

**STATUS OF
LESQUERELLA MACROCARPA (LARGE-FRUITED BLADDERPOD),
AND *PHLOX PUNGENS* (BEAVER RIM PHLOX)
IN THE UPPER GREEN RIVER BASIN, WYOMING**



Prepared for the Bureau of Land Management
Pinedale, Kemmerer, Rock Springs Field Offices
and the Wyoming State Office

By Bonnie Heidel
Wyoming Natural Diversity Database
Dept. 3381, University of Wyoming
1000 E. University Ave.
Laramie, WY 82071

May 2009

Cooperative Agreement No. KAA041037, Modification No. 4

ABSTRACT

Surveys were conducted for two sensitive plant species that are state endemics found in the Upper Green River Basin, Large-fruited bladderpod (*Lesquerella macrocarpa*) and Beaver Rim phlox (*Phlox pungens*). Earlier status reports focused on other segments of their distribution in Wyoming. As a result of 2008 fieldwork, *Phlox pungens* has been found to be more extensive and numerous than previously known. The potential distribution model was suited for identifying additional occupied habitat. The local distribution of *Lesquerella macrocarpa* was expanded but no new occurrences were found. The potential distribution model did not identify additional habitat. Both species are concentrated in outcrop landscapes that overlap with energy exploration and developments.

In addition to the updated status information, a need for evaluating *Lesquerella macrocarpa* life history and trends has been identified. Taxonomic research has been identified as a need for *Phlox pungens* to evaluate whether the “Ross Butte morph” of the Upper Green River Basin is different from the “type morph” elsewhere in the state. The updated compilation differentiates these two morphological forms for future reference should they be found to warrant recognition as separate varieties.

Report citation:

Heidel, B. 2009. Status of *Lesquerella macrocarpa* (Large-fruited bladderpod) and *Phlox pungens* (Beaver Rim phlox) in the Upper Green River Basin. Prepared for the Bureau of Land Management. Wyoming Natural Diversity Database, Laramie, WY.

Cover: Ross Ridge habitat of *Phlox pungens* (white slopes in middle of photo) and habitat of *Lesquerella macrocarpa* below (low basin knolls in distance to the right) is localized on the Upper Green River Basin landscape

TABLE OF CONTENTS

I. INTRODUCTION.....	1
II. METHODS.....	2
III. STUDY AREA.....	3
IV. <i>LESQUERELLA MACROCARPA</i> SPECIES INFORMATION.....	5
A. Classification.....	5
B. Present legal or other formal status.....	5
C. Description.....	6
D. Geographical distribution.....	8
E. Habitat.....	10
F. Population biology and demography.....	12
G. Population ecology.....	17
H. Assessment and management recommendations.....	18
I. Conservation recommendations:.....	19
J. Summary.....	20
V. <i>PHLOX PUNGENS</i> SPECIES INFORMATION.....	21
A. Classification.....	21
B. Present legal or other formal status.....	21
C. Description.....	22
D. Geographical distribution.....	25
E. Habitat.....	31
F. Population biology and demography.....	33
G. Population ecology.....	36
H. Assessment and management recommendations.....	37
I. Conservation recommendations.....	39
VI. DISCUSSION.....	40
VII. LITERATURE CITED.....	41

APPENDICES

- Appendix A. 2008 survey routes *Phlox pungens* and *Lesquerella macrocarpa*
Appendix B. Element occurrence records and maps for *Lesquerella macrocarpa*, *Phlox opalensis*, and *Phlox pungens*

FIGURES AND TABLES

Figure 1. Upper Green River study area and outlying areas for surveys of *Lesquerella macrocarpa* and *Phlox pungens* in 2008

Figure 2. *Lesquerella macrocarpa* illustration

Figure 3. *Lesquerella macrocarpa* in fruit and late flower

Figure 4. *Lesquerella macrocarpa* in full flower and early fruit

Figure 5. Distribution of *Lesquerella macrocarpa*

Figures 6-8. Habitat of *Lesquerella macrocarpa* in the Upper Green River Basin

Figures 9-10. Position of *Lesquerella macrocarpa* on the landscape.

Figure 11. *Phlox pungens* illustration

Figure 12. *Phlox pungens* photo

Figure 13. Distribution of *Phlox pungens*

Figures 14-18. Habitat of *Phlox pungens* in the Upper Green River Basin

Figure 19. *Phlox pungens* in high density

Table 1. Location information for known occurrences of *Lesquerella macrocarpa*

Table 2. Species frequently associated with *Lesquerella macrocarpa*

Table 3. Size and extent of *Lesquerella macrocarpa* occurrences

Table 4. Distinguishing characteristics of *Phlox pungens*

Table 5. Location information for known occurrences of *Phlox pungens*

Table 6. Species frequently associated with *Phlox pungens*

Table 7. Size and extent of *Phlox pungens* occurrences

ACKNOWLEDGEMENTS

This report is an update that reflects on the work of many people. Robert Dorn discovered *Phlox pungens* and also conducted *P. pungens* surveys in Fremont County to address species' status. Robert Dorn, Robert Lichvar, Hollis Marriott (Wyoming Natural Diversity Database; WYNDD) and Walter Fertig (WYNDD) conducted *Lesquerella macrocarpa* surveys in Fremont County and adjoining Sweetwater County to address species' status. Subsequent discoveries of both species in the Green River Basin were made by Robert Dorn, Tom Cramer and Walter Fertig.

Jill Larson assisted in 2008 surveys for WYNDD. Joy Handley (WYNDD) assembled digital orthophotograph sets for fieldwork, helped process 2008 field results and create maps. Mark Anderson (WYNDD) provided area-of-occupancy calculations.

Access permission of an Opal landowner is gratefully acknowledged.

Jim Glennon coordinated this project for the three southwestern field offices of the Bureau of Land Management (BLM). This project was conducted as a challenge cost-share project between the BLM and WYNDD.

I. INTRODUCTION

This status report addresses two plant species, Large-fruited bladderpod (*Lesquerella macrocarpa*) and Beaver Rim phlox (*Phlox pungens*) in the Upper Green River Basin. Both species are endemic to Wyoming and were recognized as Category 2 plants for listing under the Endangered Species Act. Both species were addressed in a prior state status report, which provided or supported the basis for removing them from consideration for listing under the Act. The prior reports also provided a basis for considering their eligibility for designation as sensitive by the Wyoming Bureau of Land Management (USDI BLM 2001, 2002). However, both have bimodal distribution in Wyoming and the original state status reports for these species were completed without conducting surveys in the Upper Green River Basin. Thus, this report is an addendum to two pre-existing status reports.

In the following document, the resulting species information and species assessment narrative are reported separately for both species, while the methods, study area and discussion sections are presented in common. This document is intended as an independent reference for both species in the Upper Green River Basin, with the most current data on their distribution in the area. It draws heavily from the most recent status reports. The following introduction provides a brief history of research on the two species leading up to this study.

Lesquerella macrocarpa was first discovered by Aven Nelson in 1900 (Nelson 1902). It is designated a Wyoming BLM sensitive species (USDI BLM 2002) and was the subject of three state status survey reports when it was known mainly from the west rim of the Great Divide basin in Fremont County and adjoining north-central Sweetwater County (Whiskey Basin Consultants 1981, Marriott 1988, Fertig 1995a). In 1992, Robert Dorn collected it near Opal. Later Tom Cramer collected *P. pungens* during floristic inventories in the Green River Basin in 1994 at Ross Butte. The Ross Butte area, with its high concentration of Wyoming species of concern, was systematically inventoried from 1995-1997 documenting the *Lesquerella macrocarpas* population (Fertig 1998). Potential distribution models were developed for BLM sensitive species (Fertig and Thurston 2003) with additional intervening habitat identified in the Upper Green River Basin beyond the three known occurrences. A summary of the known and potential distribution was assembled for this study (Heidel 2008), to systematically survey it in the Upper Green River Basin. Priority was placed upon surveying it in the Pinedale Field Office, relocating it near Opal (in the Kemmerer Field Office), and compiling site-specific information unique to its Upper Green River Basin population centers.

Phlox pungens was first discovered by Robert Dorn in 1984 (Dorn 1990). It is designated a Wyoming BLM sensitive species (USDI BLM 2002) and was the subject of a state status survey when it was known from Beaver Rim and east slope of the Wind River Range in Fremont County (Dorn 1990). Later Tom Cramer collected *P. pungens* during floristic inventories in the Green River Basin in 1995 at Ross Butte. The Ross Butte area, with its high concentration of Wyoming species of concern, was systematically inventoried from 1995-1997 documenting a large *P. pungens* population complex (Fertig 1998). Tom Cramer and Walter Fertig later collected *P. pungens* in about 10 more Upper Green River Basin locales (Cramer and Hartman 1995, 1996). Fertig also collected a vegetative specimen provisionally identified as *P. pungens* from the Rock Creek Ridge foothills of the Tunp Range in 1997 (Lincoln County; WYNDD

2009). Potential distribution models were developed for BLM sensitive species (Fertig and Thurston 2003) with additional intervening habitat identified between the widely-scattered 12 Green River Basin collection records. Thus, a summary of the known and potential distribution was assembled for this study (Heidel 2008), to systematically survey it in the Upper Green River Basin. Priority was placed upon surveying it in the Pinedale Field Office, relocating it in flower in the Tunp Range (in the Kemmerer Field Office), and compiling site-specific information unique to its Upper Green River Basin population centers.

General objectives for surveys of both *Lesquerella macrocarpa* and *Phlox pungens* in 2008 were based on Heidel (2008):

1. Survey all known occurrences in the Upper Green River Basin, with emphasis on those that have no survey data (excluding Ross Butte as well-documented)
2. Survey the western outlying occurrences of both species
3. Seek new occurrences by testing the potential distribution models where there are large areas identified as potential habitat with no known occurrences (Figures 1 and 2 of Heidel 2008)
4. Seek new occurrences by photointerpretation, and compare results using this method with the models
5. Synthesize Upper Green River Basin occurrence data in a final status report

Other Wyoming species of concern were documented incidental to these surveys. Opal phlox (*Phlox opalensis*) warrants special mention as a local endemic concentrated in Wyoming. It is present in the Upper Green River Basin where it has overlapping distribution with *P. pungens* in the Upper Green River Basin, and has overlapping habitat with *Lesquerella macrocarpa*. In 1995, it was the subject of a state status survey report in the Kemmerer and Rock Springs Field Office (Fertig 1996). It was not designated a Wyoming BLM sensitive species. While it was not part of original objectives, its local occurrences are provided for reference in the appendix.

II. METHODS

Two approaches were taken in surveying *Lesquerella macrocarpa* and *Phlox pungens*. Information on distribution and habitat was obtained from secondary sources, including the prior status reports, subsequent collections at the Rocky Mountain Herbarium (RM) and their entry in the Wyoming Natural Diversity Database (2009), and all more recent studies documenting these species. Known collection stations were revisited to document the precise location, extent, numbers, and habitat that were previously reported by township-range locations on collect labels. All occurrences based solely on collections were relocated and surveyed, to determine their extent, population numbers, habitat characteristics, and the rest of the survey information covered on the Wyoming species of concern survey form. The surveys were conducted with the most complete element occurrence information and mapping available, also using U.S. Geological Survey (USGS) topographic maps (7.5'), and black and white digital orthophotography for reference. Accompanying sets of BLM surface management maps were assembled for use in directing all surveys to BLM-administered lands.

Additional potential habitat for *Lesquerella macrocarpa* and *Phlox pungens* was sought using the potential distribution models of Fertig and Thurston (2003) in combination with photointerpretation of black and white digital orthophotography. The polygons of “potential habitat” were projected onto digital orthophotographs and printed out for each quarter-quad having potential habitat, a scale that fit onto 8 ½” x 11” paper and corresponds to the scale of USGS topographic maps (7.5’) used for navigation, orientation and characterization. The many potential distribution polygons were reviewed and selected for field survey emphasizing the high probability areas, the largest areas without known occurrences, the farthest limits of potential distribution within the study area, and to expand surveys around known occurrences. The process of preparing for this survey was summarized in a preliminary report as a study benchmark (Heidel 2008).

Field surveys were conducted June 4-13, 2008 by a two-person team working in tandem, with one person focusing on known *Phlox pungens* occurrences, and the other focusing on known *Lesquerella macrocarpa* occurrences and testing of models for both species. At each site, the extent of local distribution was mapped by use of Geospatial Positioning Systems (gps) as geo-reference used to delimit polygons drawn onto the topographic maps. Data on population numbers, habitat, and species biology were collected using WYNDD plant survey forms. Photographs and vouchers were taken. Surveys were conducted in over 73 sections with suitable habitat of *L. macrocarpa* and/or *P. pungens*; including the sections where it was previously collected but not surveyed, as represented by the record of survey routes (Appendix A). Ross Butte was not resurveyed because it had been the target of intensive, multi-year surveys (Fertig 1998). The overlapping phenology of the two target species and measure of habitat similarities were such that the presence/absence of both species were addressed simultaneously during surveys. Information gathered in the field was entered into the computerized database of WYNDD.

Incidental to this study, a select set of *Phlox* specimens was collected, representing three species growing within 50 m of one another, and shipped to a *Phlox* researcher studying polyploidy in the *Phlox* genus as it relates to evolution and phylogeny. The specimens were collected along an elevation gradient that included (from top to bottom): *P. pungens*, *P. muscoides*, and *P. opalensis*. The leaf material was sent from the field and voucher material sent separately with processing of all 2008 specimens.

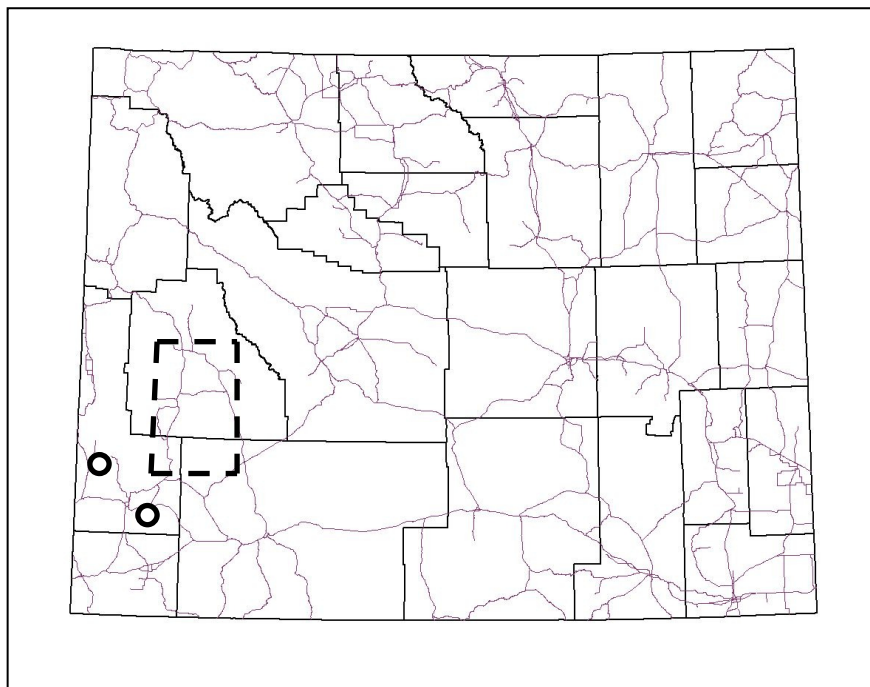
III. STUDY AREA

The study encompasses the Upper Green River Basin, representing the westernmost population centers of *Lesquerella macrocarpa* and *Phlox pungens*. This area is concentrated in the Pinedale Field Office, with known species’ distributions extending into an adjoining corner of the Rock Springs Field Office, and outliers in the Kemmerer Field Office. The study area spans three counties including Sublette, Sweetwater and Lincoln counties (Figure 1). The study area lies within the Upper Green River watershed (14040101) and the New Fork River watershed (14040102), in addition to the Opal study locales in the Blacks Fork River watershed (14040107) and the Rock Creek Ridge study locale in the Central Bear River watershed (16010102).

The Upper Green River Basin is a high intermontane basin. It has a prevalent Wyoming big sagebrush steppe vegetation cover (Merrill et al. 1996). It has prevalent Lower Eocene

surface geology (Love and Christiansen 1985). These vegetation and surface geology features are shared in common with large areas of the Wyoming Basin Ecoregion in southwestern and south-central Wyoming. It is distinguished from the rest of the Ecoregion, however, by the climatic and hydrological affects of mountain ranges bordering on three sides, and by the Fontenelle Tongue or Member of the Green River Formation, unique to this intermontane area.

Figure 1. Upper Green River study area and outlying areas for surveys of *Lesquerella macrocarpa* and *Phlox pungens* in 2008, Wyoming



The general climate is that of a cold steppe with winter drought. Nearest meteorological monitoring stations are at Big Piney, Daniel, LaBarge and Pinedale (USDI NOAA 2009). The former is centrally located, and has data from 1948-2000. At Big Piney, there is a mean annual precipitation of 20.7 cm (8.1 in), with May having the maximum precipitation of 2.6 cm (1.0 in). There is a mean annual temperature of 1.5° C (34.7 F), with July having the highest temperatures as 15.5° C (59.85° F). The growing season in Big Piney is limited, with a few weeks between mid-July to mid-August having greater than 50% probability of temperatures staying above freezing (32° F). This is consistent with the Big Piney nickname as “Ice Box of the Nation.” The 2008 surveys were conducted a year of average or above-average winter and spring precipitation, possibly a pivotal year at the culmination of a seven-year drought period.

The following two sections present separate status updates for *Lesquerella macrocarpa* and *Phlox pungens* in the Upper Green River Basin that includes a comparison with their status elsewhere in Wyoming.

IV. *LESQUERELLA MACROCARPA* SPECIES INFORMATION

A. Classification

1. Scientific name: *Lesquerella macrocarpa* A. Nels. (Nelson 1902)

More recently, the *Lesquerella* genus has been transferred to the closely-related *Physaria* genus (Al-Shehbaz and O’Kane 2002) in revisionary treatments based on molecular analysis.

2. Synonyms: None. The information posted on the Flora of North America homepage (<http://hua.huh.harvard.edu/FNA/>) indicates that Volume 7, containing Brassicaceae, will follow the new genus treatment (above). This means that *Lesquerella macrocarpa* will be transferred to the *Physaria* genus, a treatment that will be considered in updates to the Wyoming species of concern list.

3. Common name: Large-fruited bladderpod.

4. Family: Brassicaceae (Mustard family).

5. Size of genus: The *Lesquerella* genus was recognized by Rollins (1993) as comprised of 95 species, all native to North and South America. Twelve species, one with two varieties, occur in Wyoming (Dorn 2001). New species and combinations have also been proposed for the thirteen original taxa, splitting the widespread “*L. alpina*” into at least two more species as present in Wyoming (Grady and O’Kane 2007).

6. Phylogenetic relationships: Payson (1922) considered *Lesquerella macrocarpa* to be a recent derivative of *L. ludoviciana* (synonym *L. argentea*), which it resembles in certain technical features of the fruit and ovules. Rollins and Shaw (1973) disagreed with this interpretation, placing *L. macrocarpa* in the *L. prostrata* – *L. occidentalis* group based on its inflated fruits. This group is intermediate between the *Lesquerella* and *Physaria* genera, as recognized by Rollins (1993).

B. Present legal or other formal status

1. National

a. Legal status: Listed as a Category 2 (C2) species by the U.S. Fish and Wildlife Service (1993). Category 2 species were taxa for which proposing to list them as endangered or threatened was considered appropriate but for which substantial data on biological vulnerability and threats were not currently known or on file to support the preparation of rules. The Category 2 list was discontinued in 1996, and *L. macrocarpa* has no current status under the Endangered Species Act.

BLM Wyoming maintains a list of sensitive species to help focus management efforts towards maintaining habitats under a multiple use mandate and to prevent future listing as a threatened or endangered species. *Lesquerella macrocarpa* was placed on the first BLM Wyoming sensitive species list in 2001, and retained in the 2002 update (USDI BLM 2001, 2002).

b. Heritage rank: Ranked G2 by NatureServe, which was previously The Nature Conservancy's natural heritage network system. As a species, *Lesquerella macrocarpa* is considered imperiled because of rarity throughout its range (less than 20 extant occurrences are known). This global rank may need to be updated, particularly if long-term declines are documented.

2. State

a. Legal status: None.

b. Heritage rank: WYNDD ranks *Lesquerella macrocarpa* as S2, indicating that it is imperiled because of rarity in Wyoming (Heidel 2007).

C. Description

1. General non-technical description: *Lesquerella macrocarpa* is a densely silvery-gray pubescent perennial herb with decumbent stems 5-30 cm long. The basal leaf blades are ovate to oblanceolate, 0.5-3 cm long, 3-20 mm wide, and petioled. Stem leaves are narrower and stalkless. Flowers have four yellow petals 4-7 mm long. The inflated, globose fruits are 4-8 mm long and borne on recurved stalks. The fruits are slightly hairy on the outer wall and glabrous on the inner surface (Rollins 1993, Dorn 1980; Fertig et al. 1994; Fertig 1995a, Figures 2-4).

2. Technical description: Small perennial, densely pubescent; trichomes sessile or on a short stalk, finely granular, rays 4-6, distinct at base, forked or rarely bifurcate. Stems prostrate to decumbent, simple or branched, 0.5-1.5 dm long. Basal leaves entire or rarely remotely dentate, petiolate, 1.5-3 cm long, blades orbicular to broadly obovate. Cauline leaves elliptical to oblanceolate, entire and obtuse, sessile or the lower with a short petiole, 1.-2.5 cm long. Sepals 5-5.5 mm long, broadly ovate or oblong-elliptic. Petals yellow, ca 7 mm long, blade cuneate or broadly obovate and slightly narrowed to a broad claw. Paired stamens about 5.5 mm long, single stamens 4.5 mm long. Fruiting pedicels stout and sharply recurved, 5-10 mm long. Siliques 5-7 mm long, sessile, subglobose to broadly obovoid, often slightly compressed contrary to the plane of the septum, valves thin and inflated, sparsely pubescent on exterior, glabrous on interior, styles 2-3 mm long, ovules 2-4 per locule, seeds somewhat flattened, neither margined nor winged (adapted from Rollins and Shaw 1973 and Rollins 1993; in Fertig 1995a).

3. Local field characters: *Lesquerella macrocarpa* can be recognized by its rosette of oval to oblanceolate leaves, and its inflated globe-shaped fruits on recurved stalks. The fruit walls are slightly hairy on the outside and glabrous on the inside.

4. Similar species: *Lesquerella fremontii* has smaller fruits that are slightly flattened and densely pubescent on the outer walls and lightly hairy on the inner walls. Other Wyoming species of *Lesquerella* differ in having linear leaves or fruits borne on ascending or S-shaped fruit stalks. The fruits of *L. macrocarpa* resemble but are smaller those of twinpods (*Physaria* species) and they are rounded at the top rather than notched and divided into two balloon-like bladders (Marriot 1988, Dorn 1992, Fertig et al. 1994).

Figure 2. *Lesquerella macrocarpa* illustration by Jane Dorn, from Fertig et al. 1994

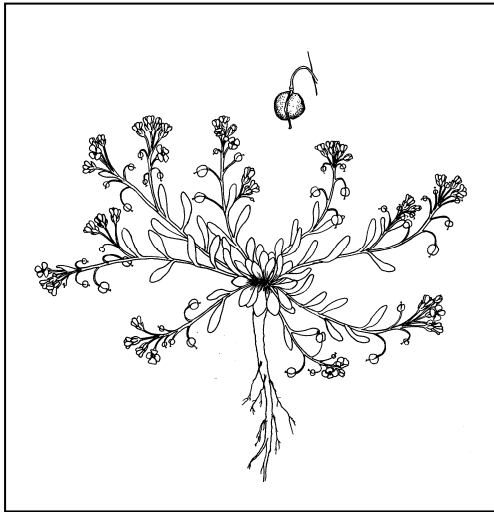


Figure 3. *Lesquerella macrocarpa* in fruit and late flower, by B. Heidel (Roberson Cr, #008, 12 June)



Figure 4. *Lesquerella macrocarpa* in full flower and early fruit, by B. Heidel (Blue Rim, #010, 7 June)

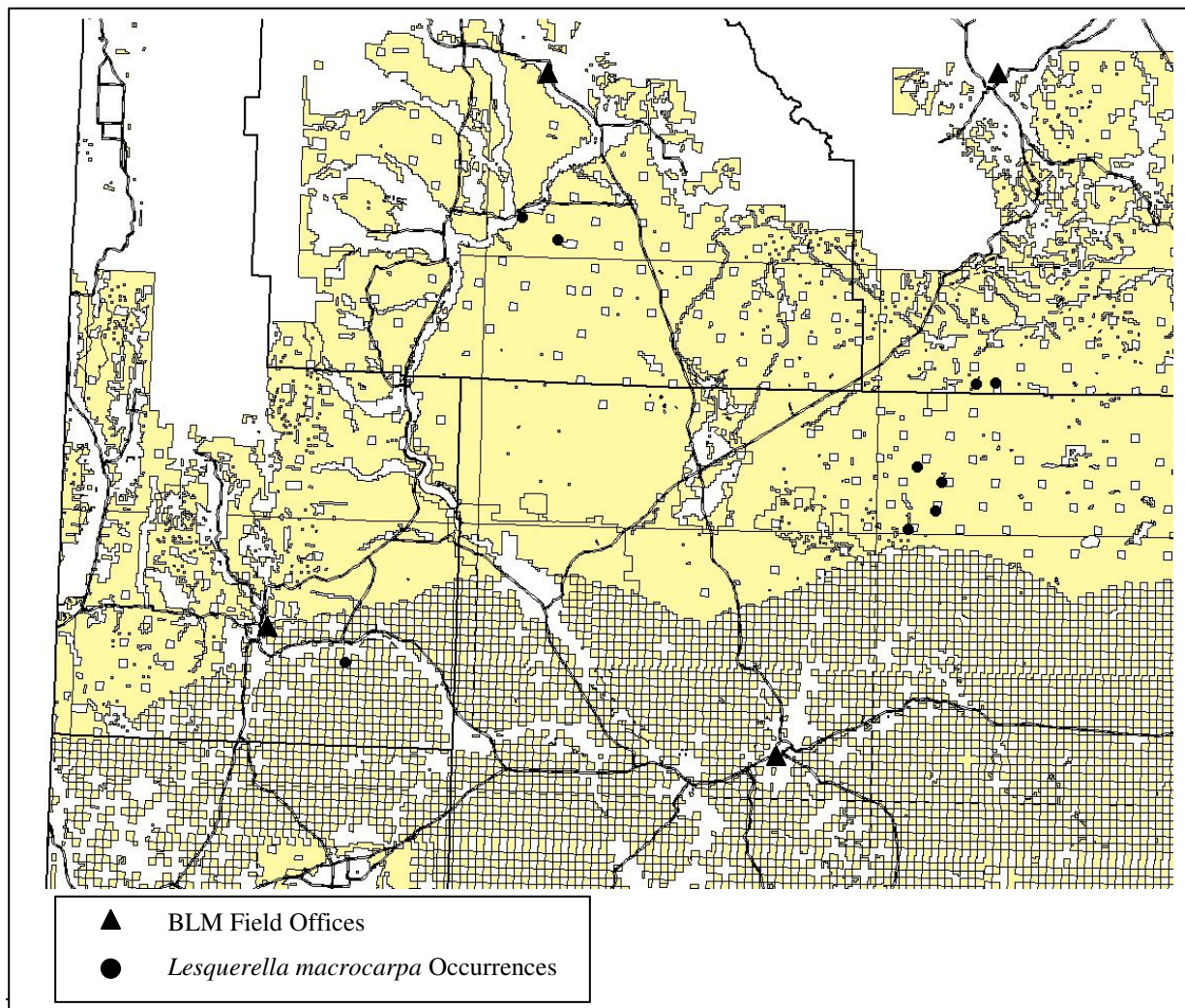


D. Geographical distribution

1. Range: Endemic to the western rim of the Great Divide Basin (Fremont and Sweetwater Counties), and the Green River Basin, near Opal (Lincoln County) and Ross Butte area (Sublette County) in Wyoming (Figure 5).

It was first discovered by Aven Nelson in 1900 at Bush Rim (Nelson 1902). Systematic surveys were conducted in the Bush Rim and the Continental Peak areas in the 1980's (Whiskey Basin Consultants 1981, Marriott 1988), representing its eastern population centers. It was first collected in the Upper Green River Basin in 1992 by Robert Dorn in the Roberson Creek area south of Opal. In 1994, it was documented farther north in the Basin by Tom Cramer in the Ross Butte area east of Big Piney (Cramer and Hartman 1995, 1996). The first status survey report (Fertig 1994) failed to find additional occurrences, and 2008 surveys failed to find additional occurrences (Appendix A).

Figure 5. Distribution of *Lesquerella macrocarpa*¹



¹ *Lesquerella macrocarpa* is a state endemic. This map represents its global distribution and its state distribution.

Table 1. Location information for known occurrences of *Lesquerella macrocarpa*

EO#	Site Name	County, State	Legal Description	Elev. (ft)	USGS 7.5' Quad	Location
001	Bush Rim/Steamboat	Sweetwater	T24N R102W S35, 36	7760	Monument Ridge	Great Divide Basin; Continental Divide, on rim above of Blind Canyon, ca 1.5 miles east of Jack Morrow Creek.
002	Bush Rim/Steamboat	Sweetwater	T24NR101W S3, 5, 8; T24N R102W S12; T25N R100W S19, 20, 29, 30; T25N R101 S35, 36 T25N R102 S1, 2	7100-7650	Freighter Gap, Monument Ridge	Great Divide Basin; south, west, and northeast sides of Bush Rim (northeast of Steamboat Mountain).
003	Continental Peak	Sweetwater	T27N R100W S27, 28, 33	7500-7700	Dickie Springs, Continental Peak	Great Divide Basin; bench between Oregon Butte and Continental Peak, ca 2 air mi northwest of summit of Continental Peak..
004	Continental Peak	Sweetwater	T27N R100W S25	7560-7600	Continental Peak	Great Divide Basin; ca 1 air miles north-northeast of Continental Peak (near the headwaters of Sand Creek.).
006	Bush Rim/Steamboat	Sweetwater	T25N R101W S20	7400	Rock Cabin Spring, Monument Ridge	Great Divide Basin; Middle Hay Bar X Ranch Road (base of ridge ca 3.5 miles north of Bush Rim).
007	Bush Rim/Steamboat	Sweetwater	T24N R101W S21	7400	Freighter Gap	Great Divide Basin; north-south trending ridge ca 1 mile east of Freighter Gap Road near the head of tributary channels of Alkali Draw, ca 2.25 miles southeast of Bush Rim.
008	Roberson Creek/Opal	Kemmerer	T20N R114W S8	6740-6760	Roberson Creek	Green River Basin; near the headwaters of Roberson Creek, west of the Roberson Creek Road, ca 3 miles south of Opal.
009	Ross Butte	Lincoln	T30N R110W S13, 14, 23, 24	6800-7480	Ross Butte	Green River Basin; Ross Butte, ca 0.75-1.6 miles south of the New Fork River. 4 locations:
010	Blue Rim and vicinity	Lincoln	T29N R109W S3; T30N R109W S21, 23, 24, 26, 27, 28, 34	7040-7250	Olsen Ranch	Green River Basin; north and east of Ross Ridge, ca 15 air miles east of Big Piney in the vicinity of Burma Point and North Alkali Draw. 15 locations.

2. Extant sites: There are ten occurrence records by current mapping conventions, but they could be aggregated into as few as four discrete population centers (Figure 5). Two population centers, represented by three (occurrences #008-010) were addressed in 2008 surveys, in the Opal area and the Ross Butte area. Exact locations of extant populations are listed in Table 1. More detailed information is provided in the element occurrence records and maps in Appendix B.

The tally of extant occurrences is complicated in the Great Divide Rim by spatially complex distribution and uncertainty over what to consider as extant. Surveys for *Lesquerella macrocarpa* in the early 1980's resulted in the discovery of two primary population centers of *L. macrocarpa* in the Bush Rim and Continental Peak areas, variously interpreted as representing either four (Whiskey Basin Consultants 1981) or seven (Marriott 1988) occurrences. Three of the seven occurrences are provisionally treated as extant though they were sought but not found in 1994 and have not been relocated since 1981.

3. Historical sites: Nelson (1902) discovered the type locality of *Lesquerella macrocarpa* "near Bush Ranch" in 1900. It is presumed that Nelson's location is the same as the extant Bush Rim occurrence (#002). Merrill and Wilcox also collected *L. macrocarpa* "45 miles north of Points of Rocks" in 1901 (Payson 1922). Based on mileage, this collection may be from the Continental Peak area.

4. Populations known or assumed extirpated: Whiskey Basin Consultants (1981) documented a small colony of *Lesquerella macrocarpa* on a bench between Oregon Butte and Continental Peak (#003). This site was surveyed in 1994, but no plants and little potential habitat were observed, and local habitat was disturbed by vehicle travel or parking. Since signs of disturbance were present, it is possible that this occurrence is extirpated.

5. Unverified/Undocumented reports: None known.

6. Sites where present status not known: Hardy (1987) mapped a location of *Lesquerella macrocarpa* in the vicinity of Rock Cabin Dugway, about 5 air miles northwest of Bush Rim (T24N R102W S23). This site is not reported in any other literature sources nor is it based on known herbarium specimens. This site has not been surveyed and its authenticity still needs to be confirmed.

7. Areas surveyed but species not located: Surveys in 2008 focused on fine-textured outcrops in the Upper Green River Basin of Sublette County, within potential habitat areas identified in a distribution model. These surveys were conducted in combination with surveys for *Phlox pungens*. Survey routes are shown in Appendix A. They are additions to the survey routes reported by Dorn (1980), Whiskey Basin Consultants (1981), Marriott (1988) and Fertig (1995).

E. Habitat

1. Associated vegetation: *Lesquerella macrocarpa* typically occurs within sparsely-vegetated habitat of Gardner saltbush-squirreltail (*Atriplex gardneri* – *Elymus elymoides*) communities, or at the unvegetated margins of them, on barren, fine-textured soils, and such "typical" habitat is found at Roberson Creek (Opal; Figure 6). It is absent from areas dominated by sagebrush or

high cover of grasses. There is not a saltbush zone at North Alkali Creek (Figure 7) and it lies above an abrupt Gardner saltbush zone at Blue Rim (Figure 8).

2. Frequently associated species: The species frequently associated with *Lesquerella macrocarpa* are much the same in the Upper Green River Basin (Pinedale FO) as in the western Great Divide Rim (Rock Springs FO). There are slight differences between the Roberson Creek occurrence near Opal (Kemmerer FO) and the other two (Table 2).

Table 2. Species frequently associated with *Lesquerella macrocarpa*

<i>Scientific name</i>	Common name	Pinedale FO	Kemmerer FO ²	Rock Springs FO ³
<i>Achnatherum hymenoides</i>	Indian ricegrass		X	X
<i>Allium textile</i>	Textile onion			X
<i>Artemisia pedatifida</i>	Birdsfoot sagebrush			X
<i>Atriplex gardneri</i>	Gardner saltbush	X	X	X
<i>Atriplex suckleyi</i>	Rillscale			X
<i>Camissonia subacaulis</i>	Long-leaved evening primrose			X
<i>Chrysothamnus viscidiflorus</i>	Green rabbitbrush	X		
<i>Cryptantha caespitosa</i>	Tufted cat's-eye	X		
<i>Cymopterus acaulis</i>	Plains cymopterus	X	X	X
<i>Elymus elymoides (Sitanion hystrix)</i>	Squirreltail	X	X	X
<i>Ericameria nauseosa</i>	Rabbitbrush	X		
<i>Eriogonum microthecum</i>	Slenderbush buckwheat	X		
<i>Ipomopsis congesta var. congesta</i>	Ballhead ipomopsis	X		X
<i>Lomatium foeniculaceum</i>	Fennel-leaved desert-parsley	X		X
<i>Lomatium nuttallii</i>	Nuttall's desert-parsely	X		
<i>Monolepis nuttalliana</i>	Poverty-weed	X		
<i>Musineon divaricatum</i>	Leafy musineon			
<i>Phacelia demissa</i>	Intermountain phacelia			
<i>Phacelia glandulosa var. deserta</i>	Desert glandular phacelia	X		
<i>Phacelia salina</i>	Bittercreek scorpionweed	X		
<i>Phlox hoodii</i>	Hood's phlox			X
<i>Phlox opalensis</i>	Opal phlox	X		
<i>Stenogonum salsuginosum</i>	Smooth two-whorl buckwheat	X		
<i>Sphaeralcea coccinea</i>	Scarlet globemallow		X	
<i>Tetradymia canescens</i>	Spineless horsebrush	X	X	
<i>Thelypodopsis elegans</i>	Elegant thelypody			X

² This column represents the associated species at Roberson Creek (Opal)

³ This column is taken from Fertig (1995)

3. Topography: Throughout its range, *Lesquerella macrocarpa* typically occurs on gentle, upland slopes of 0-15% on low hills, knolls and colluvial fans (Figures 6-8). Its position on the landscape in the Upper Green River Basin parallels that at the rim of the Great Divide Basin, as reprinted from Fertig (1995a; Figures 9-10). It is usually absent from ridgetops, summits and mesic draws. However, in the Roberson Creek (Opal) area, it was mainly on a mound-like knoll that rose above surrounding gently-rolling terrain. In the Ross Butte area, it was mostly on low Badlands ridges, knolls and low, reddish tongue-like mounds that extend from the base of Blue Rim (Figure 8). Elevations range from 6740-7760 ft. The lowest elevation site is at Roberson Creek (Opal). The Upper Green River occurrence elevations overlap with those to the east.

4. Soil relationships: Known occurrences of *Lesquerella macrocarpa* are restricted to extremely fine-textured clays and shales, often with gypsum or bentonite present (Dorn 1980). They are mapped as three different Eocene formations or members as sedimentary deposits in Eocene Lake Gosiute, a large, shallow playa lake. They include the Fontenelle-Tongue member (early Eocene outcrops at the Ross Butte area) with oil shales, marlstones, limestones and siltstones; the Laney member of the Green River Formation (mid Eocene outcrops at the Roberson Creek area) with oil shale and marlstones; and the Bridger Formation (late Eocene outcrops at the western rim of the Great Divide Basin) with tuffaceous sandstone, claystone, marlstone and conglomerate (from Christiansen and Love 1985).

Soil texture and moisture-retaining capacity may be especially critical in determining the suitability of microsites for seedling establishment (Whiskey Basin Consultants 1981). *L. macrocarpa* is usually absent from rocky soils, but may occur on fine-textured soils covered by a thin layer of oily-shale rocks (Fertig 1995a). T

5. Regional climate: Average annual precipitation in the west rim of the Great Divide Basin is 27.9 cm (10-12 in; Fertig 1995a citing Martner 1986). Mean annual temperature in the same area is 3.3°-4.4° C (38°-40° F). By contrast, the Upper Green River Basin has lower annual precipitation of 20.7 cm (8.15 in) and lower annual temperature of 1.5° C (34.7° F) than the Great Divide Basin (USDI NOAA 2009). In the potential distribution model with best fit (Fertig and Thurston 2003), maximum July temperature followed by elevation were primary distinguishing environmental characteristics used to identify potential habitat.

6. Local microclimate: *Lesquerella macrocarpa* occurs on light-colored, barren substrates on gentle slopes. These sites are exposed to high levels of solar radiation and wind, and are likely to be drier and warmer than adjacent, more highly-vegetated sites (Fertig 1995a).

F. Population biology and demography

1. Phenology: Flowering occurs from mid May to late June, depending on spring moisture conditions. Fruiting has been observed from late May to July (Fertig 1995a). Reports of fruit persisting to September (Weynand and Amidon 1990; Fertig et al. 1994) are probably erroneous. Fruits are needed for positive identification. Flowering was at peak stage on 4 June at the start of 2008 field surveys and there were mature fruits a week later. The phenology was as much as a week advanced at Opal compared to the Upper Green River Basin occurrences, with plants in fruit and late flower on 12 June.

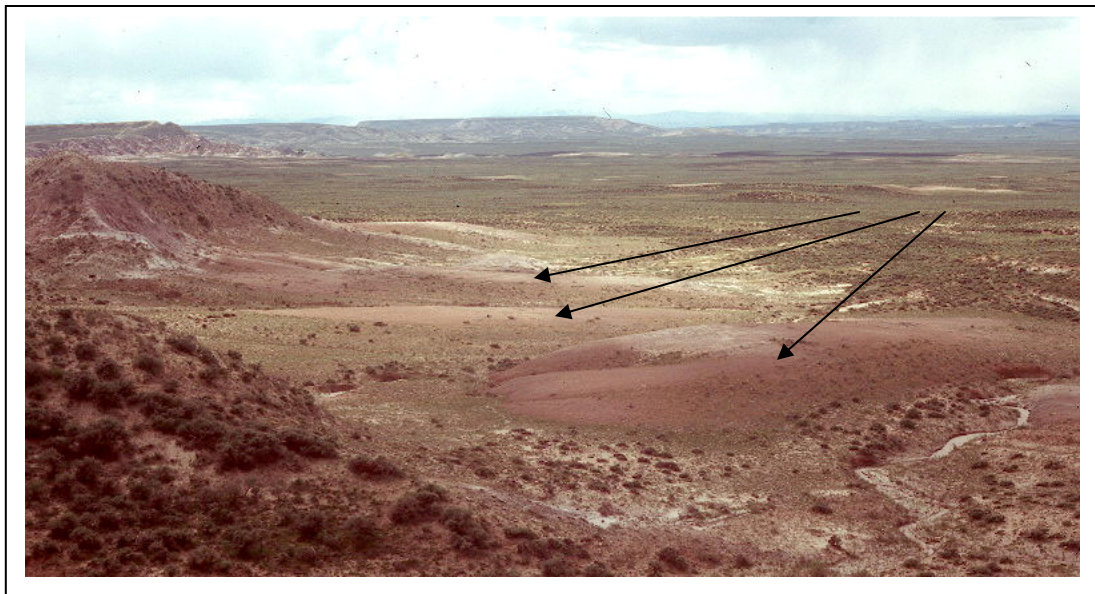
Figure 6. *Lesquerella macrocarpa* habitat on shale knoll (Roberson Creek, #008), by B. Heidel



Figure 7. *Lesquerella macrocarpa* habitat on Badlands (North Alkali Creek; #010) by B. Heidel



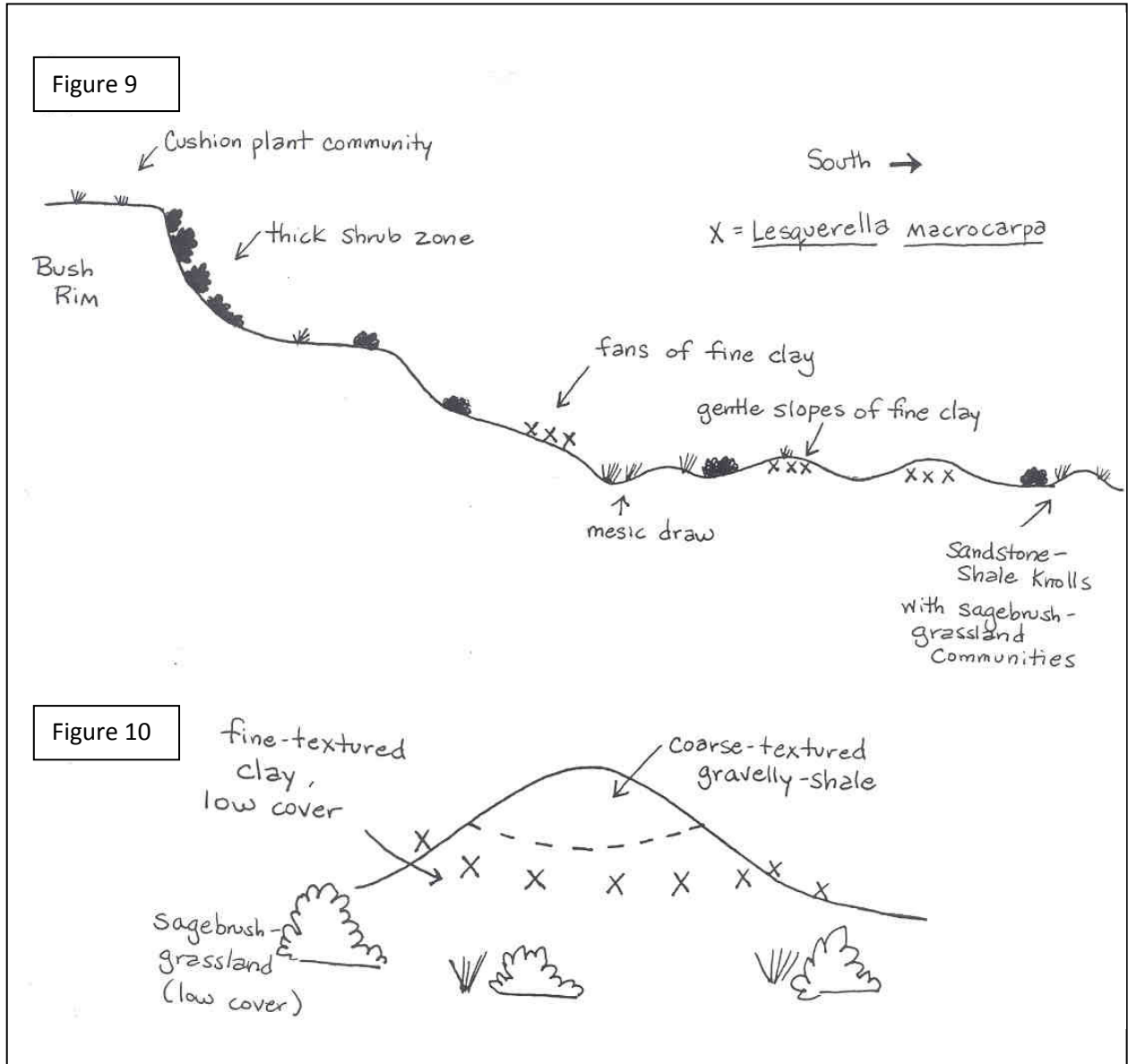
Figure 8. *Lesquerella macrocarpa* habitat on low mounds (Blue Rim; #010), by B. Heidel



Figures 9 and 10. Position of *Lesquerella macrocarpa* on the landscape.

Figure 9. View looking south from Bush Rim near the site of Transect #1. *L. macrocarpa* plants are restricted to gentle fans and slopes of low hills with sparse vegetation cover and extremely fine-textured soils.

Figure 10. Close-up of a low hill showing the localized distribution of *L. macrocarpa*. Illustrations by W. Fertig, from Fertig (1995a).⁴



⁴ The settings of *L. macrocarpa* at Ross Butte, Ross Ridge and Blue Rim are consistent with the schematic diagrams of Bush Rim habitat above except that many have north-facing aspect, e.g. Figure 8. The settings in Sec. 34 above North Alkali Creek are in Badlands on barren benches and toeslopes, Figure 7. The settings at Roberson Creek (Opal) are mainly on a low exposed knoll that is higher than the surrounding landscape, where the species is on upper slopes and more common on the north aspect than the south aspect, Figure 6.

2. Population size and condition: There are 10 occurrences previously tallied as representing 52,000 – 52,300 plants (Fertig 1994) and presumed to have numbers in the 10,000’s most years (Table 3). The Upper Green River Basin occurrences included an estimated 2700-3000 plants based on 2008 survey results. These tallies represent reproductive numbers, the meaningful stage for population tallies. The total area of populations may also vary between years. Depending on mapping conventions, there are at least 2000 acres and probably closer to 3000 acres of occupied habitat. The area of occupancy for the two population centers totals 53,392 ac (21,607 ha).

Table 3. Size and extent of *Lesquerella macrocarpa* occurrences

EO#	Site Name	Numbers ⁵	Digitized Extent (ac) ⁶	Trends
001	Bush Rim/ Steamboat	4975 (1981)	53.9	Short-term decline? Not relocated in 1994.
002	Bush Rim/ Steamboat	46,119 (1981); 50,000 (1994)	2169	Stable, followed by short-term decline? Locally rare in 2003.
003	Continental Peak	202 (1981)	20.2	Short-term decline or extirpated? Not relocated in 1994.
004	Continental Peak	630 (1981); 1500-1800 (1994)	79.9	Increase?
006	Bush Rim/ Steamboat	Undetermined	(772.4)	Short-term decline? Not relocated in 1994.
007	Bush Rim/ Steamboat	10,000 (1995)	21.8	Short-term decline? Locally rare in 2003.
008	Roberson Creek/Opal	500 (2008); 500 (1994)	4.2	Stable
009	Ross Butte	450+	(628)	Unknown
010	Blue Rim	1700-2000	42.2	Unknown
	TOTAL	Est, 10,000-70,000	Est. 2000-3500	

3. Population trend: *Lesquerella macrocarpa* is a biennial or short-lived perennial, so that population numbers are strongly-affected by seed germination levels and seedling survival rates. Population trend data are very limited and warrant further investigation. There were almost no vegetative *L. macrocarpa* plants found in 2008 surveys, supporting the interpretation that the population numbers were still showing the affects of drought. The absence of a mixed age structure may indicate that there was only one set of climate conditions and accompanying germination event since the decline of drought conditions.

⁵ Note: The original 1981 estimates included both flowering and non-flowering plants. Only the flowering plants were tallied in 1994, 1995 and 2008 and are used in this table.

⁶ Occurrences that are mapped as points with buffers of uncertainty are set off in parentheses as overestimates.

The winter and spring climate conditions for 2008 surveys were moist and mild compared to extended drought conditions of prior years. Anecdotal comments from Steve Laster indicated that numbers were relatively low in the colony with which he was familiar (Laster personal communication 2008 to B. Heidel re. T30N R109W Section 34). Given that *L. macrocarpa* life history spans over a year from germination to flower production, the effects of abundant winter and spring moisture in 2008 may not be evident as increase in flowering plant numbers until 2009 at the earliest. It was also noted that many plants at Blue Rim produced a later, second set of flowering branches in 2008 (Figure 4), prolonging flowering and increasing seed production.

Elsewhere, it was suggested that populations are stable over the long term in the Bush Rim area (Fertig 1995a), concluding that the tabulation of 52,000-52,300 plants in 1994 is comparable to the 1981 survey estimate of 83,910 plants if the non-reproductive segment of the 1981 estimate is excluded. The addition of about 2,500 plants in 2008 hypothetically brings the tally to 54,500-55,500 plants.

However, it may be misleading to aggregate the tallies of the species in any given place and time with those of others from different years. Three of the six occurrences surveyed in 1981 could not be relocated in 1994 or 1995 (#001 at Continental Divide rim above Blind Canyon, #003 at Oregon Butte, #006 at Middle Hay Bar X Ranch Road). Only one of the sites showed signs of disturbance from vehicles. The failure to find these three occurrences warrants at least one more concerted survey during favorable climate conditions before concluding that they are locally extirpated. Two occurrences were visited in 2003 by Wyoming Native Plant Society members during prolonged drought. At one roadside stop in the middle of an extensive population where numbers have been reported in the thousands (#002 at Bush Rim), extended searches turned up one plant. At another occurrence (#007 east of Freighter Gap Road), the occurrence that was reported as having 50,000 plants in 1994, i.e., over 98% of the known plants at the time in a dry year. In 2003, no more than 50 plants found in preliminary inspection. Moreover, the plants were only found within the bladed roadside margin of sparse vegetation rather than on intact slopes, a pattern that has not been reported before. The 2003 visits were not systematic surveys, and were in the third year of prolonged drought, but they indicate that population numbers can decline. It may be more appropriate to bracket high and low population estimates if there were suitable survey results.

Permanent demographic data collected in the drought years of 1988 and 1994 support the hypothesis that population numbers fluctuate in response to moisture conditions. Plots sampled in 1988 (following the drought year of 1987) contained 0.23-0.8 flowering and fruiting plants per square meter, and almost no seedlings. These same plots were resurveyed in 1994 (following the wet summer of 1993), and densities of flowering and fruiting plants were found to range from 0.4-6.5 plants per square meter. Seedling density was equally low in 1994 as 1988, suggesting that drought conditions were reducing seed germination or survival. The monitoring transects set up in 1988 in the Bush Rim area have not been revisited since 1994.

4. Reproductive biology

- a. Type of reproduction: Reproduction is by seed. Field observations suggest that many plants

die after producing fruit, suggesting a semelparous (monocarpic) reproductive trait and a short life-history as biennial or short-lived perennial, as characteristic of the genus. Demographic studies are needed to determine if the species is strictly semelparous or can survive to flower and fruit in successive years. It is likely to have a seed bank, a cryptic phase in the life history that buffers the species from prolonged adverse conditions, that may promote large oscillations in numbers and that delays germination to wetter springs (Whiskey Basin Consultants 1981).

b. Pollination biology: Unknown. The plant's yellow flowers are likely to attract flies or other small insect pollinators (Whiskey Basin Consultants 1981).

c. Seed dispersal and biology: The seeds of *Lesquerella macrocarpa* are somewhat flattened but lack wings or other structures to facilitate dispersal (Rollins 1993). It was suggested by Fertig (1995) that the branches may serve as the dispersal unit, breaking off, and establishing clumps of new plants. Dispersal by wind and water erosion might also account for or contribute to patchy patterns of local distribution. The soils often contract and crack at the surface later in the growing season, possibly also accounting for patchy local distribution and a mechanism for seed burial when seeds fall into cracks and are buried by soils that later expand with moisture.

Germination requirements of the seeds are unknown. Due to the rigors of its desert habitat, it is likely that seeds of *L. macrocarpa* can remain dormant for one to several years, forming a seed bank, a key factor in understanding population trends (above). The presence and longevity of the seed bank has not been evaluated.

G. Population ecology

1. General summary: The 2008 Upper Green River surveys results refine earlier inferences that *Lesquerella macrocarpa* may be locally abundant during favorable years with adequate spring moisture, but may decline significantly during drought years of successive dry conditions. The relatively moist winter and spring precipitation of 2008 were conducive to germination but not of sufficient duration for newly-germinated plants to flower. Monitoring is needed in consecutive years to corroborate climate-driven oscillations.

2. Competition: *Lesquerella macrocarpa* is often in zones or microhabitats with little or no other vegetation. Preliminary demographic data from 1988 and 1994 suggested that populations with higher densities may contain smaller individual plants (Fertig 1995a), reflecting intraspecific competition. It is rarely found on adjacent areas with higher cover of bunchgrass or sagebrush, whether because it is intolerant of interspecific competition, or because the well-vegetated habitats have conditions like shading that render it unsuitable.

3. Herbivory: There are not field observations to suggest that there is any herbivory on leaves or inflorescences of *Lesquerella macrocarpa*. Oil glands in the mustard genus are general deterrents. It is possible that the fruits and seeds are food sources for birds and small mammals.

4. Hybridization: There are not field observations or experimental evidence to suggest that *Lesquerella macrocarpa* hybridizes with other members of its genus. *Lesquerella alpina* var. *condensata* is documented from surrounding Ross Butte landscapes.

5. Land ownership: BLM: Almost the entire range of *Lesquerella macrocarpa* occurs on BLM-administered lands. The largest extent and number of occurrences are on lands managed by the BLM Rock Springs Field Office. The Ross Butte area and Blue Rim occurrences are managed by the Pinedale Field Office and the Roberson Creek occurrence is managed by the Kemmerer Field Office.

State of Wyoming: *Lesquerella macrocarpa* has been documented from two state sections in the Bush Rim area (T24N R102W S36; T25N R101W S35).

Private: No occurrences of *Lesquerella macrocarpa* have been found on private lands, but it is possible that it extends onto a private inholding in the Ross Butte area. Suitable habitat may occur on private sections within the BLM checkerboard in the Roberson Creek area.

H. Assessment and management recommendations

1. Potential threats to currently known populations: A small geographic range and climate-related fluctuations in population size make this species especially vulnerable to human-induced disturbances during dry years, as reported previously (Fertig 1995a). The following compendium of potential threats highlights 2008 survey observations.

2. Roads and recreational activities: A BLM road runs along part of the largest population (east of Freighter Gap, #002) where the blading apparently ran through suitable habitat. Road maintenance practices might have disproportionately large impacts on the populations in drought years. Trampling by off-road vehicles may result in direct mortality of individual plants and lead to soil compaction and erosion. The amount of damage is related to the degree of use. A segment of the occurrence in the North Alkali Draw (Section 34 of #010) had ORV traffic in occupied habitat in 2008, a readily-accessible area where motorized recreation is concentrated locally. One stray plant was found in bladed roadside habitat above Blue Rim, did not appear to be part of suitable habitat, and may be accidental.

2. Wild horses: Trampling by wild horses has been suggested as a threat by Dorn (1980) and Whiskey Basin Consultants (1981) but was not noted in the Upper Green River Basin. Plants were reported as “severely trampled” at the Continental Peak site in 1981 (Whiskey Basin Consultants 1981), but follow-up surveys at this same location in 1994 indicated that the population had either recovered or was not seriously impacted. Studies of wild horse activity in the Bush Rim Area suggest that wild horse use of *Lesquerella macrocarpa* habitat is lowest in late spring and early summer during the species’ short flowering and fruiting period (Richard Miller letter to R. Lichvar of The Nature Conservancy, postmarked 18 Oct 1979). The low forage value of the habitat but position on low topographic rises suggests that herd trampling may result as the herds seek a breezy reprieve from bugs late in the growing season rather than in grazing activity.

3. Grazing: Most of the habitat of *Lesquerella macrocarpa* on BLM lands is managed for cattle or sheep grazing. No evidence of herbivory on stems, leaves or flowers could be detected in 2008. Livestock use of occupied *L. macrocarpa* habitat is relatively limited due to the low amount of forage and lack of water. Trampling of plants and the crumbly substrate may directly affect the

species or foster erosion if use is concentrated. Small-scale management practices may have disproportionately large effects on trampling of *L. macrocarpa* occurrences from decisions like salt block placement and water developments to fence construction.

4. Mineral development: The Ross Butte and Blue Rim occurrences of *Lesquerella macrocarpa* overlap with a major gas field in the area, the Jonah Field. Off-road seismic testing associated with exploration, and construction associated with discovery and development of new oil and gas fields are potential threats to the Upper Green River Basin occurrences of *L. macrocarpa*. The development of well pads, roads, pipelines, transmission lines, and pump stations are all potential influences. These sorts of developments are currently present within one mile of *L. macrocarpa* occurrences, but not in or adjoining occupied habitat. Stakings indicate that drilling expansions are likely or pending at Ross Butte. The Roberson Creek occurrence is near pipelines and transmission lines that tie to the Opal natural gas hub.

The Ross Butte and Blue Rim area occurrences are near roads or mineral and energy development areas in a couple places. There were no visible signs of dust deposition or air quality affecting plant health, but they might in the future.

5. Noxious weeds: Elsewhere in the landscape, halophytic noxious weeds such as Halogeton (*Halogeton glomeratus*) are present along disturbance corridors like roads and pipelines and may have the capacity to invade the bare, alkaline habitat of *Lesquerella macrocarpa*. There are no known reports of noxious weeds or even weedy annuals like cheatgrass (*Bromus tectorum*), Hornseed buttercup (*Ranunculus testiculatus*), or Blue mustard (*Chorispora tenella*) invading its habitat, though they are present in at least low levels along roads in the area.

6. Management practices and response: No experimental data exist on the response of the species to large-scale management actions, such as prescribed burning or herbicide treatment.

I. Conservation recommendations:

1. Recommendations regarding present or anticipated activities: The comments made in previous status surveys (Whiskey Basin Consultants 1981, Marriott 1988, Fertig 1995a) are still pertinent. Establishment of additional roads, two-tracks, and recreational use are potential impacts to *Lesquerella macrocarpa* habitat. Well pads, pumping stations and other structures associated with oil and gas development are also potential impacts. Salt blocks, water tanks and fencelines are potential impacts when placed in or adjoining occupied habitat and associated with increased trampling by livestock or associated erosion.

2. Notification of BLM personnel of locations on BLM lands: To prevent inadvertent impacts to known populations, it would be appropriate that all BLM personnel involved in planning and on-the-ground land management activities be provided with location data for *Lesquerella macrocarpa*. It is especially important that agency minerals, engineering, and range staff have access to precise locations so that disturbances can be avoided.

3. Protected areas: *Lesquerella macrocarpa* is addressed as a BLM sensitive species (2001, 2002). In addition, the protection status of lands with endemic plants in the Wyoming Basin

Ecoregion is addressed by Fertig and Markow 1998. Two occurrences may overlap with Areas of Critical Environmental Concern, at Oregon Buttes and Steamboat Mountain. The Ross Butte proposed Area of Critical Environmental Concern was identified as an option in a recent Pinedale Resource Management Plan but not selected as the preferred alternative.

4. Status recommendations: *Lesquerella macrocarpa* is appropriately recognized as a special status plant species by the Wyoming BLM, to ensure that actions by agency personnel do not contribute to the further endangerment of the species. Although not immediately threatened with extinction solely to development pressures, the fluctuating population size of the species makes it unusually vulnerable to local, human-induced threats during drought years. Sufficient areas of habitat need to be maintained in relatively undisturbed condition to ensure that the species can survive periodic declines associated with adverse climatic conditions and the impact of developments.

J. Summary

Lesquerella macrocarpa is endemic to southwestern Wyoming. It is currently designated sensitive by the Wyoming BLM. Surveys from 1977-1994 and the 2008 survey document that it is known from only four areas. The recent surveys provide expansions of its known distribution in the Ross Butte/Ross Ridge area, and relocation and re-survey of it in the Roberson Creek/Opal area. They also underscore the significance of the west rim of the Great Divide Basin in terms of species' numbers and extent. The potential distribution model falsely identified additional areas in the Pinedale Field Office that do not support the species.

Trend information is lacking for *Lesquerella macrocarpa* and it is recommended that the state and global Heritage ranks of the species be reranked as G1/S1 if there is no other data available or if trend data show declines in numbers since 1994. Three of the ten known occurrences could not be found in 1994, they warrant survey, and the report of it at the Rock Cabin Dugway would also be appropriate to seek out in concerted surveys. *Lesquerella macrocarpa* has not had systematic surveys across the Roberson Creek area, where the federal lands checkerboard requires access permissions, and where there have been no surveys conducted on private lands. This species has not had monitoring since the 1994 data collected at two occurrences. Demographic monitoring might be considered in the future as shedding light on species' life history to provide context for available trend information.

V. *PHLOX PUNGENS* SPECIES INFORMATION

A. Classification

1. Scientific name: *Phlox pungens* Dorn (Dorn 1988)
2. Synonyms: None.
3. Common name: Beaver Rim phlox
4. Family: Polemoniaceae (Phlox family).
5. Size of genus: The *Phlox* genus is a predominantly North American genus of about 65 species (Wherry 1955, Ferguson et al. 1999). All caespitose, solitary-flowered *Phlox* of western North America and eastern Asia are placed in the large section Occidentales by Asa Gray. This geography-based treatment was challenged by Wherry and is under current review as part of work on developing a *Phlox* phylogeny based on the chloroplast genome (Ferguson et al. 1999). Twelve species of *Phlox* are recognized in Wyoming (Dorn 2001).
6. Phylogenetic relationships: *Phlox pungens* was suggested as possibly derived from *P. multiflora*, which sometimes grows adjacent to it but in a more generalized, moister habitat (Dorn 1990). *Phlox hoodii* and *P. muscoides* were also recognized as sympatric (Dorn 1990) and more recently, *P. opalensis* has been found in contiguous habitat (Cramer and Hartman 1995, 1996; Fertig 1998). In general, many eastern species of *Phlox* have been served as models for evolutionary studies investigating a diversity of phenomena (reviewed by Ferguson et al. 1999), but relations between western species are not as well known. Dorn hypothesized (1990) that the presence of *P. pungens* on at least four different substrates in Fremont County indicates that it has been around for a long time, and such interpretation is supported by the geographic isolation of two well-developed distribution centers in the Upper Green River Basin and Fremont County.

B. Present legal or other formal status

1. National

- a. Legal status: Listed as a Category 2 (C2) species by the U.S. Fish and Wildlife Service (1993). Category 2 species were taxa for which proposing to list them as endangered or threatened was considered appropriate but for which substantial data on biological vulnerability and threats were not currently known or on file to support the preparation of rules. In 1996, the Category 2 list was discontinued and *P. pungens* has no current status under the Endangered Species Act.

BLM Wyoming maintains a list of sensitive species to help focus management efforts towards maintaining habitats under a multiple use mandate and to prevent future listing as a threatened or endangered species. *Phlox pungens* was placed on the first BLM Wyoming sensitive species list in 2001, and retained in the 2002 update (USDI BLM 2001, 2002).

b. Heritage rank: Ranked G2 by NatureServe, previously The Nature Conservancy's natural heritage network system. As a species, *Phlox pungens* was considered imperiled because of rarity throughout its range (when less than 20 extant occurrences are known). It has been determined that the global and state ranks for this species warrant re-evaluation using the current documentation of 32 extant occurrences, including results from this study, possibly warranting change to global rank of G3. However, the possibility that the "Ross Butte morph" represents a discrete taxon different from the "type morph" awaits taxonomic research. Thus, ranks remain unchanged pending taxonomic outcome. In the status information that follows, the two morphs are differentiated for possible future reference.

2. State

a. Legal status: None.

b. Heritage rank: WYNDD ranks *Phlox pungens* as S2, indicating that it is imperiled because of rarity in Wyoming (Heidel 2007). The state rank needs update like the global rank if all Wyoming occurrences are the same taxon (see the preceding discussion of global rank). However, the possibility that the "Ross Butte morph" represents a discrete taxon awaits taxonomic research, and state ranks also remain in place pending taxonomic outcome.

C. Description

1. General non-technical description: *Phlox pungens* is a leafy perennial forb that forms loose mats of prostrate or short, erect stems 8 cm or less high. The stiff, prickly leaves are lance-shaped, 4-8 mm long, 1-1.5 mm wide, and have glandular or ciliate margins. The margins and midribs of the leaves are prominently thickened and gradually taper to a sharp tip. The white-petaled flowers are usually over 15 mm in diameter and have a glandular-hairy calyx tube (Dorn 1990, 1992; Fertig et al. 1994). Populations of *P. pungens* from the Green River Basin differ from "typical" populations of the southeast Wind River Range and Beaver Rim in having short-stalked glandular hairs on the leaves and narrower leaf blades (under 1 mm wide) that lack thick midribs and margins. These populations have been referred to as the "Ross Butte morph" and may represent an undescribed variety (Fertig 1998; Figures 11-12).

2. Technical description: Perennial forming loose mats or upright and scarcely mat-forming, 8 cm or less high, internodes pubescent with short, mostly straight, often glandular hairs; leaves still and pungent, mostly lanceolate or lance-linear, 4-8 mm long, 1-1.5 (2) mm wide, pubescent, often glandular, ciliate, punctuate, the margins and dorsal midrib strongly thickened, gradually tapering into a sharp terminal bristle; calyx 6-9 mm long, densely glandular-pubescent, the lobes sharply spinulose-tipped; corolla white, the tube 8-12 mm long, the limb 4-6 mm long; anthers about 1 mm long; style 6-9 mm long; seeds 2.5-3 mm long, the surface roughened (Dorn 1990).

3. Local field characters: The glandular pubescence and large white flowers separate it from the other species in the area. The dead leaves persist and are very stiff and prickly.

4. Similar species: *Phlox kelseyi* has soft leaves without thickened midribs or margins. *P. multiflora* has glabrous leaves and calyces. *P. hoodii* and *P. muscoides* have flowers less than 12 mm wide and are more densely matted. The latter three species and *P. opalensis* are adjoining or near *P. pungens* habitat in the Upper Green River Basin.

Figure 11. *Phlox pungens* illustration, by Isobel Nichols, from Fertig et al. 1994

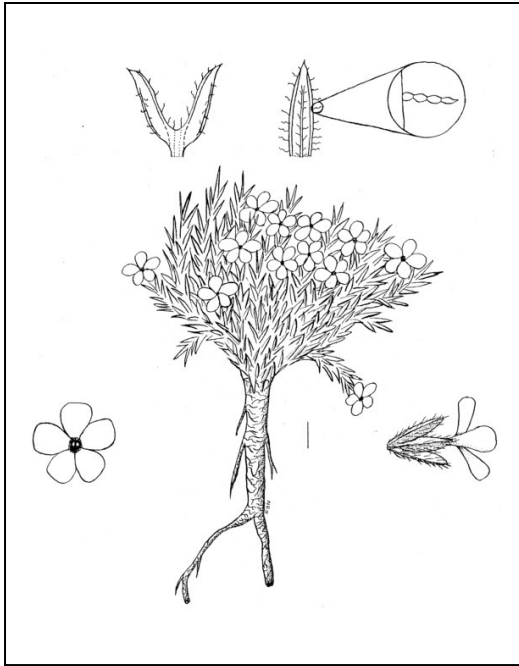


Figure 12. *Phlox pungens* (Rock Creek Ridge, #027. 13 June), by B. Heidel



Southwestern Wyoming has relatively high diversity in the *Phlox* genus, where ten of the twelve known species in the state are present. Most populations of *P. pungens* in the Upper Green River Basin have at least one other species of *Phlox* present in the vicinity, usually in different habitat though their habitats may be contiguous. A table of distinguishing characteristics for these species is prepared as reference (Table 4).

Table 4. Distinguishing characteristics of *Phlox pungens*⁷

Species	Corolla diameter	Leaf shape	Leaf length x width (mm)	Calyx	Other traits
<i>Phlox albomarginata</i>	6-9	Lanceolate	2-5 (7) x 1-2.5	Calyx tube with long, crinkly hairs, not glandular	Lvs. prominently white-margined
<i>Phlox andicola</i>	Usually (12) 15 +	Linear- or lance-linear; 1 mm or less wide	4-22	Calyx teeth subequal or longer than tube	Lvs w/ long crinkly hairs; sandy habitat
<i>Phlox hoodii</i>	Usually 10 (12) or less	Often linear, usually stiff and pungent	(2.5) 4-10 (13) x 0.5 (1)	Calyx pubescent	Lvs often loosely pubescent w/ cobwebby hairs
<i>Phlox kelseyi</i>	Usually (12) 15 +	Narrowly lanceolate	10-25 x 1-2.5	Calyx hairy	Lvs. often succulent and glandular, ciliate margins; the only WY species in alkaline wet meadow habitat
<i>Phlox longifolia</i>	Usually (12) 15 +	Linear	(15) 25-80 x 1-6	Calyx carinate toward base	The only WY species w/ upright growth form
<i>Phlox multiflora</i>	Usually (12) 15 +	Linear	(10) 12-30 x 1-2	Calyx often pubescent or scaberulous	Leaf margins not ciliate
<i>Phlox muscoides</i>	Usually 10 (12) or less	Narrowly lanceolate	1-5 (7) x 1	Calyx wooly	Lvs. w/ dense, wooly hairs at base, lvs usually concealing the stem in the field
<i>Phlox opalensis</i>	Usually (12) 15 +	Lance-linear, abruptly tapering to sharp tip	2-10 x 1	Calyx teeth shorter than tube, pubescent, not glandular	Lvs. crinkly-hairy at base, stem internodes pubescent with long, crinkly hairs
<i>Phlox pulvinata</i>	Usually (12) 15 +	Lance-linear	5-12 (15) x 1-2.5	Calyx tube often pubescent not glandular	Montane elevation, densely matted
<i>Phlox pungens</i>	Usually (12) 15 +	Lance-linear; very stiff and prickly	4-8 x 0.7-2	Calyx tube glandular-hairy	Leaf margins and dorsal midrib usually strongly thickened, ciliate margins except for the Ross Butte morph, which also lvs less than 1 mm wide and stalked glands on lvs.

⁷ Based on keys and distribution information in Dorn (2001) augmented by Hitchcock et al. 1959, Cronquist et al. 1984

D. Geographical distribution

1. Range: *Phlox pungens* is endemic to the Wind River and Green River basins including the East Slope foothills of the Wind River Range and the Beaver Rim, in Fremont, Lincoln, and Sublette counties, Wyoming (Figure 13). The "typical" form is restricted to Fremont County, and the "Ross Butte morph" is found in the Green River Basin in Sublette County, the adjoining northwestern corner of Sweetwater County, and the Tunp Range foothills in Lincoln County.

Phlox pungens was first discovered in 1984 in Fremont County. There were later surveys from 1987 and 1990 (Dorn 1990) in the eastern part of its distribution, and later floristic inventories (Welp 1997, Massatti 2007) in the eastern part of its distribution, as well as a site-specific inventory at Red Canyon Ranch (Fertig 1995b). It was first discovered in the western part of its distribution by Cramer as part of floristic inventories from 1994-1995 (Cramer and Hartman 1995, 1996), and later species surveys in the same area (summarized in Fertig and Markow 1998). Tom Cramer and Walter Fertig collected *P. pungens* in a total of 11 discrete Upper Green River Basin locales. Walter Fertig also collected a vegetative specimen provisionally identified as *P. pungens* from the Rock Creek Ridge in the Tunp Range foothills in 1997. The 2008 surveys documented seven new occurrences and expanded on all known occurrences.

2. Extant sites: Known from 31 occurrences in the state, all of which have been discovered or relocated since 1990. There are 18 in the Upper Green River Basin, one in the Tunp Range foothills, and 12 in the Beaver Rim and confluent Wind River Range and foothills. The western occurrences represent the "Ross Butte morph" and are reported separately in Table 5. More detailed information is provided in the element occurrence records and maps in Appendix C.

3. Historical sites: None.

4. Unverified/Undocumented reports: None known.

5. Areas surveyed but species not located: Survey routes are shown in Appendix A. They are additions to the survey routes reported by Dorn (1990).

6. Sites where present status not known: None.

7. Areas surveyed but species not located: Surveys in 2008 focused on fine-textured outcrops in the Upper Green River Basin of Sublette County, within potential habitat areas identified in a distribution model. These surveys were conducted in combination with surveys for *Lesquerella macrocarpa*. The species was not found in any locations west of the Green River, despite predictions of potential habitat by the model (Fertig and Thurston 2003). Survey routes are shown in Appendix A.

Figure 13. Distribution of *Phlox pungens*⁸

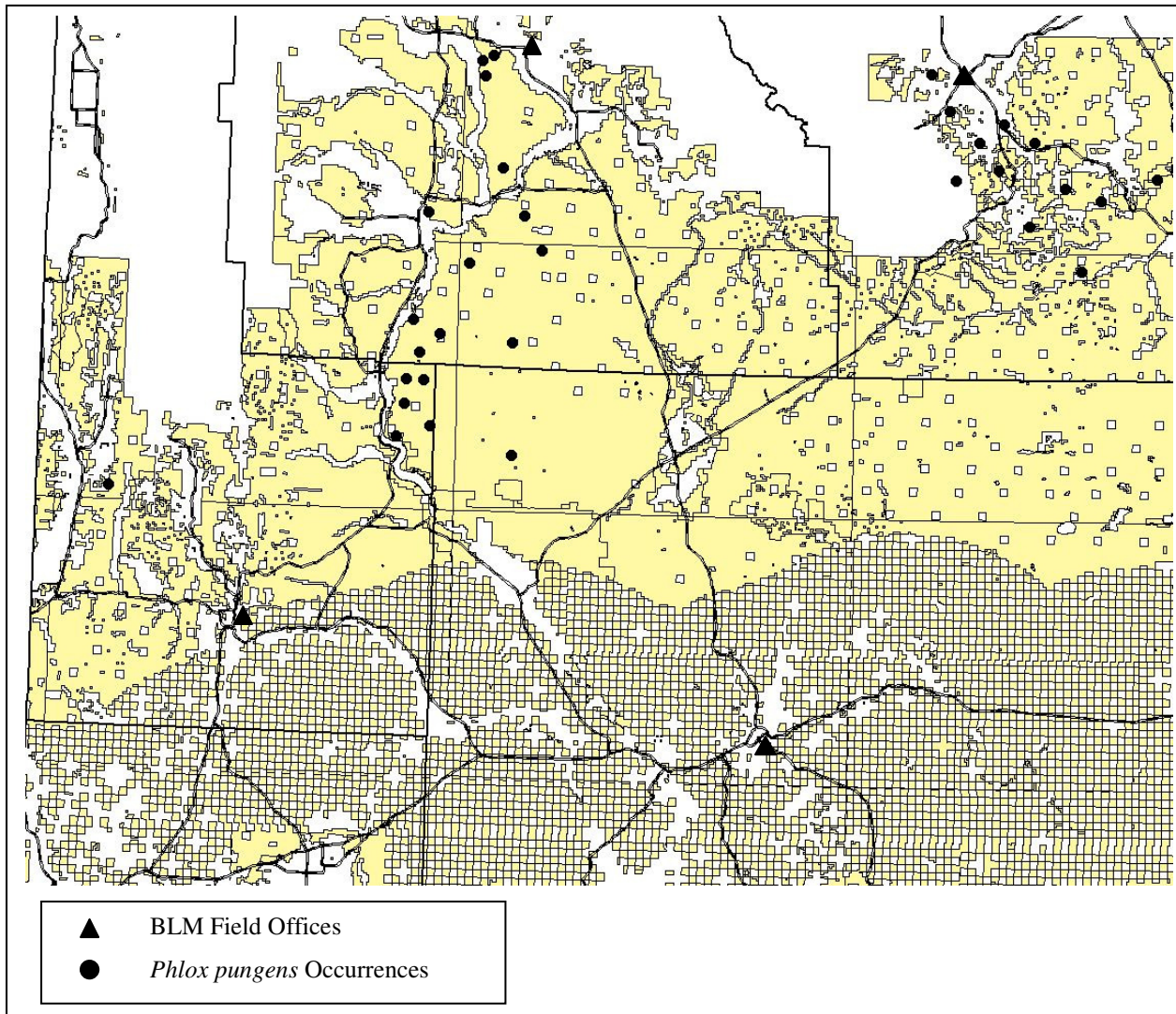


Table 5. Location information for known occurrences of *Phlox pungens*

EO#	Site Name	County, State	Legal Description	Elevation (ft)	USGS 7.5' Quad	Location
<i>Phlox pungens</i> – Ross Butte morph						
5	Ross Butte	Sublette	T30NR109W S19, 23, 28, 30, 34; T30NR110W S13, 14, 23,	7000- 7400	Olsen Ranch Ross Butte	Green River Basin; Ross Butte and Ross Ridge ecosystem

⁸ *Phlox pungens* is a state endemic. This map represents its global distribution and its state distribution.

			24,25,26,27,35			west of Burma Rd.
8	Anderson Canyon	Lincoln, Sweetwater	T25NR111W S8, 9, 17, 18	6750-6910	Anderson Canyon	Green River Basin; Anderson Canyon, ca 10 mi southeast of La Barge
9	Steed Canyon	Lincoln	T26N R111W S7, 18	6950-7020	Anderson Canyon	Green River Basin, Steed Canyon, ca 5.5 miles east-southeast of La Barge
10	Bird Canyon	Sublette	T27NR111W S20, 29; T27N R112W S25	7000-7150	La Barge SE	Green River Basin; Upper Bird Canyon, ca. 4.5-7.5 mi northeast of La Barge
14	West Buckhorn Draw	Sublette	T27NR109W S18, 19; T27NR110W S13, 24	7010-7300	Sugar Loaf	Green River Basin, north end of West Buckhorn Draw, ca 17 mi east of La Barge
15	Marbleton	Sublette	T30NR111W S20, 28, 29	6860-7000	Big Piney East	Green River Basin, west side of Muddy Cr, 1.5 mi east of Marbleton
16	Mount Airy	Sublette	T33NR110W S1, 12	7350-7600	Mount Airy	Green River Basin; north end of The Mesa at Mount Airy
17	The Mesa East	Sublette	T31NR110W S25	7100-7260	Mesa Spring	Green River Basin; southeast end of The Mesa
25	North of Anderson Canyon	Lincoln	T25NR112W S21,22	6600	Names Hills	Green River Basin; Anderson Canyon, 9 mi south-southeast of La Barge
26	Alkali Creek, Reardon Draw, Chapel Canyon	Sublette	T28NR109W S7; T28NR110W S5, 6, 7, 8, 19,	6980-7300	Sugar Loaf NE, Sugar Loaf NW, Milleson	Green River Basin, Reardon Draw, Alkali

			27, 28, 33; T28N R111W S1		Draw	Cr, head of Chapel Canyon, ca 13 mi northeast of La Barge
27	Rock Creek Ridge	Lincoln	T24NR118W S30, 31	6840- 6860	Sublette Canyon	Overthrust Belt; west slope of Rock Creek Ridge in Tunp Range, ca 7 mi southeast of Cokeville
28	Figure Four Canyon	Sublette	T27NR111W S10, 15, 17	7000- 7160	La Barge SE	Green River Basin; upper end of Figure Four Canyon, ca 9 mi northeast of La Barge
31	North of Figure Four Canyon	Sublette	T27NR112W S1, 2; T28NR112W S35	6840- 7280	La Barge SE	Green River Basin; ca. 1.5 mi north of Figure Four Canyon
34	Upper Delaney Canyon	Lincoln	T26NR112W S34, 35	6830- 6970	Anderson Canyon, Names Hill	Green River Basin; Upper Delaney Canyon, ca 6 mi south- southeast of La Barge
35	Above Steed Canyon	Lincoln	T26N R112W S11, 14	6950- 7120	Anderson Canyon, Names Hill	Green River Basin; tributary to Upper Steed Canyon
38	The Mesa West	Sublette	T33NR110W S11, 14	7720- 7740	Mount Airy	Green River Basin; west slope of The Mesa, ca 1.5 mi west of Mountain Airy
39	Hennick Draw	Sublette	T33NR110W S 23, 26	7260- 7300	Mount Airy	Green River Basin; west slope of The Mesa, Hennick Draw
40	Eighteenmile Canyon	Sweetwater	T25NR109W S31	6540- 6600	Twelvemile Sink	Green River Basin; Eighteenmile

						Canyon, ca 21 mi west of Farson
41	Isolated area	Sublette	T29NR109W S14	7110	Sugar Loaf NE	Green River Basin; ca 2 mi southwest of Wild Horse Reservoir
<i>Phlox pungens</i> – Typical morph						
1	Beaver Rim	Fremont	T30NR96W S1, 10, 11, 12, 13, 15, 16, 17, 19 20; T31NR95W S1, 2, 3, 4, 9, 10, 11, 12, 17, 18, 19, 27, 29, 30; T31NR96W S24,25,35,; T32NR94W S30; T32NR95W S24, 25, 26, 27, 35	6600	Sweetwater Station, Elkhorn Springs, Dishpan Butte, Yellowstone Ranch, Red Canyon	Sweetwater River Plateau; Beaver Rim, on escarpment below rim.
2	Twin Creek	Fremont	T30NR97W S7; T30NR98W S12; T31NR97W S31,32,29; T31NR98W S12,25,26,36	5800-6700	Schoettlin Mountain, Delmonte Ridge, Weiser Pass	Wind River Basin; Carr Reservoir to Wilson Draw.
3	Cedar Ridge	Fremont	T32NR98W S33	5800	Weiser Pass	Wind River Basin; Cedar Ridge, north of U.S. Highway 287, 13 miles southeast of Lander.
4	Chalk Spring	Fremont	T30NR98W S29	6900	Gravel Spring	Wind River Basin; ca 21 miles south-southeast of Lander [vicinity of Chalk Spring].
6	Little Popo Agie Valley	Fremont	T32NR99W S23	5600	Weiser Pass Wolf Point	Wind River Basin; Little Popo Agie River Valley, east of Dry Lake, ca 7 air miles southeast of

						Lander.
7	Red Canyon	Fremont	T31NR99W S3, 4, 9, 10, 14, 15, 22, 23, 25, 26, 27, 36	5600-6350	Gravel Spring, Weiser Pass, Wolf Point	Wind River Range; Red Canyon Rim on east side of Red Canyon Road
11	Table Mountain	Fremont	T32NR100W S10	6400-6600	Mount Arter SE	Wind River Range; north slope of Table Mountain, ca 5 air miles southwest of Lander.
12	Beaver Rim – east end	Fremont	T30NR97W S1, 3, 10, 11	5800-6200	Schoettlin Mountain	Wind River Basin; southeast end of Beaver Rim, ridge on north side of Red Canyon, east bank of Beaver Cr.
13	Northeast of Lewiston Lakes	Fremont	T29NR97W S28	7200-7260	Lewiston Lakes	Sweetwater River Valley; south end of Beaver Rim, east of "Rocky Ridge", 1.5 air mi south of Atlantic City.
23	West of Beason Creek mouth	Fremont	T32NR99W S30, 32	7200	Wolf Point	Wind River Basin; southeast of Peak 6204
29	Ed Young Mountain	Fremont	T31NR100W S26	8400-8550	Wolf Point	East slope Wind River Range; south slope of Ed Young Mountain, ca 15 mi south of Lander.
30	Fremont	Fremont	T33NR100W S33	5800-6160	Mount Arter SE	Wind River Range/Wind River Basin; between Baldwin and Squaw creeks, ca 4 mi west of Lander.

E. Habitat

1. Associated vegetation: *Phlox pungens* occurs on sparsely-vegetated communities including cushion plant/bunchgrass vegetation and openings in *Artemisia nova*/*A. tridentata* grasslands. Less frequently, this species may be associated with *Atriplex gardneri*, *Cercocarpus montanus*, or *Ericameria nauseosus* communities (Fertig 1998). Its affinity for sparsely-vegetated settings is the basis for characterizing it as a pioneer species (Dorn 1990), though this term is usually applied to species with special adaptations to colonize, and without adaptations to persist.

2. Frequently associated species: The species frequently associated with *Phlox pungens* in the two parts of its range are listed in Table 6, drawing from Dorn (1990) for Wind River/Beaver Rim information. The table suggests that there are low levels of vegetation composition overlap between species' habitat in the two areas.

Table 6. Species frequently associated with *Phlox pungens*

Scientific name	Common name	Pinedale, Rock Springs and Kemmerer Field Offices	Lander Field Office
<i>Artemisia frigida</i>	Fringed sagewort		X
<i>Artemisia nova</i>	Black sagebrush	X	
<i>Artemisia tridentata</i>	Wyoming big sagebrush	X	X
<i>Astragalus drabelliformis</i>	Big Piney milkvetch	X	
<i>Astragalus jejunus</i>	Starveling milkvetch	X	
<i>Astragalus missouriensis</i>	Missouri milkvetch		X
<i>Astragalus spatulatus</i>	Spoonleaf milkvetch	X	X
<i>Atriplex gardneri</i>	Gardner's saltbush	X	
<i>Carex filifolia</i>	Thread-leaved sedge		X
<i>Cercocarpus montanus</i>	Alder-leaf mountain mahogany	X	
<i>Commandra umbellate</i>	Bastard toadflax	X	
<i>Chrysothamnus viscidiflorus</i>	Green rabbitbrush	X	
<i>Cryptantha caespitosa</i>	Tufted cat's-eye	X	
<i>Cryptantha celosioides</i>	Butte candle		X
<i>Elymus (lanceolatus?)</i>	Thickspike (?) wheatgrass	X	
<i>Elymus spicatus</i>	Bluebunch wheatgrass	X	X
<i>Eremogene hookeri</i>	Hooker's sandwort		X
<i>Ericameria nauseosa</i>	Rubber rabbitbrush		X
<i>Erigeron compositus</i>	Cut-leaved fleabane	X	
<i>Erigeron ochroleucus</i>	Buff fleabane		X
<i>Eriogonum brevicaulis</i>	Shortstem wild buckwheat	X	X
<i>Eriogonum flavum</i>	Yellow wild buckwheat		X
<i>Eriogonum ovalifolium</i>	Cushion wild buckwheat		X

<i>Erysimum asperum</i>	Western wallflower		X
<i>Euphorbia brachycera</i>	Horned spurge		X
<i>Hesperostipa comata</i>	Needle-and-thread		X
<i>Hymenoxys torreyana</i>	Torrey's four-nerved daisy		X
<i>Ipomopsis congesta</i>	Ballhead skyrocket	X	X
<i>Ipomopsis crebifolia</i>	Compact gilia	X	
<i>Iversia gordonii</i>	Godron's ivesia		X
<i>Linum lewisii</i>	Wild blue flax	X	
<i>Lomatium foeniculaceum</i>	Carrot-leaf desert-parsley	X	
<i>Lygodesmia juncea</i>	Rush skeletonweed		X
<i>Machaeranthera grindelioides</i>	Rayless tansy-aster		X
<i>Machaeranthera tanacetifolia</i>	Tansy-aster	X	
<i>Phlox hoodii</i>	Hood's phlox		X
<i>Phlox multiflora</i>	Rocky Mountain phlox		X
<i>Phlox muscoides</i>	Moss phlox	X	
<i>Physaria acutifolia</i>	Sharp-leaf twinpod	X	
<i>Physaria saximontana</i>	Rocky Mountain twinpod		X
<i>Poa secunda</i>	Sandberg's bluegrass	X	
<i>Sphaeromeria capitata</i>	Cluster-head chicken-sage		X
<i>Stenotus armerioides</i>	Thrift mock goldenweed	X	
<i>Townsendia spathulata</i>	Sword Easter daisy		X

3. Topography: *Phlox pungens* occurs in sparsely-vegetated uplands on the top, crest, upper mid and occasionally lower slopes of ridges and hills, generally from 5-45% (Dorn 1990, Fertig 1998). The elevation ranges from 5600-8550 ft. It was recently collected higher on the East Slope of the Wind River Range than previously known (Massatti 2007). All of the Upper Green River occurrences are at intermediate elevations (6500-7600 ft) compared to the Beaver Rim/Wind River area. It tends to be most extensive on upper slopes (Figures 14-18).

4. Soil relationships: Soils are poorly developed and derived directly from the parent material (Dorn 1990), representing entisols. *Phlox pungens* occurs on a range of substrates, including relatively barren limestone, weathered conglomerate, redbed, volcanic-rich sandstone, siltstone, or weathered claystone slopes, most commonly on a southwest to northwest exposure (Dorn 1990, Fertig et al. 1994). Populations of the "Ross Butte morph" in the Green River Basin often occur on gray to reddish-brown clay-shale soils with a surface layer of white limey-sandstone on variable aspect. Dorn (1990) provided a much more detailed description of substrates and the formations where it occurs in the Wind River east Slope/Beaver Rim but noted that they all contain some limestone, are well-drained, and that *P. pungens* appears to favor a sandy soil.

5. Regional climate: Average annual precipitation in the Wind River East Slope/Beaver Rim is about 27.9 cm (10 in; Dorn 1990 citing Lowers 1960). The Upper Green River Basin seems to

have a lower annual precipitation of 20.7 cm (8.15 in; USDI NOAA 2009). The latter also has what may be a lower annual temperature of 1.5° C (34.69° F). In the potential distribution model with best fit (Fertig and Thurston 2003), maximum July temperature followed by soils and geology were primary distinguishing environmental characteristics used to identify potential habitat.

6. Local microclimate: The habitat of *Phlox pungens* is exposed to full sun and wind. The species may modify its microclimate by retaining dead branches and leaf bases at the base of current year's growth that seem to accumulate soil and retain moisture.

F. Population biology and demography

1. Phenology: Flowering occurs from May to early June with fruits maturing several weeks later (Dorn 1990).

Flowering was already at a peak on 4 June at the start of 2008 surveys, and all plants were still in late flower on 13 June. There appeared to be a profusion of flowering in 2008, possibly associated with moisture conditions, in which most or all branches produced flowers. The phenology was similar at Rock Creek Ridge (Tunp Range), present at similar elevation to the west.

2. Population size and condition: There are 30 occurrences of *Phlox pungens* concentrated in the Upper Green River Basin and the Beaver Rim/ Wind River area. The Upper Green River harbors 19 of the occurrences and roughly 60% of total known species numbers. Depending on mapping conventions, the area of occupied habitat is in the 1000,s while the total area of occupancy for the two population centers totals 321,793 ac (130,225 ha). The occurrences vary from a single small colony to a series of colonies across recurring habitat in contiguous sections. They also vary from low density (e.g., northeast of Lewiston Lakes, #013) to high density (e.g., Marbleton, #015, Figure 19).

It is noteworthy that the species is not evenly distributed, but that over 80% of known numbers are in four occurrences. Three of the four are in the Upper Green River Basin. Likewise, the extensiveness of this species on the landscape varies greatly. There are two occurrences that span over ten sections (#005 at Ross Butte/Ross Ridge; and #026 at the upper ends of Alkali Creek, Reardon Draw and the divide between). By contrast, a small, isolated occurrence was also documented in an area of less than 20 m x 20 m as an island of outcrop surrounded by extensive shrub steppe, all mapped as potential habitat.

Figure 14. *Phlox pungens* habitat, Ross Ridge southeast aspect, by B. Heidel (across from Fig. 16)



Figure 15. *Phlox pungens* habitat, Marbleton (foreground and midview) by B. Heidel



Figure 16. *Phlox pungens* habitat, Ross Ridge Northwest aspect (foreground and midview above road; Note: *P. opalensis* habitat in upper left). By B. Heidel



Figure 17. *Phlox pungens* habitat, Hennick Draw, Gentle terrain (ridgeline), by J. Larson.

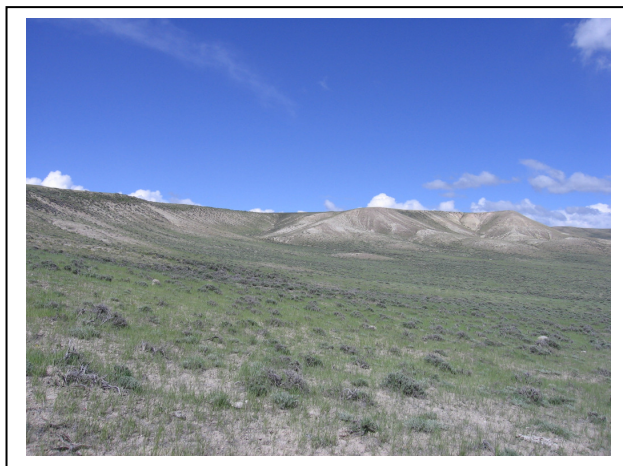


Figure 18. *Phlox pungens* in Badlands outwash, Marbleton (same site as Fig. 15), by B. Heidel



Table 7. Size and extent of *Phlox pungens* occurrences

EO#	Site Name	Numbers ⁹	Digitized area (ac) ¹⁰
<i>Phlox pungens</i> – Ross Butte morph			
5	Ross Butte	100,000-127,000	(951)
8	Anderson Canyon	1600+	(144)
9	Steed Canyon	800+	(129)
10	Bird Canyon	1800+	44
14	West Buckhorn Draw	50,000-100,000	43
15	Marbleton	10,000+	39
16	Mount Airy	1000	28
17	The Mesa East	1000+	2
25	North of Anderson Canyon	1500+	55
26	Alkali Creek, Reardon Draw, Chapel Canyon	150,000+	(952)
27	Rock Creek Ridge	340	0.3
28	Figure Four Canyon	2000	35
31	North of Figure Four Canyon	1300	33
34	Upper Delaney Canyon	1450	10
35	Above Steed Canyon	3700	19
38	The Mesa West	600	19
39	Hennick Draw	800	11
40	Eighteenmile Canyon	50-100	0.1
41	Isolated area	50	0.1
<i>Phlox pungens</i> – Typical morph			
1	Beaver Rim	198,000	1318
2	Twin Creek	5000+	(330)
3	Cedar Ridge	Unknown	Unknown
4	Chalk Spring	Unknown	Unknown
6	Little Popo Agie Valley	Unknown	Unknown
7	Red Canyon	100,000+	(212)
11	Table Mountain	Unknown	(31)
12	Beaver Rim – east end	10,000	33
13	Northeast of Lewiston Lakes	300-500	9
23	West of Beason Creek mouth	Unknown	Unknown
29	Ed Young Mountain	Unknown	Unknown
30	Above Baldwin, Squaw Creeks	Unknown	Unknown
	TOTAL	325,000-400,000 (Ross Butte morph)+ 213,000+ (Typical morph) = 538,000+	1000's

⁹ Numbers are based on the 2008 surveys and the most current available data in the WYNDD database (2008).

¹⁰ Occurrences that are mapped as points with buffers of uncertainty are set off in parentheses as overestimates.

Figure 19. *Phlox pungens* in high density (Marbleton, #015)



Dorn (1990) estimated the population to be 200,000 plants at two known sites in the Beaver Rim area in 1990. Since 1990, additional sizeable populations have been discovered, especially in the Green River Basin. Tens to hundreds of thousands of plants have been discovered in the Ross Butte, Little Colorado Desert, and Red Canyon areas by Fertig from 1993-1998. A tally of known occurrences (Table 7) supports the interpretation that numbers are over 200,000 in the Beaver Rim/Wind River area and over 300,000 in the Upper Green River Basin.

3. Population trend: *Phlox pungens* is a perennial with a woody caudex that may be long-lived. There were almost no dead plants observed, and it is expected that trend would be relative stable. There were no seedlings observed, either.

4. Reproductive biology

Type of reproduction: All reproduction is presumably by seed.

6. Pollination biology: Unknown. Members of the *Phlox* genus include both obligate out-crossing and selfing species. The morphology of the *Phlox* flower is generally considered to be modified for lepidopteran pollination, and noctuid moths have been linked to the pollination of another caespitose *Phlox* species (Grant and Grant 1965).

7. Seed dispersal and biology: Seed dispersal is likely to occur over short distances, both down slope and down wind, with the aid of wind and water.

G. Population ecology

1. General summary: Upper Green River surveys in 2008 relocated all past occurrences of *Phlox pungens*, and documented high population numbers in many cases, with vigorous plants. The relatively moist winter and spring precipitation of 2008 may have been conducive to the high levels of flowering observed. The lifespan of *P. pungens* is not known, but the woody

taproots and production of new branches each year from the taproot confer resilience if not longevity.

2. Competition: *Phlox pungens* is often in microhabitats between cushion plants, bunchgrasses and shrubs. Its numbers diminish in adjacent areas with higher cover of bunchgrass or sagebrush, whether because it is intolerant of interspecific competition, or because the environmental conditions of well-vegetated habitat have conditions like shading that render it unsuitable.

3. Herbivory: No signs of herbivory have been observed. The pungent leaf tips and persisting bristly dead branches around new growth of the year deter herbivory.

4. Hybridization: There are no reports of hybridization in past *Phlox pungens* surveys. In 2008, there was one dry creek below Reardon Reservoir No. 2 in Reardon Draw with low numbers of *Phlox*, where collections were made of putative *P. pungens* in a dwarf form that seemed to be intermediate with *P. muscoides* and had mixed size classes of flowers, as well as a few individuals that seemed to have the hairs of *P. opalensis* but with slight glandularity as of *P. pungens* (Larson 11129). The location is near a very large population of *P. pungens*, but with no known *P. opalensis* occurrences in the area. It is surprising that there are not more incidents of hybridization with as many as five *Phlox* species in the immediate area and synchronous flowering.

5. Land ownership

BLM: Much of the range of *Phlox pungens* occurs on BLM-administered lands. The largest extent and number of occurrences are split between lands managed by the BLM Pinedale and Lander Field Offices, and to a lesser extent, the Rock Springs Field Office and Kemmerer Field Office.

USFS: One Fremont County occurrence of *Phlox pungens* is on the Wind River Ranger District of Shoshone National Forest (Massatti 2007).

State of Wyoming: *Phlox pungens* has been documented from two state sections in the Beaver Rim and Wind River areas.

Private: There are at least three occurrences on private lands, as documented by public information sources. A large part of the Red Canyon population is part of the Red Canyon Ranch on lands managed by The Nature Conservancy.

H. Assessment and management recommendations

1. Potential threats to currently known populations: *Phlox pungens* distribution in the Upper Green River Basin overlaps with major gas fields, including the Jonah and the Pinedale Fields. Surface disturbances associated with oil and gas activity, highway and road construction, and pipeline construction are primary past and present threats (Dorn 1990), as well as pump stations and transmission lines. These sorts of developments are currently present within one mile of *P. pungens* occurrences, but few are in or adjoining occupied habitat. Stakings indicate that drilling

expansions are likely or pending at Ross Butte. The Rock Creek Redge occurrence overlaps with a transmission line. There are no updates available on threats to the species in the Beaver Rim/Wind River area.

Several Upper Green River occurrences of *Phlox pungens* are in canyon settings near roads used by oil rigs and other heavy machinery. There were no visible signs of dust deposition noted or air quality affecting plant health, but dust particles would adhere to the gland-covered leaves and calyx of *P. pungens* which might be affected by dust or other aspects of air quality.

2. Recreation: Off-road vehicle recreational tracks crossed one occurrence at a few places (#025 at Marbleton) but the current level of use affects a low fraction of the population, generally where present in gentler terrain. This particular occurrence is also located closest to a town.
3. Wild horses: One of the sites has a watering tank for wild horses in the center (#014 at West Buckhorn Draw above Desert Well #2), but the horse trails skirt occupied habitat and there are not signs of herbivory or trampling.
4. Grazing: Even in ravines with long histories of livestock use and abundant weedy annuals in the bottoms, *Phlox pungens* was still present on the side slopes (e.g., #008 at Anderson Canyon, #040 at Eighteenmile Canyon, and part of #026 at Chapel Canyon). The degree of exotic species encroachment in such settings does not seem to be limiting the species' extent or numbers at present.
5. Mineral and energy development: The Upper Green River Basin occurrences of *Phlox pungens* fringe or overlap with two of the major gas fields of the area, the Jonah Field and the Pinedale Field. Two occurrences are crossed by a pipeline (#010 at Upper Bird Canyon; and #035 at Steed Canyon); the Upper Bird Canyon pipeline in particular had Halogeton (*Halogeton glomeratus*) present in the corridor but not spreading at present. The Lincoln County occurrence (#027) is on a slope that is crossed by a transmission line, and one of the largest colonies lies underneath the 3-tier tower corridor. Had one of the towers been placed 10 m north, a large colony would have been impacted. Another occurrence was potentially affected by radio towers (#016 at Mount Airy) though in only a small portion of habitat. In addition to these direct impacts, stakes that ran through populations were observed (e.g., #035) at Steed Canyon, for unknown development.

There are mineral and energy developments at the margins of the two largest occurrences including Ross Butte/Ross Ridge (#005) and Alkali Draw/Reardon Draw (#026). Stakes were also present on an access route to Ross Butte/Ross Ridge and an unimproved road ran through part of the occurrence.

Many of the occurrences are near roads and in canyons below mineral and energy development. There were no apparent signs of dust deposition or air quality affecting plant health.

6. Noxious weeds: Exotic species were almost absent from the list of associated species, with a trace amount of cheatgrass (*Bromus tectorum*) present in the Eighteen Mile Canyon occurrence. Most weeds in the area were closely associated with road corridors, pipelines, and other disturbances.

7. Management practices and response: No experimental data exist on the response of the species to large-scale management actions, such as prescribed burning or herbicide treatment.

I. Conservation recommendations

1. Recommendations regarding present or anticipated activities: The recommendations made in the previous status survey (Dorn 1990) are still pertinent. Establishment of additional roads, two-tracks, and planning that promotes recreational use signify potential impacts to *Lesquerella macrocarpa* habitat. Well pads, roads, and other structures associated with oil and gas development also signify potential impacts to occupied habitat. Reservoirs, salt blocks and water tanks may also signify potential impacts when placed in or adjoining occupied habitat.

2. Notification of BLM personnel of locations on BLM lands: To prevent inadvertent impacts to known populations, all appropriate BLM personnel involved in planning and on-the-ground land management activities should have access to location data for *Phlox pungens*. It is especially important that agency minerals, engineering, and range staff know precise locations so that disturbances can be avoided.

3. Protected areas: One of the largest occurrences is on the Red Canyon Ranch managed by The Nature Conservancy. Another large occurrence is on the Beaver Rim Area of Critical Environmental Concern. Both of these are in Fremont County. These two areas span much of the species' range of elevation, and represent contrasting habitats in the eastern part of its distribution. In the Green River Basin, the Ross Butte area was identified as a prospective area of critical environmental concern in the Pinedale Resource Management Plan alternatives, but was not selected.

4. Status recommendations: *Phlox pungens* was recommended for dropping from consideration as a candidate species for listing under the Endangered Species Act (Dorn 1990) when it was only known from the Wind River foothills/Beaver Rim, based on the interpretation that its habitat had no significant threats. It is certainly more extensive and numerous than previously known. However, it may be appropriate to defer review of its BLM designation pending taxonomic review of the "Ross Butte morph," and whether there is a single species to consider or else two varieties. If there are new levels of noxious weed encroachment in either part of its distribution, or new levels of quarrying activity, then this would signify a new level of threat to it and its habitat.

J. Summary

Phlox pungens is endemic to southwestern Wyoming. It is currently designated as sensitive by the Wyoming BLM. The recent surveys extended its known distribution southward in the Rock Springs Field Office (Eighteenmile Canyon) and up-and-down the Green River, in keeping with the potential distribution model (Fertig and Thurston 2003).

Phlox pungens has Upper Green River Basin numbers of occurrences that appear to be more occurrences with higher total population numbers than the Wind River Basin/Beaver Rim area. The primary piece of information needed for interpreting species status is taxonomic research of the status of the “Ross Butte morph” as present in the Upper Green River Basin. An update of state and global ranks will be needed in any case.

Phlox pungens is often but not always on steep-sloped habitats where threats are generally low. There are a high enough frequency of disturbances (over 33%) at Upper Green River Basin sites that give reason to question whether the species is secure on BLM lands without sensitive status or special land management designation; even if the scale of the disturbances are low at present.

VI. DISCUSSION

The utility of potential distribution models for the two species was found to differ in 2008 surveys, as might be associated with differences between species, model algorithms and design. The *Phlox pungens* model (Fertig and Thurston 2003) worked extremely well in large areas of high probability habitat east of the Green River and was the basis for filling gaps and documenting a new record in Sweetwater County on Eighteenmile Canyon. However, it also predicted habitat on the west side of the river, where the geology differs and no occurrences could be found. By contrast, the *Lesquerella macrocarpa* model produced by the same authors predicted additional townships of potential habitat where none could be found. It is surprising that the models worked as well as they did for species having bimodal distribution.

Photointerpretation greatly enhanced the use of potential distribution models, which in combination with topographic maps, served to target the largest outcrops at suitable landforms and positions in the landscape. The methods were not adequately for independent testing of models vs. photointerpretation.

At face value, it seems that *Lesquerella macrocarpa* population numbers and extent are low in the Upper Green River Basin compared to the Great Divide Basin rim. This interpretation is tempered by trend uncertainties for a species whose numbers have been highly variable. By contrast, *Phlox pungens* numbers and population size appear to be more numerous in the Upper Green River Basin than in the Beaver Rim/ Wind River areas, a species of relatively stable numbers. However, there are survey gaps in the latter. In any case, the Upper Green River population centers for both species complement the more eastern population centers and support the case that they represent paleoendemics occupying relict habitat. The divergence between the “Ross Butte morph” of *Phlox pungens* and the typical morphological form found at the eastern population center underscores the conservation significance of its Upper Green River populations.

Both *Lesquerella macrocarpa* and *Phlox pungens* as documented in the Upper Green River Basin are concentrated on or near topographic breaks. The canyon slopes, ridges and rims on which they occur overlap with the major energy development fields in the Basin. Disturbances to date in their Upper Green River Basin habitats have been localized. They may

still be considered vulnerable considering that their habitat is also relatively localized and unevenly distributed in the Upper Green River Basin.

The prior species status reports on *Lesquerella macrocarpa* and *Phlox pungens* still represent almost all of their most current status information in the eastern population centers. There are special challenges of piecing together a comprehensive state status picture for species of bimodal distribution, particularly when it involves different snapshot evaluations of threats and trends. This update is a contribution toward that comprehensive perspective, pointing the way to key status questions (*L. macrocarpa* trends, *P. pungens* taxonomy), providing the baseline information needed for programmatic effectiveness.

VII. LITERATURE CITED

- Al-Shehbaz, I.A. and S.L. O’Kane. 2002. *Lesquerella* is united with *Physaria*. *Novon* 12: 319-329.
- Cramer, T. and R.L. Hartman. 1995. General floristic/sensitive plant species survey of the Upper Green River Basin, Wyoming. Unpublished report prepared for the Rock Springs District and Wyoming State Office, BLM, by the Rocky Mountain Herbarium, University of Wyoming.
- Cramer, T. and R.L. Hartman. 1996. General floristic/sensitive plant species survey of the Upper Green River Basin, Wyoming, final report. Unpublished report prepared for the Rock Springs District and Wyoming State Office, BLM, by the Rocky Mountain Herbarium, University of Wyoming.
- Cronquist, A., A.H. Holmgren, N.H. Holmgren, J.L. Reveal, and P.K. Holmgren. 1984. Vol. 4, Subclass Asteridae (Except Asteraceae). *Intermountain Flora: Vascular Plants of the Intermountain West, USA*. Columbia University Press, New York.
- Dorn, R.D. 1988. *Vascular Plants of Wyoming*. Mountain West Publ., Cheyenne.
- Dorn, R.D. 1990. Report on the status of *Phlox pungens*, a candidate Threatened species. Prepared for the U.S. Fish and Wildlife Service. By Mountain West Environmental Services.
- Dorn, R.D. 2001. *Vascular Plants of Wyoming*, third ed., Mountain West Publishing, Cheyenne, WY.
- Ferguson, C.J., F. Kramer and R.K. Jansen. 1999. Relationships of eastern North American *Phlox* (Polemoniaceae) based on ITS sequence data. *Systematic Botany* 24(4): 616-631.
- Fertig, W., C. Refsdal, and J. Whipple. 1994. *Wyoming Rare Plant Field Guide*. Wyoming Rare Plant Technical Committee, Cheyenne Wyoming.

- Fertig, W. 1995a. Status report on *Lesquerella macrocarpa* in southwestern Wyoming. Prepared for the Bureau of Land Management. Wyoming Natural Diversity Database, Laramie, WY.
- Fertig, W. 1995b. Plants of The Nature Conservancy's Red Canyon Ranch. Unpublished report prepared for the Wyoming Nature Conservancy by the Wyoming Natural Diversity Database, Laramie, Wyoming.
- Fertig, W. 1996. Status report on *Phlox opalensis* in southwestern Wyoming and northeastern Utah. Unpublished report prepared by the Wyoming Natural Diversity Database for the Bureau of Land Management, Wyoming State Office, and the Rock Springs District by the Wyoming Natural Diversity Database, Laramie, WY.
- Fertig, W. 1998. Plant species of special concern of the Ross Butte ecosystem, Sublette County, Wyoming. Prepared for the Bureau of Land Management. Wyoming Natural Diversity Database, Laramie, WY.
- Fertig, W., L. Welp, and S. Markow. 1998. The status of rare plants in southwest Wyoming. Report prepared for the Bureau of Land Management by the Wyoming Natural Diversity Database, Laramie, WY.
- Fertig, W. and R. Thurston. 2003. Modeling the potential distribution of BLM Sensitive and USFWS Threatened and Endangered plant species in Wyoming. Unpublished report prepared for the Bureau of Land Management Wyoming State Office by Wyoming Natural Diversity Database, University of Wyoming, Laramie, WY.
- Grady, B.R. and S.L. O'Kane. 2007. New species and combinations in *Physaria* (Brassicaceae) from western North America. *Novon* 17: 182-192.
- Grant, V. and K. Grant. 1965. Flower Pollination in the Phlox Family. Columbia University Press, New York, NY.
- Hardy, R.V. 1987. Guide to sensitive plant species and plant communities of botanical interest. Unpublished report prepared by the Rock Springs District, Bureau of Land Management. Rock Springs, WY.
- Heidel, B. 2007. Wyoming plant species of concern. Wyoming Natural Diversity Database, Laramie, WY.
- Heidel, B. 2008. Preparations for systematic surveys of *Lesquerella macrocarpa* (Large-fruited bladderpod) and *Phlox pungens* (Beaver Rim phlox) in the Upper Green River Basin. Prepared for the Bureau of Land Management. Wyoming Natural Diversity Database, Laramie, WY.
- Hitchcock, C.L., A. Cronquist, and M. Ownbey. 1959. Pt. 4. Ericaceae through Campanulaceae, IN: Hitchcock, C.L., A. Cronquist, M. Owenbey, and J.W. Thompson (eds). *Vascular*

- Plants of the Pacific Northwest. University of Washington Publications in Biology 17(4): 1-510.
- Love, J.D. and A.D. Christiansen. 1985. Geologic Map of Wyoming (1:500,000). U.S. Geologic Survey.
- Marriott, H. 1988. Draft habitat management plan for Threatened, Endangered and Sensitive plant species and their habitats on the Rock Springs District, Bureau of Land Management. Prepared by the Wyoming Natural Diversity Database, Laramie, WY.
- Massatti, R.T. 2007. A floristic inventory of the East Slope of the Wind River Mountain Range and vicinity, Wyoming. Masters Thesis. University of Wyoming, Laramie, WY.
- Merrill, Evelyn H., Thomas W. Kohley, Margo E. Herdendorf, William A. Reiners, Kenneth L. Driese, Ronald W. Marrs, and Stanley H. Anderson. 1996. The Wyoming gap analysis project final report. University of Wyoming, Laramie WY. 109 pp. + appendices.
- Nelson, A. 1902. Contributions of the Rocky Mountain Herbarium IV. Bot. Gaz. 34: 366-367.
- Payson, E. B. 1922. A monograph of the genus *Lesquerella*. Annals of the Missouri Botanical Garden 8: 103-236.
- Refsdal, C.H. 1996. A general floristic inventory of southwest Wyoming and adjacent northeast Utah, 1994-1995. Unpublished report prepared for the Bureau of Land Management Wyoming State Office, Bureau of Land Management Vernal Supervisor's Office, US Fish and Wildlife Service, and US Forest Service Region 4 by the University of Wyoming, Rocky Mountain Herbarium, Laramie, WY.
- Rollins, R.C. and E.A. Shaw. 1973. The genus *Lesquerella* (Cruciferae) in North America. Harvard University Press, Cambridge, MA.
- Rollins, R.C. 1993. The Cruciferae of Continental North America, Systematics of the Mustard Family from the Arctic to Panama. Stanford University Press, Stanford, CA.
- USDI Bureau of Land Management. 2001. BLM (Wyoming) Sensitive species policy and list. Instruction Memorandum No. WY-2001-040.
- USDI Bureau of Land Management. 2002. Update of Bureau of Land Management (BLM) Wyoming Sensitive Species List - 2002. Information Bulletin No. WY-2003-001.
- USDI Fish and Wildlife Service. 1990. Endangered and Threatened Wildlife and Plants, 50 CFR 17.11 & 17.12, April 15. Published by the U.S. Government Printing Office, Washington, D.C.
- USDI Fish and Wildlife Service. 1993. Plant taxa for listing as Endangered or Threatened species; Notice of Review. Federal Register 58(188): 51144-51190.

USDI National Oceanic and Atmospheric Association. 2009. Wyoming climate summaries.
Posted at: <http://www.wrcc.dri.edu/summary/climsmwy.html> .

Welp, L.A. 1997. A floristic survey of the Great Divide Basin, Green Mountains, and Upper Sweetwater Plateau in southwest Wyoming. Unpublished Master's thesis, University of Wyoming

Weynand, B. and B. Amidon. 1990. 1990. An Illustrated Field Guide to the Sensitive Plants of the Rock Springs District. Bureau of Land Management, Rock Springs District, Rock Springs, WY.

Wherry, E.T. 1955. The genus *Phlox*. Morris Arboretum Monograph 3:1-174.

Whiskey Basin Consultants. 1981. Final report, Threatened and Endangered plants inventory. Unpublished report prepared for the Wyoming State Office, Bureau of Land Management.