forest community types prepared for GAP analysis as having predictive values (including *Artemisia tridentata* ssp. *vaseyana*, *Juniperus scopulorum*, and *Populus tremuloides*). They might be the prevailing cover in the landscapes surrounding montane populations but do not correspond with occupied species' habitat. All of the above habitat information and the following associated species information come from the Wind River Range and pertain to Shoshone National Forest habitat. The habitat and species associated with *L. fremontii* at the low end of its elevation range on the desert ridge represented by the Beaver Rim populations are not known.

The immediately associated plant species are likewise species of rocky, often calcareous, habitats that are part of a sparse shrubland, grassland, or

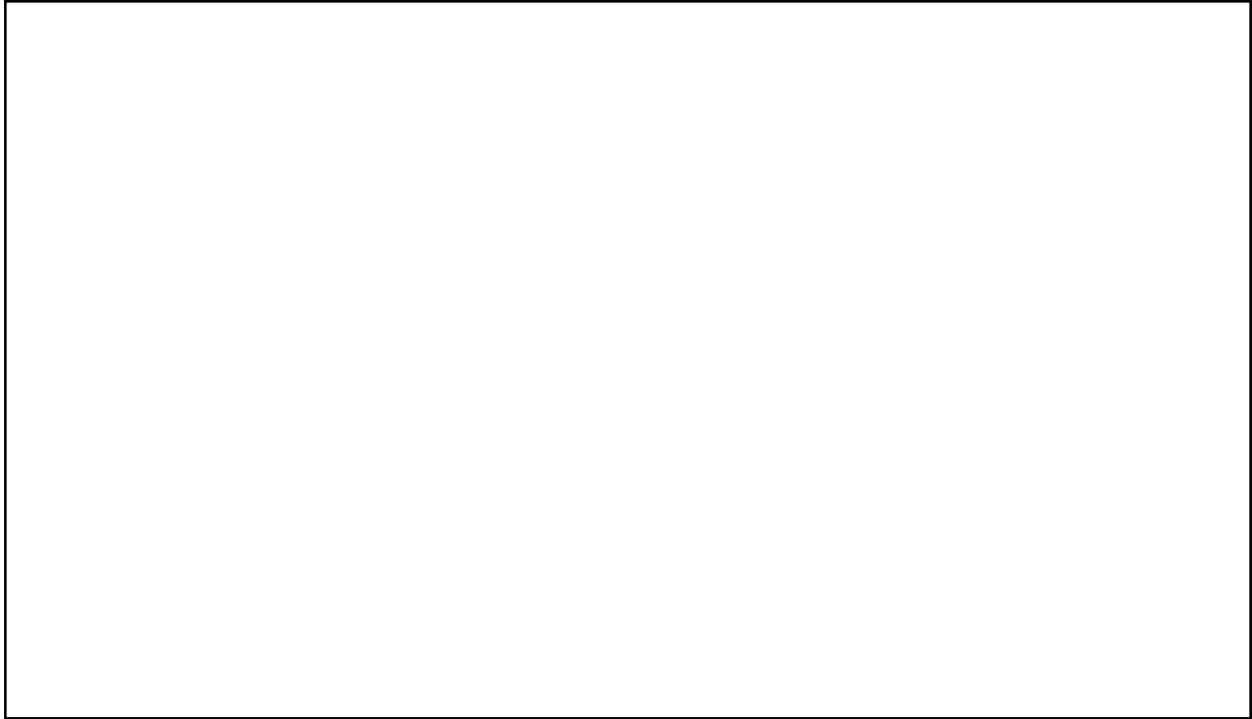


Figure 5. Schematic diagram of *Lesquerella fremontii* habitat, by Walter Fertig (Fertig 1995a); used with permission.



Figure 6. Habitat of *Lesquerella fremontii* on Limestone Mountain (upper slopes, foreground), by Bonnie Heidel; used with permission.



Figure 7. Habitat of *Lesquerella fremontii* on Young Mountain (mid-slope, foreground), by Walter Fertig; used with permission.



Figure 8. Habitat of *Lesquerella fremontii* on Young Mountain (mid-slope below cliffs), by Walter Fertig; used with permission.

essentially unvegetated habitat. They include: *Arenaria congesta* (*Eremogone congesta*; ballhead sandwort), *Artemisia tripartita* (threetip sagebrush), *Balsamorhiza incana* (hoary balsamroot), *Draba oligosperma* (few-seed draba), *Elymus spicatus* (bluebunch wheatgrass), *Erigeron compositus* (cut-leaved daisy), *Festuca idahoensis* (Idaho fescue), *Haplopappus acaulis* (*Stenotus acaulis*; stemless mock goldenweed), *Hymenoxys acaulis* (stemless hymenoxys), *Hymenoxys richardsonii* (Richardson's hymenoxys), *Koeleria macrantha* (Junegrass), *Lomatium cous* (biscuitroot), *Lupinus argenteus* (silvery lupine), *Oxytropis sericea* (white locoweed), *Phlox hoodii* (Hood's phlox), *Phlox multiflora* (many-flowered phlox), *Poa secunda* (Sandberg bluegrass), *Potentilla ovina* (sheep cinquefoil), *Sedum lanceolatum* (lance-leaved stonecrop), *Senecio canus* (woolly groundsel), and *Townsendia spathulata* (spoon-leaved Easter-daisy) (**Table 2**; Fertig 1995a). Scott and Scott (2003) note four species occurring with *L. fremontii* in their study areas and blooming at the same time: *Draba oligosperma* (few-seed draba), *Erysimum asperum* (dune wallflower), *Potentilla diversifolia* var. *perdissecta* (mountain-meadow cinquefoil), and *Townsendia parryi* (Parry's Townsend-daisy). Four rare species are directly associated with *L. fremontii* at the highest-elevation occurrence at Arrow Mountain: *Androsace chamaejasme* ssp. *carinata* (sweet-flowered rock-jasmine), *Aquilegia jonesii* (Jones' columbine), *Braya humilis* (low braya), and *Saussurea weberi* (Weber's saw-wort).

Average annual precipitation in the southeastern Wind River Range is 16 to 20 inches (406 to 508 mm), with peak levels in January and May. Mean annual temperature is 35 °F (1.6 °C), with mean maximum and minimum temperatures in January of 26° and 0 °F (- 3.3° and - 18 °C) and mean maximum and minimum temperatures in July of 79° and 41 °F (26° and 5 °C) (Martner 1986). Monthly temperatures are higher on average and precipitation is lower in *Lesquerella fremontii* habitat along Beaver Rim than this weather station data. Microhabitat may also shift the effective climate conditions. *Lesquerella fremontii* often occurs on south or west-facing upper slopes, facing the prevailing wind. Evaporation from solar radiation and wind may make these microhabitats drier at ground level than regional precipitation data would indicate. However, the gravelly nature of the soils inhabited by *L. fremontii* may allow for deeper water infiltration following snowmelt and thus mitigate the drying effects of sun and wind, certainly early in the growing season when *L. fremontii* produces flower and fruits. The soils were characterized as relatively mesic by Fertig (1995a) for this reason.

The habitat of *Lesquerella fremontii* generally appears to be stable in its relatively sparse vegetation, and there have been no reports of encroachment. Scott and Scott (2003) found *L. fremontii* on upper margins of "current roadcuts, old roadways, and other disturbed surfaces, such as pocket gopher and yellowbelly marmot diggings" They also reported that one locale photographed with many *L. fremontii* plants was extirpated later in the season due to the water erosion associated with a short, intense thunderstorm.

Reproductive biology and autecology

Reproduction

Lesquerella fremontii is a short-lived semelparous perennial that reproduces exclusively by seed. Flowering occurs from late May through June, and fruits dehisce from July through August. A historic specimen in 1936 was collected in flower on May 15, and that is the earliest collection date for the species. Flowering time appears to be staggered between different flowering stems on the same plant. Inflorescences are indeterminate, and flowering and fruit maturation is prolonged under favorable conditions. Fruit production can also vary depending on the number of inflorescences per plant and the climate conditions needed for fruit production. Most inflorescences have 5 to 6 fruits (Fertig 1995a), and each fruit has 4 to 6 seeds (Rollins and Shaw 1973), for an ordinary range of 20 to 36 seeds per inflorescence.

Pollinators and pollination ecology

The pollinators of *Lesquerella fremontii* are unknown. Bees and flies are the most commonly-observed pollinators in the *Lesquerella* genus (Rollins and Shaw 1973). Pollination research in another western perennial member of the genus, *L. fendleri*, has documented that this other species offers both pollen and nectar rewards, and that pollination occurs strictly by outcrossing rather than selfing, though there is also agospermous reproduction (Mitchell 1997). In general, honey bees have been used as pollination vectors in agricultural research associated with cultivated members of *Lesquerella* (Dierig et al. 2003).

The rate of effective pollination for the related *Lesquerella fendleri* was found to be density-dependent at small scales (when there was more than one individual within one square meter) but not over larger areas (Mitchell 1997), and this may be the case for *L. fremontii*. Demographic monitoring plots were established in areas of relatively high *L. fremontii* density, with a mean of 9.5 plants per square meter in a

30 square meter belt transect at one high-quality site on Limestone Mountain (Fertig 1995a).

Dispersal mechanisms

The seeds of *Lesquerella fremontii* are somewhat flattened but lack wings or other structures to facilitate dispersal (Rollins 1993). The seeds appear suited to lodging in surface irregularities around parent plants. In 1994, numerous plants were observed with decumbent branches bearing five to six mature fruits. It is possible that the entire branch serves as the dispersal agent. This type of dispersal could also contribute to the clumped, non-random distribution pattern that was observed in field surveys and documented in baseline monitoring transects at the same time (Fertig 1995a). The occurrence of mature plants to the leeward of rocks or at the edge of clumps of vegetation suggests that some type of cover or shade is necessary for seed germination or seedling establishment.

Hybridization

There is no evidence to suggest that *Lesquerella fremontii* hybridizes with other members of the genus. Genetic characteristics and concerns have not been identified.

Phenotypic plasticity

The specimens of *Lesquerella fremontii* at RM exhibit a range of characteristics that may reflect phenotypic plasticity, including flowering stem length, the number of flowering stems, leaf length, and leaf width. It is not known to what degree these characteristics vary with environmental conditions as compared to plant age, phenology, or genotype.

Life history

The basic life history stages of *Lesquerella fremontii* include seed, seedling, and mature plants in both vegetative and flowering phases. The life cycle diagram is presented in **Figure 9**. Life history data are not available to determine the critical stage(s) in this species' life history. Species life history information was identified as critical information needed to minimize any potential conflicts with road/trail construction or remediation in its habitat (Scott and Scott 2003).

It is not possible to determine the age of *Lesquerella fremontii* plants with certainty, but old leaf bases persist on the root crown, and successive leaf bases are produced above old ones with a slight gap in

between. This might offer a way to determine plant age but requires digging. Review of plant specimens at RM indicates that there are multiple collections of plants with no leaf base remnants, perhaps indicating that they flowered within one to two years after germination. There are also a small number of plants that appear to have at least five clustered intervals of leaf base remnants on the root crown, which may indicate that they are six to seven years old. Most specimens have one to two leaf base clusters.

The relative population make-up of flowering to non-flowering *Lesquerella fremontii* plants is noted for only two populations, and non-flowering plants constitute only 10 to 20 percent of those populations. One possible explanation for the high proportion of flowering-to-non-flowering plants is that flowering plants do not revert to non-flowering phases in subsequent years, so the proportion really reflects a ratio of mature to immature plants. Alternatively, the results of monitoring transects in which non-flowering plants were documented to be more common than estimates would indicate offer the suggestion that the drab-colored vegetative plants were overlooked (Fertig 1995a).

It is not known whether the seeds of *Lesquerella fremontii* germinate in the fall or spring, but spring plantings of this species are successful in rock gardens (Rock Garden Plant Database 2003). There are no reports of seedlings in the literature or in the surveys. Both annual and perennial species of *Lesquerella* have been documented as having a seed bank, including *L. lescurii* and *L. lyrata* of the southeastern United States (Baskin et al. 1992, Baskin and Baskin 2000), and *L. fendleri* of the southwestern United States (Cabin et al. 2000). In general, having a seed bank is an adaptive strategy for plant species of highly variable environments that allows populations to persist without flowering and germinating every year, essentially waiting to take advantage of favorable climate conditions (Rees 1994).

Community ecology

Lesquerella fremontii occurs in open habitat. Whether this reflects a requirement for low-competition settings or for high light conditions is unknown. There is rarely shadow cast by nearby woody vegetation into *L. fremontii* habitat, and the species is typically found on south-facing slopes. Its dense, overlapping leaf hairs may be an adaptation for reducing water loss (Rollins and Shaw 1973). In this way, it is stress tolerant. Like other *Lesquerella* species, it grows and flowers early in the growing season and thereby avoids stressful conditions later in the summer. It generally fits the

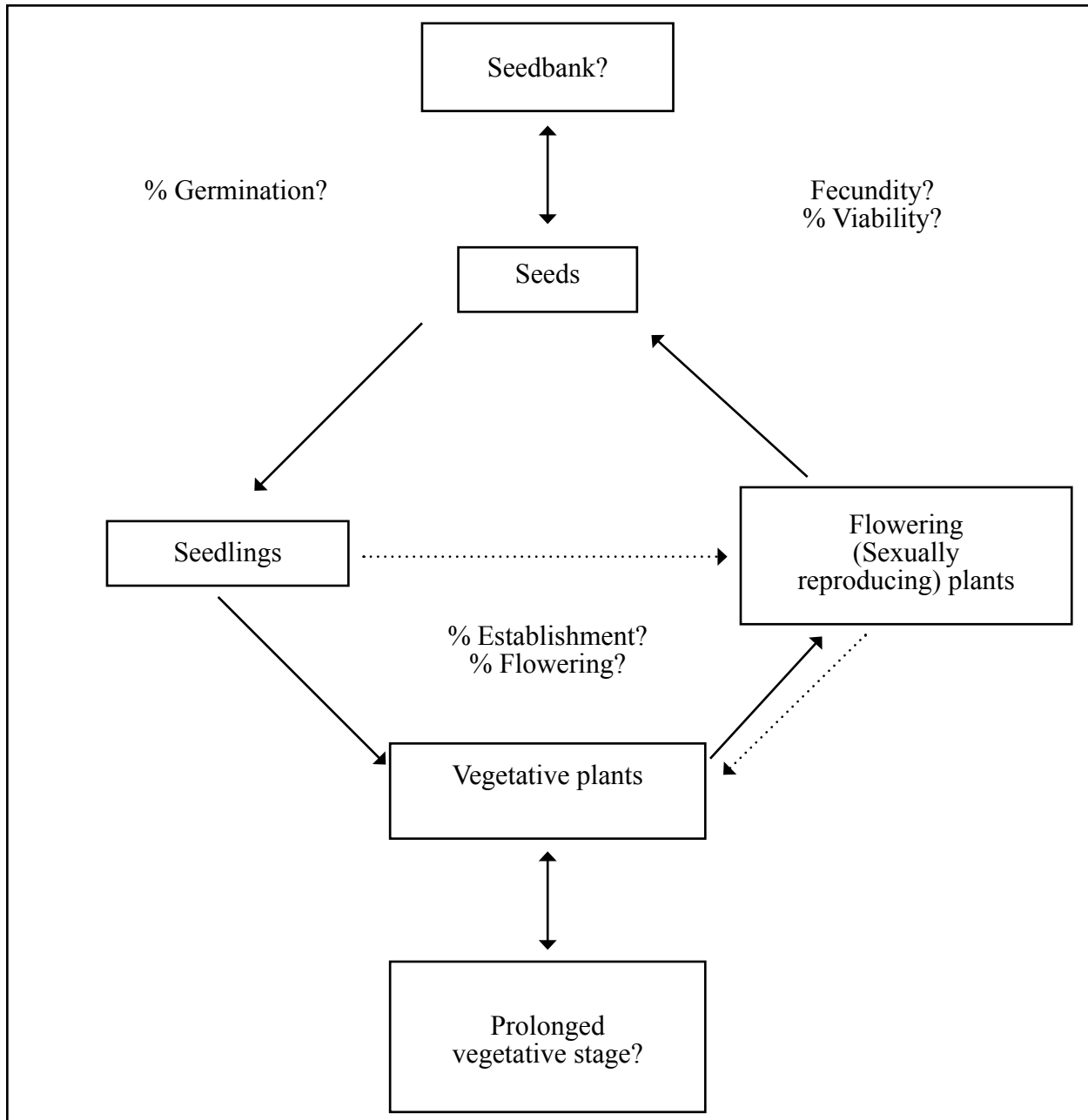


Figure 9. Life cycle diagram for *Lesquerella fremontii*. Dashed lines indicate pathways that are possible but not proven.

pattern of a stress-tolerant species of unproductive, low-competition habitat, in the sense of Grimes (2001).

The dominant species in *Lesquerella fremontii* habitat include bunchgrasses, such as *Elymus spicatus* (bluebunch wheatgrass) and *Festuca idahoensis* (Idaho fescue), that form a tight clump and tap nutrient and water resources in the immediate vicinity, but which also leave large areas of unoccupied habitat. The resulting vegetation patterns are patchy, and the intervening spaces are suited to species that are poor competitors.

A possible model for the influence of surrounding vegetation on *Lesquerella fremontii* is presented by research involving *L. carinata* var. *languida* in montane settings of Montana and by research involving *L. filiformis* in limestone glade openings in Missouri. The former is a short-lived perennial, and the latter is a winter annual. Survivorship was highest for *L. carinata* var. *languida* away from *Elymus spicatus* in years of normal or above-normal precipitation, and it was highest for *L. filiformis* in the open. These patterns reversed in dry years when survivorship was highest

for *L. carinata* var. *languida* close to *Elymus spicatus* and for *L. fliformis* in shade. The vegetation competes with these two species of *Lesquerella* under favorable conditions, but their survival is facilitated by nearby vegetation under adverse conditions (Greenlee and Calloway 1996, Thomas 1996). These interchangeable competition/facilitation relationships with surrounding vegetation are particularly important for short-lived perennials with fluctuating populations, and they have been interpreted as making a case for maintaining habitat heterogeneity (Greenlee and Calloway 1996, Thomas 1996). Known and suspected habitat and community ecology requirements for *L. fremontii* are presented in an envirogram (**Figure 10**).

Herbivory

There have been no signs of herbivory noted in surveys of *Lesquerella fremontii* or on herbarium specimens at RM. Most populations fall within active grazing allotments, with the exception of the Arrow Mountain population in the western end of the Wind River Range, and cattle graze in the immediate vicinity of the Limestone Mountain and Sinks Canyon populations (Fertig 1995a).

Mycorrhizal relationships

Members of the family Brassicaceae do not form mycorrhizal relationships (S. Miller personal communication 2002).

CONSERVATION

Threats

The immediate threats to *Lesquerella fremontii* from human activities are associated with road construction, quarrying, and off-road vehicle use. Most Shoshone National Forest populations are near or at least have part of the population near roads, except for the Arrow Mountain population in the Fitzpatrick Wilderness Area. Off-road vehicles may cause direct mortality of plants and degrade habitat through soil compaction and erosion. The absence of plants in existing roadbeds in suitable habitat suggests that road construction and trampling by vehicles are negative impacts (Fertig 1995a). Within the past ten years a parking lot for off-road vehicle recreationalists was built on USFS lands at the summit of Limestone Mountain (B. Heidel personal observation 2003). This parking lot and the trails from it provide primary public access to open ridges with *L. fremontii* habitat (**Figure 6**). Road and trail development, enhancement, and maintenance, including

grading or re-contouring, and corridor management, such as herbicide treatment, are also practices that potentially impact the species. The traffic and disturbance associated with roads and trails also make them corridors for exotic species introduction and encroachment. An inactive limestone quarry is found on the Shoshone National Forest below the summit of Limestone Mountain in the population area. It may have removed *L. fremontii* habitat locally. In any case, the close association between *L. fremontii* and calcareous sites makes it vulnerable to surface disturbances resulting from quarrying activity and subsidiary development (Fertig 1995a).

The recurrence of *Lesquerella fremontii* along upper slopes of roadcuts (Scott and Scott 2003, B. Heidel personal observation 2003) indicates that it has the potential to colonize from higher established population segments. It is not known whether the roadcut colonizers replaced the population numbers that were lost in natural habitat, or if the roadcut colonizers persist and contribute to viability.

Oil and gas exploration and development, and development associated with mining are potential threats. In particular, the fragile soils and erodible slopes inhabited by *Lesquerella fremontii* are vulnerable to direct damage from road construction and habitat degradation by vehicles testing seismic lines. Well pads, roads, and other structures associated with oil, gas, and hard-rock mineral development may affect *L. fremontii* and its habitat. The population of *L. fremontii* reported from the top of Beaver Rim (Element Occurrence Record 009) is found within the Beaver Rim ACEC (Jones 1989). The Lander Resource Area Resource Management Plan (USDI Bureau of Land Management 1987) allows oil and gas development in this area with no surface occupancy stipulations. Six subpopulations of the Limestone Mountain population are within the BLM Red Canyon Management Unit ACEC. The management plan for this area is intended to protect wildlife and scenic values through seasonal controls on vehicle use and no-surface occupancy stipulations and other restrictions on mineral development (USDI Bureau of Land Management 1987). Subpopulations on adjoining Shoshone National Forest lands are not currently protected. These known and suspected threats are represented as malentities on an envirogram for *L. fremontii* (**Figure 10**).

Cattle-grazing occurs in the vicinity of the Beaver Rim and Limestone-Young Mountain populations of *Lesquerella fremontii*, but no plants were observed to be grazed during 1994 surveys (Fertig 1995a,b). Livestock use of *L. fremontii* habitat appears to be relatively minor due to the low amount of available forage, rugged

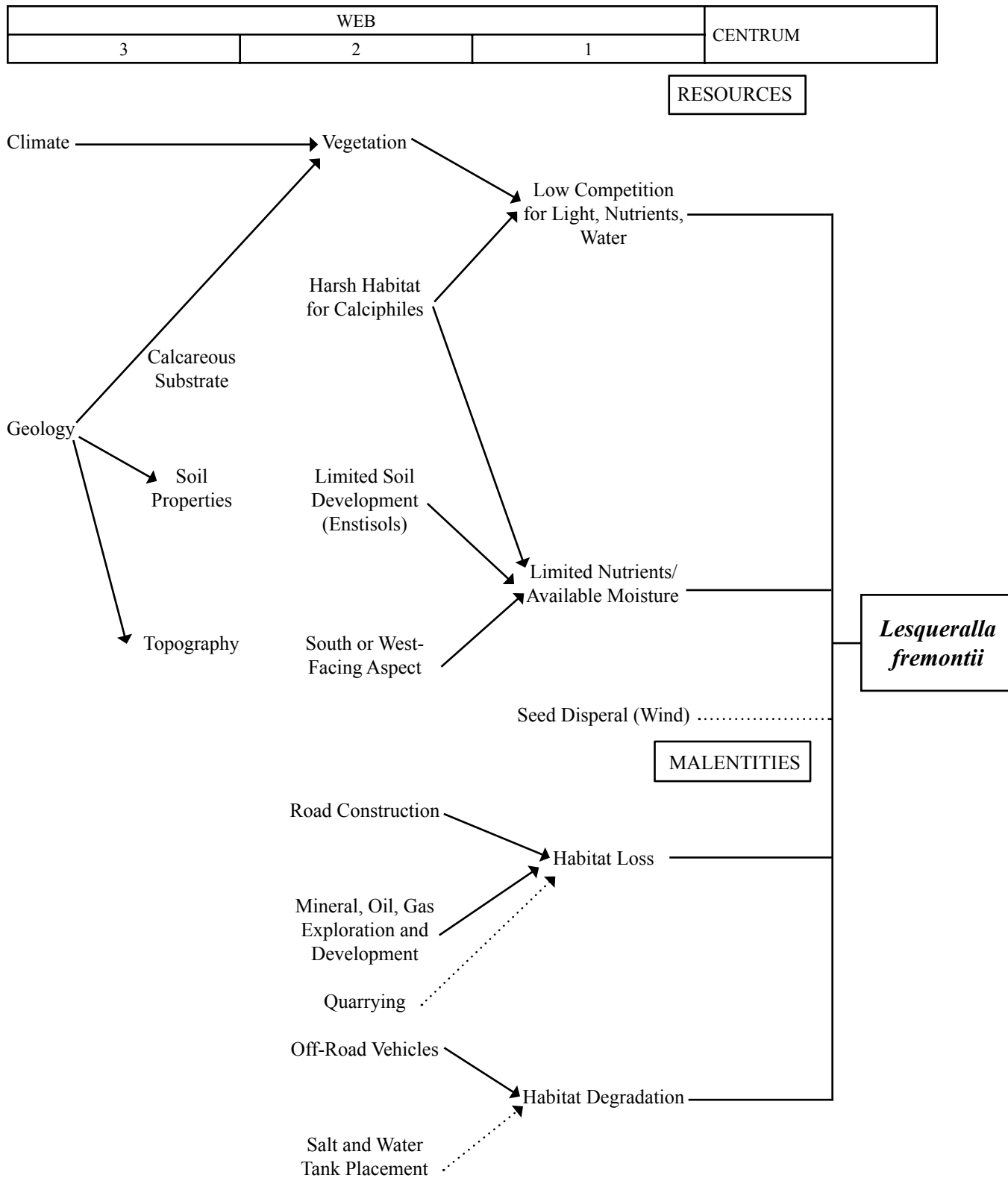


Figure 10. Envirogram of key resources and malentities for *Lesquerella fremontii*. Dashed lines indicate resources or malentities that are possible but not proven to be key variables.

terrain, lack of water and general late-summer timing of grazing. Furthermore, because of the early flowering and fruiting period of *L. fremontii*, late summer grazing probably does not adversely affect fruit production or dispersal (Fertig 1995b). Trampling by livestock is a potential threat at high stocking, and even heavy human traffic has proven detrimental to *L. filiformis* (Thomas and Willson 1992). Salt block and water tank placement also potentially affect *L. fremontii* habitat. A small subpopulation of the Limestone Mountain occurrence lies within The Nature Conservancy's Red Canyon Preserve where cattle-grazing is a management tool by the Conservancy.

No experimental data exist on the response of this species to management actions, such as prescribed burning or herbicide treatment. Detailed mapping of the Red Canyon population was established in the wake of the 2002 Red Canyon wildfire, and though a portion of the Limestone Mountain population was burned, species distribution has not been re-examined after the initial mapping. There are no noxious weeds reported in *Lesquerella fremontii* populations to date, but the potential exists. The invasion of exotic species, particularly those that are active early in the growing season or advance secondary succession, is also a potential threat.

There are no known instances of *Lesquerella fremontii* being excavated for transplanting, but it is considered to be a rock garden plant (Rock Garden Plant Database 2003). There are no other known or suspected consumptive uses of this species for commercial, recreational, scientific, or educational purposes.

Conservation Status in the Rocky Mountain Region

Lesquerella fremontii has a narrow distribution and specialized habitat requirements, making it vulnerable to habitat degradation and loss. Most occurrences fall within multiple-use management areas and are located in accessible settings. *Lesquerella fremontii* has no conservation status in the Rocky Mountain Region or the Shoshone National Forest, apart from its status as a sensitive species. Potential impacts to the species have been identified in USFS project reviews involving road construction (K. Houston personal communication 2003).

Conservation of *Lesquerella fremontii* on the Shoshone National Forest is a significant contribution to its viability. Four of the eight extant occurrences are

on the Shoshone National Forest, in part or in full. The largest of these is comprised of 27 subpopulations, 12 of which are on the Shoshone National Forest. In addition, two other unmappable collection sites of the species, including the type collection station, may have been on the Shoshone National Forest.

Potential Management in the Rocky Mountain Region

The elements necessary for maintaining *Lesquerella fremontii* viability in the Rocky Mountain Region center on maintaining its habitat. One of the key areas is around Limestone Mountain (including Young Mountain, Freaks Mountain, and Red Canyon), where the population is a magnitude larger than all others combined. The metapopulation concept may apply in this case, depending on pollination and dispersal agents. The coordinated maintenance of *L. fremontii* habitat at and around Limestone Mountain is challenging because this extensive population is split between different agencies and ownerships. The largest proportion of subpopulations (12 of 27) is on the Shoshone National Forest, and most public access is through or from the forest. This gives the forest a key role in regulating the traffic to and across *L. fremontii* habitat.

There is no information on the population trends of *Lesquerella fremontii* and natural fluctuations, or the life history context. It is appropriate to set goals of maintaining stable or growing populations, but it is impossible to meet them without first collecting baseline information through a monitoring program. The possibility of collaborating on monitoring with the BLM may warrant discussion insofar as monitoring plots have already been established in subpopulations located very near the Shoshone National Forest.

Prescribed burning has not been addressed. Even though the habitat of *Lesquerella fremontii* is sparsely-vegetated and carries low fuel load, it can burn in dry conditions when there are crown fires in surrounding habitat. Evaluation of this species' response to the 2002 wildfire that burned a portion of its Limestone Mountain population is needed to understand current status and to consider the affects of fire when setting wildfire management zones.

The process of updating the Bighorn National Forest plan is slated to begin in 2004 (K. Houston personal communication 2003), and the prospect of proposing research natural area designation for Arrow Mountain and other sites will be considered. The

planning process will also provide the framework for transportation planning and weed management planning that indirectly affect the species' management.

Tools and practices

Aerial photo-interpretation and GPS readings are valuable tools in documenting the distribution of sensitive species, and they would add detail and accuracy to the location information collected in past surveys of *Lesquerella fremontii*. The Wyoming Natural Diversity Database (WYNDD) survey results have all been mapped onto field maps. They have been digitized, and the resulting electronic data are available from WYNDD for future reference. The data to go with each of the subpopulation polygons documented in Fertig (1995) are available, but they have yet to be linked to polygons in the new Biotics database system designed for managing spatially complex data. Likewise, entry of the Sinks Canyon survey results (Scott and Scott 2003) is pending.

The three *Lesquerella fremontii* monitoring transects established on BLM lands in 1994 were set up as demographic transects (Fertig 1995). Yearly monitoring was not pursued, so it is not possible to get demographic information from a single re-reading of the belt transects in the future. However, they could still be used for their original purpose if there were a commitment for a minimum of three consecutive years of monitoring. The belt transects were set up following the monitoring techniques outlined in Lesica (1986). They were not set up for trend analysis, but may serve as an initial gauge. The only other dataset for evaluating trend of *L. fremontii* would be to evaluate presence/absence of *L. fremontii* in the Limestone Mountain subpopulations as mapped. If maintenance of overall numbers is the immediate objective, then this serves the purpose and provides the most rudimentary form of monitoring (Menges and Gordon 1996, Elzinga et al. 1998).

Any project planning, surveying, or monitoring work would also benefit from documenting the relative contribution of flowering and non-flowering plants to population numbers. It would also be valuable to note and to characterize the presence/absence of woody species encroachment, the presence/absence of invasive species, and the presence/absence of local disturbance and bare ground.

Information and Research Needs

Surveys to relocate two collection label sites of *Lesquerella fremontii* on the Shoshone Natural Forest

are needed. The national forest surveys include the type collection site of Ripley and Barneby (8931) and the Lichvar (2763) collection site located "5 miles west of Limestone Mountain." Revisits to the two occurrences that could not be relocated during 1994 drought conditions on BLM lands are also needed.

Systematic surveys of *Lesquerella fremontii* have not been conducted in the Shoshone National Forest, except in part of the Limestone Mountain area incidental to BLM surveys (Fertig 1995) and in the evaluation of the Arrow Mountain area as a potential research natural area (Jones and Fertig 1999). More recently, Richard Scott mapped *L. fremontii* populations in the Sinks Canyon area and in the Red Canyon area adjoining Limestone Mountain (Scott and Scott 2003). Additional systematic survey is warranted. The highest probabilities for finding new populations would be on unsurveyed slopes in the Wind River Range and Beaver Rim, identified by overlaying the potential distribution map with digital orthophotos or topographic maps at 7.5' or 15' scale, taking into consideration those areas that have already been surveyed (reported in Fertig 1995). The potential distribution model might also be incorporated in planning surveys to relocate the two previously-described collection label sites.

As part of survey efforts, more details are needed on the impacts of disturbances and on signs of succession in *Lesquerella fremontii* habitat. There are three tasks to be pursued along these lines. First, the potential influence of the Red Canyon fire to *L. fremontii* warrants preliminary evaluation by comparing populations as they were mapped before the fire to populations as they are mapped after the fire. A more refined monitoring design may be set up as dictated by outcome. Second, the contribution of roadside habitat to this species' viability needs closer examination, with surveys in surrounding habitats to understand relative numbers, and surveys in both settings to understand relative contribution to species' viability. Third, the effects of and potential expansion of off-road vehicle use on Limestone Mountain warrant further evaluation, particularly at the subpopulation closest to the new parking lot. On-site review may corroborate or refute the need for monitoring.

Life history baseline information is needed to set realistic trend goals for *Lesquerella fremontii*. It can be acquired through demographic monitoring that characterizes life history stages and their transitions. Information on the influence of climate is also needed, as indicated by the apparent absence of *L. fremontii* under drought conditions in the low elevation BLM

populations (Fertig 1995). Drought-induced declines in *L. carinata* var. *languida* numbers were documented in montane limestone slope habitats of Montana (Greenlee and Callaway 1996). Greenhouse studies may also contribute life history baseline information. Species biology research is lacking and warranted, particularly if demographic monitoring results point to the need for more research into the possible seed bank, pollination biology, or high mortality at certain stages.

Finally, research into the taxonomic and evolutionary relations between *Lesquerella fremontii* and its closest relative, *L. macrocarpa*, is needed as it potentially offers insight into the conservation status and needs of two similarly rare and vulnerable local endemic species.

DEFINITIONS

Agospermous – producing embryos and seeds without fertilization

Aneuploid – having a chromosome number that is more than or less than, but not an exact multiple of, the basic chromosome number

Calcareous – containing calcium carbonate

Calciphile – plant species that occurs mainly on calcareous substrate

Decumbent – having the lower part on the ground with tips rising gradually upwards

Dehisce – to burst or split open at maturity

Diploid – having a double set of homologous chromosomes

Endemic – native to, and restricted to, a particular geographical region

Extant – currently known to exist

Glabrous – smooth, lacking hairs

Indeterminate flowering – development of the inflorescence from the base upwards, so that theoretically it could continue to elongate indefinitely.

Inflorescence – flowering part of a plant, comprised of flowering stalk and flowers

Mesic – moderately moist

Metapopulation – A group of partially isolated populations connected by pathways of gene exchange (pollination or dispersal)

Outcrossing – breeding between genetically discrete individuals

Perennial – a plant which normally lives for more than two seasons

Phenology – seasonality and timing of growth and reproductive stages

Phenotypic plasticity – the capacity for marked variation in the morphology of an organism as a result of environmental influences

Polyploid – having more than two sets of homologous chromosomes

Prostrate – lying flat on the ground

Pubescent – covered with hair

Recurved – curved downward or backward

Rosette – a cluster of leaves radiating out from the base of the stem or primordial stem

Sedimentary – rock formed by deposition of particulate matter transported by wind, water or ice, or by precipitation from solution in water under normal surface temperatures and pressures, or by the aggregation of inorganic material from skeletal remains

Selfing – self-fertilization

Semelparous – capable of reproducing more than once in the life cycle

Silicle – a short fruit in the Brassicaceae, usually not more than 3 times as long as wide, and usually containing a single, membranous partition

Stellate – with three or more branches radiating out from the center

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