Status of *Physaria saximontana* var. *saximontana* (Rocky Mountain Twinpod) in Central Wyoming,

Fremont, Hot Springs, and Park counties

Prepared for the Bureau of Land Management – State Office, Lander and Worland Field Offices

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ABSTRACT

Systematic surveys of *Physaria saximontana* var. *saximontana* (Rocky Mountain twinpod) were conducted in Fremont, Hot Springs and Park counties, central Wyoming of the Bureau of Land Management (BLM) Lander and Worland Field Offices. The taxon is a state endemic that is now known from 32 occurrences in three counties. Three very extensive occurrences are in Fremont County. Two records from two additional counties remain unresolved and the phenomenon of sympatry between species also warrants work.

ACKNOWLEDGEMENTS

Victoria Pennington, Wyoming Natural Diversity Database (WYNDD) helped conduct *Physaria saximontana* var. *saximontana* field surveys, contributed many preparations for 2013 field surveys, and helped in all facets of compiling results. Consultation with Dr. Steve O'Kane is acknowledged with thanks. The Rocky Mountain Herbarium facility (University of Wyoming) and personnel are integral to this and all species studies. Specimens and photos were taken by Rosemary Grinnan and the availability of those specimens was made possible by Tanya Skurski, BLM Lander Field Office, contributing to this study. The support and interest of Adrienne Pilmanis in the BLM Wyoming Office and colleagues in BLM Lander and Worland field offices is greatly appreciated. This work built on the extensive collecting of earlier WYNDD botanists including Hollis Marriott and Walter Fertig. It was conducted as a challenge cost-share between the BLM and WYNDD, under Cooperative Agreement No. L12AC20036, the original agreement.

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Cover page: *Physaria saximontana* var. *saximontana* (Rocky Mountain twinpod), by W. Fertig

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INTRODUCTION

Physaria saximontana var. *saximontana* (Rocky Mountain twinpod) is a state endemic originally known from Fremont and Hot Springs counties in central Wyoming (Fertig et al. 1994, Dorn 2001). It is a BLM Sensitive species (USDI BLM 2010) that has been documented incidental to floristic studies (Haines 1988, Jones 1993, Fertig 1995, Welp et al. 1996, Welp 1997, Roderick 1999, Taylor 2000, Taylor 2003), surveys for other sensitive species (Fertig 1992, Fertig et al. 1998, Heidel 2011), and other botanical studies, including the baseline inventory of the (then-proposed) Beaver Rim Area of Environmental Concern (Jones 1989). Later, a detailed literature review on *P. s.* var. *saximontana* was prepared for the U.S. Forest Service – Rocky Mountain Region (Glisson 2004). The goal of this study was to conduct systematic surveys that built on all prior work, test potential distribution modeling, and interpret all the information at hand. Field surveys were conducted by Wyoming Natural Diversity Database (WYNDD) staff to determine landscape extent, habitat characteristics, species' biology, and to help assess status.

STUDY AREA

The 2013 surveys addressed most areas of potential habitat on public lands in western Fremont and Hot Springs counties, within the BLM Lander and Worland field offices, respectively. Surveys did not address the two known sites on Shoshone National Forest, the three known sites on Wind River Indian Reservation, the six known sites on private lands, and very recent BLM surveys. Areas such as Beaver Rim and Red Canyon, where it was already mapped in detail, were not revisited except if their extent was in question. A priority was placed on surveying new potential habitat and known sites that had no population mapping.

METHODS

At the start of this project, all available literature on *Physaria saximontana* var. *saximontana* was reviewed, known distribution in Fremont and Hot Springs counties was studied, and the potential distribution model as developed by Fertig and Thurston (2003) was referenced. An ArcMap project was set up using known and potential distribution, digital ortho-photographs (NAIP 2006), and U.S. Geological Survey mapping.

Three approaches were taken in targeting areas for survey: revisits to imprecisely-mapped collection points, photointerpretation, and use of a potential distribution model. Highest probability areas found on public land were targeted (Figure 1) from the potential distribution model by Fertig and Thurston (2003). Photointerpretation flagged the largest outcrops with potential habitat and was used to cross-check the model in visiting visually similar outcrops inside and outside areas of potential habitat.

In preparation for fieldwork, digital ortho quarter-quads (doqqs) were printed with section lines, known distribution, and potential distribution superimposed onto 8 ½" x 11" pages of paper, representing about the same scale as 1:24,000 U.S.G.S. topographic maps. The aerials and U.S.G.S. maps were both used for reference in setting field survey priorities and navigation in the field. Just the high- and medium-levels of potential distribution probability were projected. About 60 U.S.G.S. topographic map areas intersected with potential habitat, representing about 120 doqq printouts (Figure 1).

Surveys for *Physaria saximontana* var. *saximontana* were conducted by 1-2 people between 3 June – 8 July 2013. When working in tandem, different segments of potential habitat were surveyed. When *P. s.* var. *saximontana* was found, determinations were made of its extent, and characterizations were made of its environmental setting, habitat conditions, and plant associates. Geographic Positioning System (GPS) coordinates were taken for subpopulations of 10 m radius or less. Otherwise multiple GPS coordinates were taken to map polygons back in the office. Plants were often counted, at least in a portion of occupied habitat to come up with estimates, or else frequency was noted (uncommon, common, abundant/dominant). Sensitive plant survey forms were filled out, and later entered into the WYNDD database.

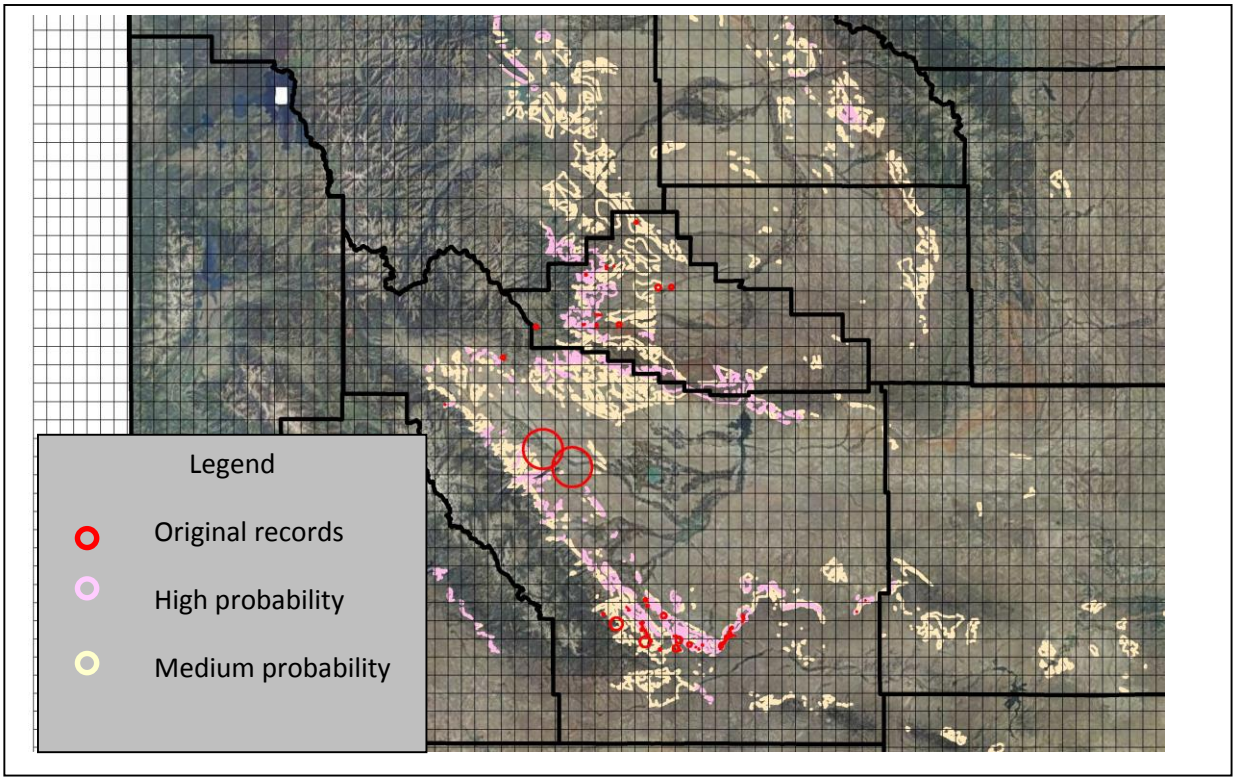


Figure 1. Original records and potential distribution model of *P. s.* var. *saximontana*, based on central database, overlain on output from Fertig and Thurston (2003) (Note: The boundaries of 7.5' topographic quarter-quad boundaries are included as thin black lines.)

In the field surveys, voucher specimens were collected for every new population and for most revisited populations. All specimens were deposited at Rocky Mountain Herbarium (RM). Photographs were taken of the species and its occupied habitat at most surveys.

GPS coordinates were collected in each discrete survey area where *Physaria saximontana* var. *saximontana* was sought but not found. The survey routes were marked onto U.S.G.S. topographic maps, digitized in the office, and cross-checked with the projected GPS coordinates.

RESULTS - SPECIES INFORMATION

Classification

Scientific name: *Physaria saximontana* var. *saximontana* Rollins

Synonyms: None

Common name: Rocky Mountain twinpod

Family: Brassicaceae

Size of genus: The *Physaria* genus, in current taxonomic literature, is a merger of the *Lesquerella* genus and a narrower circumscription of the *Physaria* genus (Al-Shehbaz and O'Kane 2002). Payson (1921) proposed, and Rollins (1939) echoed, that *Physaria* was derived from *Lesquerella* and the two are closely-related (Rollins and Shaw 1973), but the former name has greater antiquity and takes precedent. Steven O'Kane, author of the *Physaria* treatment in *Flora of North America* (2010), reported that the genus *Physaria* consists of 106 species, 88 species in North America north of Mexico. Of these, 23 species are in Wyoming (Heidel and O'Kane 2010, 2012). Other members of the genus occur in Mexico, Argentina, Bolivia, and northeastern Russia. Prior to the merger of the two genera, *Physaria* consisted of 22 species north of Mexico (Al-Shehbaz and O'Kane 2002) of which 10 were reported for Wyoming (Dorn 2001). The *Physaria* genus in current treatment has the highest number of endemic species among all genera of vascular plants in Wyoming (Heidel and O'Kane 2010), with eight state endemics or regional endemics.

Phyllogenetic relationships: Rollins compared *Physaria saximontana* var. *saximontana* with *P. didymocarpa* when he first described the species and its varieties (Rollins 1984):

> "For several years I have been encountering populations of *Physaria* with many of the features of *P. didymocarpa*, but with a number of distinctive characters that make them difficult to accept as part of that species. These populations occur southeast of the Wind River Mountains of west central Wyoming, and extend northward through the main

chains of the central Rocky Mountains of Montana. The area overlaps, but is mostly to the south of, the primary geographical range of *P. didymocarpa*, which is largely in Canada and western Montana (Mulligan 1967). The most significant differences between *P. didymocarpa* and *P. saximontana* are in the silique shape and in the position of the orifice on the inner face of each valve. The siliques of *P. didymocarpa* are cordate at the base because the valves produce a narrow sinus at the base of the replum. …On the other hand, the siliques of *P. saximontana* have no sinus at their base. Here, the replum is attached at the very base of the valves and the orifice to each valve is also at the base. But in *P. didymocarpa* the valve orifice is near the middle of each valve face."

The first monograph on the *Physaria* genus was by Rollins (1939). Relationships between species of the genus are under ongoing investigation by O'Kane. This is particularly daunting in a genus known for "cryptic species" not always readily discerned by morphological traits in the field (local field characters). The challenge is complicated for Wyoming botanists by modest differences among distinguishing characteristics used in keys for the same species as represented by Dorn (2001) and O'Kane (2010), and by slightly different attributes ascribed for the same species (Table 1). The Dorn key is generally consistent with the characters presented by Rollins (1984, 1993).

History of the taxon: *Physaria saximontana* was first collected in 1946 by M. C. Wiegand, but not recognized as a new species until it was described by Reed Rollins (1984). Rollins described its two varieties at the same time.

Physaria saximontana var. *saximontana* was elevated to a subspecies by O'Kane (2007), treated as a variety by Dorn (2001) in accordance with Article 4 of the International Code. The other variety of the species is *P. s.* var. *dentata*, a Montana endemic, found from montane to alpine elevations in nine counties spanning the Greater Yellowstone area, the Front Range, and Island Ranges (Lesica 2012).

Present legal or other formal status

U.S. Fish & Wildlife Service: None. In 1992, *Physaria saximontana* var. *saximontana* was added to the species under review for designation under the Endangered Species Act, placed in a Category 2 status (USDI Fish & Wildlife Service 1992). The recognition of Category 2 status was replaced with a new Species at Risk category in 1996. However, the category has no legal standing and the list is not maintained.

Agency status: Designated Sensitive by Wyoming Bureau of Land Management (BLM 2010). In addition, *Physaria saximontana* var. *saximontana* was addressed in a technical conservation assessment for Region 2 of the U.S. Forest Service (Rocky Mountain Region), representing a

peer-reviewed literature review for globally rare species in or near National Forests of the Region (Glisson 2004). It is not designated sensitive by Region 2 of the U.S. Forest Service because the great majority of occurrences are outside of national forest boundaries, at lower elevations. In keeping with its BLM status, it is under consideration for recognition as a Species of Local Concern by the Shoshone National Forest (USDA Forest Service 2014).

Table 1. Distinguishing characteristics of *Physaria saximontana* var. *saximontana* from other *Physaria* taxa that overlap in distribution or are in adjoining counties (Rollins 1993, Dorn 2001, O'Kane 2010).

Taxon	**Shape of fruit**	**Flower color**	**Number of funiculi per locule**[1]	**Shape and position of partition between locules**	**Basal leaf pubescence (use 10X hand lens)**	**Basal leaf shape and outline**
P. saximontana var. *saximontana*	Silicles strongly didymous, basal sinus absent or obsolete	Deep yellow	2 (Dorn 2001); 4 (O'Kane 2010)	Narrowly ovate to broadly oblong; not narrowed at middle	Densely pubescent, trichomes appressed	Orbicular to broadly obovate, entire or with broadly tooth-like angles
P. acutifolia	Silicles strongly didymous, basal and apical sinuses prominent, usually nearly equal	Deep yellow	Usually (1) 2	Narrowly oblong to linear; rarely lanceolate to oblanceolate	Smooth-looking, with multi-ray hairs	Obovate to orbicular, apex rounded or obtuse, entire or very rarely with a few scattered teeth
P. eburniflora	Silicles strongly didymous, base slightly cordate, apex with a deep closed sinus	White (O'Kane 2010); usually pale yellow (Dorn 2001)	4-8	Elliptic to ovate, not narrowed at middle	Densely silvery-pubescent, trichomes in multiple layers, appressed	Suborbicular, entire
P. didymocarpa var. *lanata*	Silicles strongly didymous, basal and apical sinuses prominent, usually nearly equal	Deep yellow	Usually 2 (Dorn 2001); but reported as (2) 4 (O'Kane 2010)	Narrowly oblong to linear; rarely lanceolate to oblanceolate	Densely-hairy with spreading, long, simple, tangled hairs; shaggy-looking, particularly at petiole base	Obovate, apex angular, slightly to coarsely dentate
P. didymocarpa var. *didymocarpa*	Silicles strongly didymous, basal and apical sinuses prominent, usually nearly equal	Deep yellow	Mostly 4 (3 to 6)	Oblong to ovate	Smooth-looking, with appressed, forked or simple hairs	Obovate, apex angular, repand to dentate
P. brassicoides	Silicles with little or no sinus below	Deep yellow	Usually 2	Narrowly oblong to linear; rarely lanceolate to oblanceolate; constricted toward middle	Smooth-looking, with multi-ray hairs	Orbicular to obovate, apex angular, margins repand or rarely entire

Global Heritage rank: G3 (vulnerable throughout its range)

[1] The number of funiculi (stalks) should correspond with the number of ovules per locule, and may be greater than the number of seeds because seed abortion or lack of fertilization are common (O'Kane 2010).

State Legal status: None

State Heritage rank: S3 (vulnerable throughout the state). As a state endemic, the state rank is identical to the global rank.

Description

General non-technical description: Rocky Mountain twinpod is a perennial herb with a basal rosette of mostly entire, spoon-shaped or rounded, hairy, grey-green, long-petioled leaves. Flowering stems are usually prostrate to decumbent with small, linear leaves. Flowers are yellow with 4 petals 8-10 mm long. Mature fruits are gray-hairy, inflated, and deeply notched at the top but not at the base. The membranous partition (replum) dividing each half of the fruit is oval with two stubby stalks (funiculi) on each face (Rollins 1984; Fertig 1995; Fertig et al. 1994).

Technical description: Perennials; caudex usually simple; (silvery) pubescent throughout, trichome rays furcated. Stems several from base, prostrate to decumbent, 0.3-1 cm. Basal leaves (rosulate; petiole winged); blade orbicular to broadly obovate, 1.5-3 cm, margins entire or with broad, obscure toothlike angles each side at apex, (apex obtuse, surfaces densely pubescent, trichomes appressed). Cauline leaves: blade broadly spatulate to linear oblanceolate, 1-1.5 cm, margins entire. Racemes condensed, (subumbellate to slightly more elongated, few-flowered). Fruiting pedicels (divaricately-ascending, straight to slightly curved), 6-10 mm. Flowers: sepals narrowly lanceolate, 5-6 mm; petals yellowish, often with come purple, spatulate, 7.3-9.2 mm (not clawed). Fruits didymous, irregular, suborbicular, deeply bilobed, inflated in age, 10-12 mm x 12-15 mm, (papery, basal sinus absent or obsolete, apical sinus deep); valves retaining seeds after dehiscence), densely pubescent, trichomes spreading, (ovaries and immature fruit downy); replum narrowly ovate to broadly oblong, not narrowed at middle, as wide or wider than fruit, apex acute to obtuse; ovules 4 per locule; style 3-7 mm. Seeds flattened (O'Kane 2010).

Local field characters: The most reliable field character is the shape of the fruit. *Physaria saximontana* var. *saximontana* has a fruit that is deeply notched at the top but not notched at the base. By comparison, both *P. acutifolia* and *P. didymocarpa* are deeply notched at both top and base. *P. eburniflora* is only slightly notched at the base. The latter is also distinguished from *P. s.* var. *saximontana* by its pale yellow or cream color as opposed to the bright, intense yellow of all other Wyoming species in the genus. This trait cannot be evaluated on withered petals.

When field surveys started in 2013, we were working in Fremont County with *Physaria saximontana* var. *saximontana* plants that had immature fruits, so that fruit shape could not be reliably determined. As a rule of thumb, funiculi were counted on one or more plants (possible at any stage of fruit development) to distinguish it from *P. didymocarpa* following the key in Dorn (2001). Local field characteristics are discussed further on the following pages.

Figure 2. *Physaria saximontana* var. *saximontana* illustration, by Robin Jones. From: Fertig, W., C. Refsdal, and J. Whipple. 1994. Wyoming Rare Plant Field Guide. Wyoming Rare Plant Technical Committee, Cheyenne, WY.

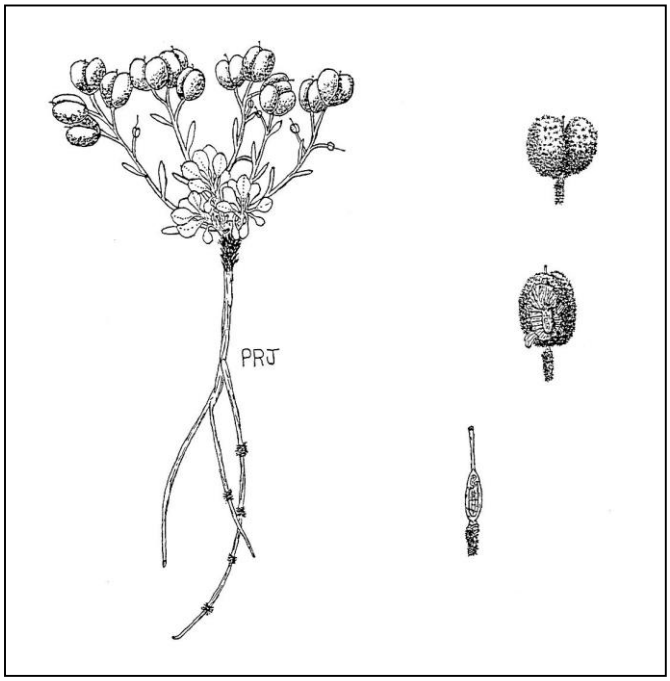


Figure 3. *P. s.* var. *saximontana* in flower, by W. Fertig

Figure 4. *P. s.* var. *saximontana* in fruit, by B. Heidel

Similar species: *Physaria didymocarpa* has three or more funiculi on each face of the partition and longer leaves. *P. acutifolia* has a linear replum and fruits that are equally lobed above and below (Fertig et al. 1994). Walter Fertig prepared a set of illustrations to compare these species (Figure 5).

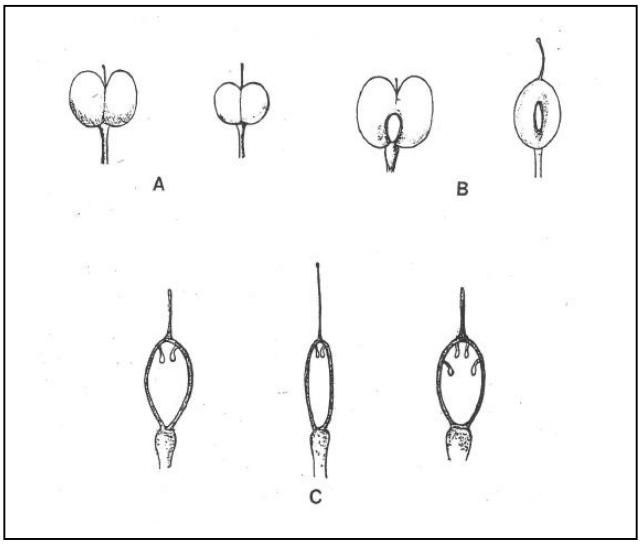


Figure 5. Fruit characters of *Physaria* species, by Walter Fertig (from Fertig 1992).

A. Fruit of *P. saximontana* var. *saximontana* (left) and *P. acutifolia* (right);
B. Fruit of *P. saximontana* var. *saximontana* with tissue removed to expose the elliptical orifice, located at the base of the fruit (left), and similar view of *P. acutifolia* showing linear orifice located at middle of fruit (right);
C. Replum with persistent funiculi of *P. saximontana* var. *saximontana* (left), *P. acutifolia* (middle) and *P. didymocarpa* (right).

It is very uncommon to have different species of twinpod growing together, but overlaps between a Threatened species (*Physaria congesta*) and a common species (*P. acutifolia*) have been reported in Colorado (Kurzel and Alward 2012). There are extremely few reports of hybridization between *Physaria* species (Kothera et al. 2007). Therefore, there is limited basis for interpreting distribution overlaps between *P. didymocarpa* and *P. acutifolia,* collected in the same landscape as *P. saximontana* var. *saximontana* in Hot Springs County, and distribution overlaps between *P. s.* var. *saximontana* and *P. eburniflora* in Fremont County. Specimens in the flowering stage are for needed for making the latter distinction, although not suited for distinguishing it from the other *Physaria* species. In the Figure 5 diagram, *P. eburniflora* would most closely resemble *P. didymocarpa* (5.c. far right cross-section) based on the number of funiculi. This trait is highlighted in the *Physaria* key of Dorn (2001) but not mentioned in the key of O'Kane (2010).

Phenology: Flowers late May-late June. Mature fruits present June-August (Fertig et al. 1994; 2013 study). The phenology varies between sites and between years, with flowering lasting about 2-3 weeks in most years. Flowering was finished when fieldwork began in 2013 during the first week of June (Fremont County), and fruits were beginning to fall apart when fieldwork was completed during the first two weeks of July (Hot Springs County).

Geographical distribution

Range: *Physaria saximontana* var. *saximontana* is endemic to Wyoming's southern Bighorn and Wind River Basins, and foothills of the Wind River, Owl Creek, and Absaroka Ranges in Fremont and Hot Springs counties (Figure 6).

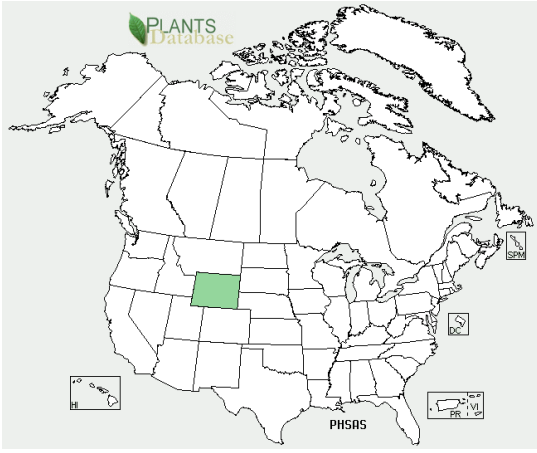


Figure 6. *Physaria saximontana* var. *saximontana* distribution rangewide, from PLANTS database (2013)

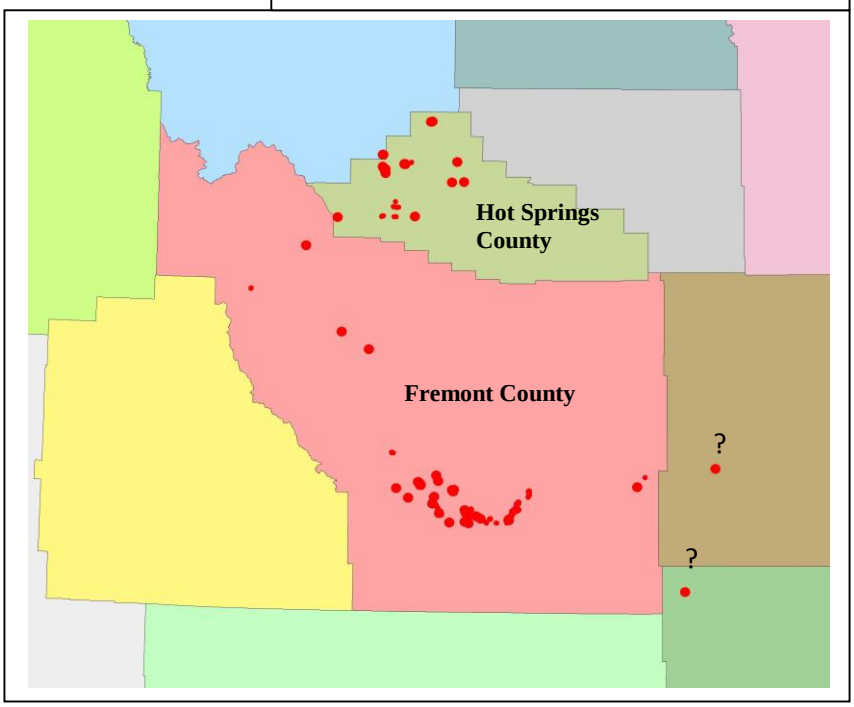


Figure 7. *Physaria saximontana* var. *saximontana* distribution in Wyoming

Extant sites: *Physaria saximontana* var. *saximontana* is known from 32 extant occurrences[2] in central Wyoming (Figure 7; Table 2, Appendix B). Eighteen occurrences are in Fremont County, 13 are in Hot Springs County and one occurrence is in Park County. As a result of 2013

[2] Occurrences are record units used by NatureServe. As applied by WYNDD botanists, they are working approximations of populations based on spatial discontinuity of distribution as inferred to reduce or eliminate gene exchange by dispersal and pollination. Separation distances of 2 km (1.6 mi) are generally used to delimit populations.

surveys, *Physaria saximontana* var. *saximontana* is now known from 13 additional sections, although only five represent new occurrences and the rest are extensions of existing records.

Historical sites: None.

Unverified/Undocumented reports: *Physaria saximontana* var. *saximontana* is also reported for Carbon County by Roderick et al. (1999) and from Natrona County (Rocky Mountain Herbarium 2013) represented as records under review (Figure 7). Both collections (Hartman 13065, 57263) represent county records and warrant verification. Both specimens were collected in fruit and their locations are in areas where *P. eburniflora* is known to be present. The Carbon County site was surveyed 1 June 2014 at a time when the only persisting petals that could be found were withered, and color determination was not reliable. Distribution questions remain unanswered.

Sites where present status not known: Three of the earliest *Physaria saximontana* var. *saximontana* collections were made on the Wind River Indian Reservation in the 1980's. The location information accompanying these collections was not precise and their present status is unknown. Likewise, the location of one recent collection made on Shoshone National Forest is not known precisely, reported as being from any of several sections in which a floristics collection was made. With these three exceptions, all others have more detailed location information if not more recent data.

The full geographic scope of potential habitat was sought in Fremont and Hot Springs counties, as identified in the model (Fertig and Thurston 2003) except for the Wind River Indian Reservation, Shoshone National Forest, and private lands. In some cases, occupied habitat represented isolated parcels surrounded by private land (e.g., all background in Figure 10, and most of the long anticline ridge in Figure 12). In addition, the Owl Creek Mountains east of the Wind River in Hot Springs County, and the Wind River Basin foothills in the northwestern corner of Fremont County around Dubois were lower in priority and not covered. Surveys extended into contiguous potential habitat of Park County in one area when considering the length of Enos Creek, but did not include most areas identified in that county (Fertig and Thurston 2003) or in six other counties.

Table 2. Location of *Physaria saximontana* var. *saximontana* populations in Wyoming

#	Co.	Directions	Legal Description	USGS Topographic Quad	Last Obs. Date.	Elev. min-max.	Public lands
1	FRE	Wind River Basin; Beaver Rim, vicinity of Devils Gap, Dishpan Butte and old highway, ca 6-9 miles northwest of Sweetwater Station.	T30N R96W Sec: 2 Note: N2, SW4*T30N R96W Sec: 03 Note: E2*T30N R96W Sec: 10 Note: SE4 of NE4*T30N R96W Sec: 11 Note: NW4 of SW4 of NW4, NW4 of NE4 of NW4*T31N R95W Sec: 03 Note: W2*T31N R95W Sec: 10 Note: NW4 of NW4 of NW4*T31N R95W Sec: 18 Note: *T31N R95W Sec: 19 Note: S2 of NW4, SW4*T31N R95W Sec: 29 Note: *T31N R95W Sec: 30 Note: N2, NW4 of NW4 of SW4*T31N R96W Sec: 24 Note: E2 of SE4*T31N R96W Sec: 25 Note: *T31N R96W Sec: 26 Note: E2 of SE4*T31N R96W Sec: 35 Note: E2 of NE4, SE4*T31N R96W Sec: 36 Note: NW4, W2 of SW4*T32N R95W Sec: 34 Note: SW4, S2 of NW4	Red Canyon, Dishpan Butte, Yellowstone Ranch	8 May 2012	6800-7100	BLM Lander Field Office, State of Wyoming
2	FRE	Wind River Basin; Sheep Mountain and hills along Twin Creek, ca 11 air miles southeast of junction of US Highway 287 and Wyoming Highway 28. Also: Wind River Basin; southeast end of Beaver Rim, ridge on north side of Red Canyon on east bank of Beaver Creek, 2-2.5 miles west of US Highway 287. Also on ridge on north side of Red Bluff Canyon and on ridge just west of hot spring, ca 0.5 mi west of Spring Gulch.	T30N R97W Sec: 03 Note: *T30N R97W Sec: 04 Note: *T30N R97W Sec: 06 Note: *T30N R97W Sec: 07 Note: SW4*T30N R98W Sec: 01 Note: *T30N R98W Sec: 02 Note: *T30N R98W Sec: 11 Note: *T30N R98W Sec: 12 Note: *T30N R98W Sec: 13 Note: *T30N R98W Sec: 14 Note: *T31N R97W Sec: 30 Note: *T31N R97W Sec: 31 Note: *T31N R97W Sec: 33 Note: *T31N R98W Sec: 25 Note: SW4 of NW4*T31N R98W Sec: 26 Note: SE4 of NE4*T31N R98W Sec: 36 T30N R97W Sec: 01 Note: center*T30N R97W Sec: 02 Note: *T30N R97W Sec: 03 Note: SE4 of SE4 of SE4*T30N R97W Sec: 10 Note: NE4 of NE4 of NE4*T30N R97W Sec: 11 Note: SE4 of SW4 of NE4, NE4 of NW4 of SE4Note: Connecting what was previously mapped as record #020.	Schoettlin Mountain, Gravel Spring, Del Monte Ridge, Weiser Pass, Red Canyon	29 Jun 2013	6100--6950	BLM Lander Field Office
3	FRE	Wind River Basin; "east of Lander off US Highway 287". Mapped on ridge between US Highway 287 and Lyons Valley west of the Little Popo Agie River.	T32N R99W; T32N R99W - PVT	Lander	28 May 1981	5700-6000	
4	FRE	Southeast Wind River Range; Red Canyon Rim on east side of Red Canyon Road from the Little Popo Agie River south to Foster Draw and	T30N R99W Sec: 01 Note: *T30N R99W Sec: 02 Note: *T30N R99W Sec: 03 Note: *T30N R99W Sec: 04 Note: *T31N R99W Sec: 03 Note: SW4 of SE4 of SW4*T31N R99W Sec: 04 Note: *T31N R99W Sec: 09 Note: NE4 of NE4*T31N R99W Sec: 10 Note: *T31N R99W Sec:	Gravel Spring, Miners Delight, Weiser Pass, Wolf Point	27 Jun 2013	5500-7130	State of Wyoming , (Red Canyon

		Wyoming Highway 28, and at toe of Oil Well Hill and slopes south of Deep Creek on west side of Red Canyon Creek.	14 Note: SW4 of SW4*T31N R99W Sec: 15 Note: *T31N R99W Sec: 22 Note: NE4 of NE4 of NE4*T31N R99W Sec: 23 Note: *T31N R99W Sec: 25 Note: W2 of SW4*T31N R99W Sec: 26 Note: E2*T31N R99W Sec: 27 Note: *T31N R99W Sec: 28 Note: *T31N R99W Sec: 33 Note: *T31N R99W Sec: 34 Note: *T31N R99W Sec: 35 Note: *T31N R99W Sec: 36 Note: NW4, NW4 of SE4				Ranch Preserve)
5	FRE	Wind River Basin; north of East Branch Sand Draw, ca 2 air miles northwest of Crow Mountain.	T 7N R5W – RESERVATION	Crow Mountain	9 Jul 1981	8300	
6	FRE	Northeast Wind River Range; foothill slopes at south end of Torrey Rim, ca 0.2 miles north of Trail Lake trailhead, ca 1.75 miles west of Trail Lake, ca 7 air miles south of Dubois.	040N106W Sec: 21 Note: N2 of NE4	Torrey Lake	14 Jun 1996	7700-7850	Shoshone National Forest
7	FRE	Wind River Basin; "15 miles northwest of Fort Washakie" [may be in vicinity of Winchester Butte, south of the Wind River].	[MULTIPLE TOWNSHIPS ARE LISTED AS POSSIBLE] - RESERVATION	Argo Butte, Lookout Butte SW, Bull Lake East, or Crowheart Butte	22 Jul 1983	No data	
8	FRE	Wind River Basin; ca 25 miles northwest of Morton [may be in vicinity of US Highway 26-287 south of the Wind River near Crowheart Butte].	004N003W - RESERVATION	Crowheart Butte	22 Jun 1981	No data	
10	HOT	Owl Creek Mountains; South Fork Owl Creek.	T43N102W Sec: 17 Note: *T43N102W Sec: 18 Note: *T43N103W Sec: 11 Note: *T43N103W Sec: 13 Note:	Monument Peak	24 Aug 1991	8420-8850	BLM Worland Field Office
11	FRE	Wind River Basin; Little Popo Agie River Valley, east of Dry Lake and US Highway 287/WY 28 junction, ca 7 air mi southeast of Lander.	T32N R99W; *T32N R99W - PVT	Weiser Pass, Wolf Point	16 Jun 1989	5600	
12	FRE	Wind River Basin; Cedar Ridge, north of WY/US Highway 789-287, 13 mi southeast of Lander.	T31N R98W Sec: 04 Note: *T32N R98W Sec: 28 Note: *T32N R98W Sec: 32 Note: *T32N R98W Sec: 33 Note: *T32N R98W Sec: 34 Note:	Weiser Pass	4 Jun 2013	5800	BLM Lander Field Office

13	FRE	Western Wind River Basin; small ridge northeast of Twin Creek, north of junction with Tweed Creek, 18 mi south-southeast of Lander.	T30N R98W - PVT	Gravel Spring	12 Jun 1991	6800	
14	HOT	Eastern foothills of the Absaroka Mountains; ca 4.5 air mi north of Anchor Reservoir, ca 33 air mi west-northwest of Thermopolis.	044N R100W Sec: 32 Note: E2 of SE4*044N R100W Sec: 33 Note: NW4 o SW4 of SW4, SW4 of SE4, W2 of SE4 of SE4*044N R100W Sec: 34 Note: center of S2 of SW4	Anchor Reservoir	14 Jul 1992	6700-7400	BLM Worland Field Office
15	HOT	Eastern foothills of the Absaroka Mountains; ridge on north side of Grass Creek at confluence of Little Grass Creek, ca 1.25 mi northwest of Adam Weiss Peak, ca 33.5 air mi northwest of Thermopolis.	T45N R99W Sec: 06 Note: SW4 of SE4 of NW4	Adam Weiss Peak	6 Jul 2013	6600-6800	State of Wyoming*BLM Worland Field Office
16	HOT	Eastern foothills of the Absaroka Mountains; ridge ca 1 mi north-northwest of summits of Twin Buttes, ca 35 air mi west of Thermopolis.	T45N R100W Sec: 02 Note: NE4 of NW4, NW4 of NE4*T45N R100W Sec: 11 Note: SE4 of SE4 of NW4, E2 of SW4, SW4 of SE4	Adam Weiss Peak	7 Jul 2013	6600-7100	BLM Worland Field Office
17	HOT	Eastern foothills of the Absaroka Mountains; ridge on north side of Grass Creek, 1 mi west of confluence of Sanford Creek.	T45N R101W Sec: 13 Note:	Milk Creek	7 Jul 2013	7200	BLM Worland Field Office
18	HOT	Southern Bighorn Basin; Wagonhound Bench, along Wagonhound Creek, ca 3.5 air mi north of Hamilton Dome, ca 22 air mi northwest of Thermopolis.	044N R98W Sec: 02 Note: *T45N R98W Sec: 26 Note: *T45N R98W Sec: 34 Note: *T45N R98W Sec: 35 Note: *T45N R98W Sec: 36 Note:	Hamilton Dome	6 Jun 1983 (failed to find in 2013)	5200	BLM Worland Field Office
19	FRE	Southern Wind River Range; southeast side of Fossil Hill, ca 1.5 air mi north of Indian Ridge, ca 0.25 air mi north of Burnt Gulch Creek.	T32N R100W Sec: 30 Note: SW4 of SW4*T32N R100W Sec: 31 Note: *T32N R101W Sec: 25 Note: *T32N R101W Sec: 36 Note:	Fossil Hill	29 Jun 1995	7840-7880	Shoshone National Forest

21	FRE	Sweetwater Plateau/Wind River Basin; toe of Beaver Rim. South population is near head of tributary draw of Coyote Creek, ca 1.5 air miles south of Wild Horse Springs and ca 2.5 air miles east-northeast of Mud Springs. North population is at head of Willow Springs Draw, ca 4 miles south of the Lucky Mac Uranium Mill.	T32N090W Sec: 09 Note: SW4 of NE4 of SE4*T32N090W Sec: 30 Note: SW4 of NE4	Coyote Springs, Gas Hills	12 Jun 2013	6900-7100	BLM Lander Field Office
22	HOT	Bighorn Basin; west side of Hillberry Rim, ca. 0.8 miles east of Wyoming Highway 120.	047N R99W Sec: 13 Note: SW4 of NE4	Hillberry Rim	8 Jul 2013	5600-5800	BLM Worland Field Office
25	FRE	Wind River Range; ca 3.5 miles east on Willow Creek Road, ca 6 air miles southwest of Lander.	T32N R99W Sec: 19 Note: NW4 of SW4*T32N R99W Sec: 30 Note: N2 of NW4*T32N R100W Sec: 24 Note: S2 of NE4	Wolf Point	8 Jun 2006	6010-6280	BLM Lander Field Office*State of Wyoming
26	HOT	Owl Creek Mountains; butte on north side of North Fork Owl Creek and south of North Fork Road, ca 33 air miles west-northwest of Thermopolis.	T43N R100W Sec: 16 Note: NW	Anchor Reservoir	5 Jul 2013	6900	BLM Lander Field Office
27	HOT	Bighorn Basin; north of Upper Cottonwood Creek Road, ca 28 miles northwest of Thermopolis.	T45N R97W - ROAD RIGHT-OF-WAY OR PVT	Hamilton Dome	21 Jun 1991	5200	
28	HOT	Owl Creek Mountains; just south of County Road and North Fork Owl Creek, ca 4 miles east-northeast of Anchor Reservoir, ca 30 miles west of Thermopolis.	T43N R99W; *T43N R99W; *T43N R99W; T43N R99W - PVT	Anchor Reservoir	22 Jun 1997	6200	
30	FRE	East slope Wind River Range; headwaters of Willow Creek to Wolf Trail along Canyon Creek, ca 12 air miles south of Lander.	[MULTIPLE TOWNSHIPS ARE LISTED AS POSSIBLE]	Wolf Point, Fossil Hill	25 Jul 2005	7660-8270	Shoshone National Forest

31	HOT	North slope Owl Creek Mountains; between North and Middle forks of Owl Creek, ca 5 miles west-northwest of Anchor Reservoir, ca 35 air miles west-northwest of Thermopolis.	T43N R101W Sec: 13 Note: NW4, NW4 of NW4 of NE4	Eagle Nest Ranch	1 Jun 2010	7080-7360	BLM Worland Field Office
34	FRE	East slope Wind River Range; south side of Red Butte, north side of County Road 212/Shoshone Lake Road, ca 5.5 miles west of Lander.	T33N R100W Sec 7 S2 of SW4	Mount Arter SE	28 Jun 2013	5720-6560	BLM Lander Field Office
35	HOT	Big Horn Basin; lower north slopes of Ilo Ridge, ca 1 mile south of Grass Creek, ca 5.5 miles east-southeast of Grass Creek townsite, ca 27 miles west-northwest of Thermopolis.	T45N R98W Sec 1 NE4	Red Ridge	8 Jul 2013	5620	BLM Worland Field Office
36	HOT	Eastern foothills of the Absaroka Mountains; ca 1 mile southwest of Cottonwood Creek, ca 2.5 miles west of Putney Flat, ca 5 miles east of Eagle Nest Ranch, ca 33 miles west-northwest of Thermopolis.	T44N R100W Sec 28 center	Twentyone Creek	5 Jul 2013	6860	BLM Worland Field Office
37	PAR	Owl Creek Mountains; north side of Enos Creek, ca 40 miles northwest of Thermopolis.	T46N R101 Sec. 25 SW4	Soapy Dale Peak	7 Jul 2013	7440-7600	BLM Worland Field Office

Historical sites: None.

Unverified/Undocumented reports: None.

Areas surveyed but species not located: BLM occurrences of *Physaria saximontana* var. *saximontana* were surveyed and relocated if they were based on collections. Survey efforts were unsuccessful at one Hot Springs collection record on Wagonhound Creek (#018). That record was described as located in a creekbottom setting, atypical for the taxon unless it "washed in". Surveys instead concentrated on nearest outcrops, but only *P. acutifolia* was found.

All places where *Physaria saximontana* var. *saximontana* was sought but not found are represented in Appendix A. In total, there were over 73 sections that were surveyed where it was not found, 63 of which were identified as having high or medium potential identified in the potential distribution model for *P. s.* var. *saximontana* (Table 3). The entire Beaver Rim was surveyed in the large gap in known distribution, confirming that it was unoccupied. A summary of survey results against potential distribution model layers is represented in Table 3, in which the model was tested at different scales, seeking inclusions and extensions of existing distribution patterns, as well as areas remote from known distribution. Of the sections with positive surveys, the majority were identified by photointerpretation and the majority of sections with negative surveys were identified using a potential distribution model.

Table 3. Positive and negative *Physaria saximontana* var. *saximontana* survey tallies by section

County	Tally of sections with positive surveys	Tally of sections with negative surveys (not including access routes and other marginal habitat)	TOTAL
Fremont	14	39	53
Hot Springs	11	8	19
Park	1	0	1
TOTAL	26	47	73

Land ownership: Most Fremont and Hot Springs County occurrences are on lands administered by the BLM Lander and Worland Field Offices, respectively (Table 2). A few are on State Lands, two are on Shoshone National Forest and three are in the Wind River Indian Reservation. It was surveyed on some private lands in the 1990's including the Red Canyon Nature Preserve owned by The Nature Conservancy.

Habitat

Ridges and slopes on sandy, gravelly, and rocky soils of limestone, red sandstone, or clay. The vegetation is mainly sparsely vegetated cushion plant communities in sagebrush grasslands and open *Pinus flexilis* and *Juniperus osteosperma* woodlands, with *Eremogone hookeri, Cymopterus longilobus, C. terebinthinus, Eriogonum brevicaule* var. *brevicaule, Phlox pungens* and *Elymus spicatus* (Fertig et al. 1994, Glisson 2004, Evert 2010, Heidel 2014). It is concentrated in foothills, extending from lower montane to basin margin elevations at 1585-2565 m (5200-8420 ft).

Associated vegetation: The vegetation is often sparsely-vegetated rather than well-developed, and dominant or common species often include *Elymus spicatus* (bluebunch wheatgrass), *Achnatherum hymenoides* (Indian ricegrass), and *Pinus flexilis* (limber pine).

Frequently associated species: The species often associated with *Physaria saximontana* var. *saximontana* in both counties, besides the vegetation dominants, are *Eriogonum brevicaule* var. *brevicaule* (Shortstem wild buckwheat), *Phacelia sericea* var. *sericea* (Purplefringe), and *Stephanomeria runcinata* (Desert wire-lettuce). Other than these, the associated species tend to differ between counties, with *Phlox pungens* (Beaver Rim phlox) as one of the most consistent associated species in Fremont County, and *Eriogonum ovalifolium* var. *ochroleucum* (Cushion wild-buckwheat) as one of the most consistent associated species in Hot Springs County. Additional plants associated with *P. s.* var. *saximontana* are presented in Table 4.

In the BLM Lander FO, *Physaria saximontana* var. *saximontana* is frequently associated with one other BLM Sensitive species, *Phlox pungens* (Beaver Rim phlox), and sometimes associated with *Trifolium barnebyi* (Barneby's clover) and *Lesquerella fremontii* (Fremont bladderpod; syn. *Physaria fremontii*). In the BLM Worland FO, it is sometimes associated with *Cymopteris evertii* (Evert's waferparsnip).

Topography: *Physaria saximontana* var. *saximontana* is often found in the most exposed topographic positions, namely on upper slopes and rims. It is most extensive where outcrops are most extensive, sometimes at other topographic positions. It is found on almost all aspects, but is most often on south-facing slopes. The elevation is from 1585-2565 m (5200-8420 ft). Where other species of *Physaria* occur in the same locale, preliminary information suggests that the different species tend to sort out by topographic position. In general, nine abiotic environmental attributes sorted out in classification tree model building of potential distribution by Fertig and Thurston (2003), and they are listed from most to least significant: Soils, October precipitation / Bedrock geology, Relief, January temperature / Landcover, July precipitation, Relief, and Surficial geology.

Table 4. Plants associated with *Physaria saximontana* var. *saximontana*

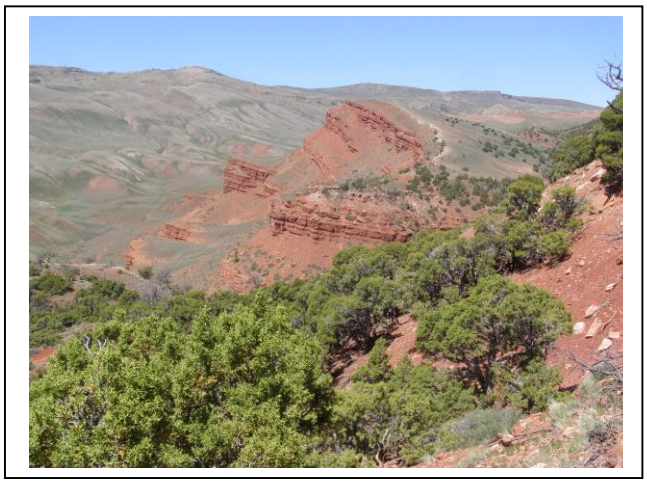
Family [__aceae]	Species	Common Name	Synonym	Fremont Co.	Hot Springs Co.
Poa	*Achnatherum hymenoides*	Indian ricegrass	*Oryzopsis hymenoides; Stipa hymenoides*	X	X
Aster	*Artemisia frigida*	Prairie sagebrush [Fringed sagebrush]			X
Aster	*Artemisia ludoviciana* var. *ludoviciana*	White sagebrush			x
Aster	*Artemisia tridentata* var. *wyomingensis*	Wyoming big sagebrush	*Seriphidium vaseyanum*	X	x
Fab	*Astragalus kentrophyta* var. *tegetarius*	Spiny milkvetch		x	
Fab	*Astragalus simplicifolius*	Little bun milkvetch		x	
Fab	*Astragalus tenellus*	Loose-flower milkvetch		x	
Fab	*Astragalus vexilliflexus*	Bent-flower milkvetch			x
Api	*Bupleurum americanum*	American thorow-wax			x
Cyper	*Carex filifolia*	Thread-leaf sedge		x	
Aster	*Chaenactis douglasii* var. *Montana*	Dusty-maiden [Hoary dusty-maiden]	*Chaenactis douglasii* var. *douglasii*		x
Aster	*Chrysothamnus viscidiflorus* var. *viscidiflorus*	Green rabbitbrush	*Includes* var. *stenophyllus*	x	
Boragin	*Cryptantha celosioides*	Buttecandle [Cockscomb cryptantha]		x	
Api	*Cymopterus evertii*	Evert's spring-parsley			x
Api	*Cymopterus longilobus*	Henderson's wavewing	*Cymopterus hendersonii; Pteryxia hendersonii*		x
Api	*Cymopterus terebinthinus var. albiflorus*	Turpentine wavewing	*Pteryxia terebinthina* var *albiflora*	x	x
Ranuncul	*Delphinium geyeri*	Geyer's larkspur		x	
Brassic	*Descurainia incana* var. *incana*	Mountain tansy-mustard	*Descurainia richardsonii* var. *sonnei; D. incisa* var. *incisa, D. incana* ssp. *incisa*		x
Poa	*Elymus spicatus*	Bluebunch wheatgrass	*Agropyron spicatum; Pseuodroegneria spicata; includes* ssp. *inermis & spicata*	x	x
Caryophyll	*Eremogone hookeri* var. *pinetorum*	Hooker's sandwort	*Arenaria hookeri* var. *pinetorum*	x	
Aster	*Ericameria nauseosa* var. *nauseosa*	Rubber-rabbitbrush	*Chrysothamnus nauseosus* var. *nauseosus*	x	
Aster	*Erigeron compositus* var. *discoideus*	Dwarf mountain fleabane [Cut-leaved fleabane]			x
Polygon	*Eriogonum brevicaule* var. *brevicaule*	Shortstem wild buckwheat		x	x
Polygon	*Eriogonum ovalifolium* var. *ochroleucum*	Cushion wild buckwheat	*Eriogonum ovalifolium* var. *macropodum*		x
Onagr	*Gaura coccinea*	Scarlet beeblossom		x	
Aster	*Gutierrezia sarothrae*	Kindlingweed [Broom snakeweed]		x	
Aster	*Hymenopappus filifolius* var. *luteus*	Fine-leaf woollywhite		x	
Aster	*Hymenoxys richardsonii* var. *richardsonii*	Colorado rubberweed [Richardson's hymenoxys]		x	
Ros	*Ivesia gordonii*	Alpine mousetail [Gordon's ivesia]		x	
Cupress	*Juniperus osteosperma*	Utah juniper		x	
Cupress	*Juniperus scopulorum*	Rocky Mountain juniper			x
Brassic	*Lesquerella alpina (=Physaria reediana)*	Alpine bladderpod	*Includes var spatulata*	x	
Brassic	*Lesquerella fremontii*	Fremont bladderpod		x	
Poa	*Leucopoa kingii*	False fescue [Spikefescue]	*Hesperochloa kingii*		x

Fab	*Lupinus argenteus* var. *argenteus*	Silver-stem lupine		x	x
Aster	*Machaeranthera grindelioides*	Rayless tansy-aster [Gumweed aster]	*Haplopappus nuttallii*	x	
Caryophyll	*Minuartia obtusiloba*	Alpine stitchwort	*Arenaria obtusiloba*	x	
Onagr	*Oenothera cespitosa* var. *cespitosa*	Tufted evening-primrose	*Oenothera caespitosa* var. *caespitosa*	x	
Aster	*Oonopsis multicaulis*	Branched false goldenweed	*Haplopappus multicaulis*	x	
Aster	*Packera cana*	Silver-woolly groundsel	*Senecio canus*	x	
Scrophulari	*Penstemon cyaneus*	Platte River beardtongue			x
Scrophulari	*Penstemon laricifolius* var. *laricifolius*	Larch-leaf beardtongue		x	x
Scrophulari	*Penstemon paysoniorum*	Payson's beardtongue		x	
Hydrophyll	*Phacelia hastata* var. *hastata*	Silver-leaf scorpion-weed	*Phacelia hastata* var. *leucophylla*		x
Hydrophyll	*Phacelia sericea* var. *sericea*	Purplefringe [Silky phacelia]		x	x
Polemoni	*Phlox hoodii*	Carpet phlox [Hood's phlox]	*Includes* ssp. *canescens, glabrata, hoodii, & viscidula*	x	
Polemoni	*Phlox pungens*	Prickly phlox [Beaver Rim phlox]		x	
Brassic	*Physaria acutifolia*	Sharp-leaf twinpod			x
Brassic	*Physaria didymocarpa*	Common twinpod			x
Pin	*Pinus flexilis*	Limber pine		x	x
Aster	*Platyschkuhria integrifolia*	Basin-daisy	*Bahia nudicaulis*	x	
Pin	*Pseudotsuga menziesii* var. *glauca*	Douglas-fir			x
Fab	*Psoralidium lanceolatum*	Wild lemonweed [Lemon scurf-pea]	*Psoralea lanceolata*	x	
Ros	*Purshia tridentata*	Bitterbrush		x	
Anacardi	*Rhus aromatica* var. *trilobata*	Ill-scented sumac	*Rhus trilobata* var. *trilobata*	x	x
Aster	*Stenotus acaulis*	Stemless mock goldenweed	*Haplopappus acaulis*	x	
Aster	*Stenotus armerioides*	Thrift mock goldenweed	*Haplopappus armerioides*	x	
Aster	*Stephanomeria runcinata*	Flowering-straw [Desert wirelettuce]		x	x
Fab	*Thermopsis rhombifolia* var. *rhombifolia*	Prairie golden-banner			x
Aster	*Townsendia spathulata*	Sword Townsend-daisy		x	

Soil relationships: *Physaria saximontana* var. *saximontana* grows on a variety of soils that generally fall within the Entisol order, have little or no profile development or organic accumulation. Textures may be sandy, gravelly, or silty and derived from sedimentary parent material including sandstone, limestone, conglomerate, or siltstone.

Geology: The distribution of *Physaria saximontana* var. *saximontana* and hence the potential distribution model tends to follow the pattern of bedrock geology outcrops, and therefore resembles the bedrock geology map (Love and Christiansen 1985). In Hot Springs and southern Park counties, it generally lies within areas mapped as intrusive igneous rocks of the Thorofare Creek group, though only found on sedimentary outcrops within this unit. In the Lander area, it is most consistently found on areas mapped as Chugwater and Dinwoody formations, and in the Beaver Rim area, on the White River and Wagon Bed formations. The former are readily discerned by the deep red coloration (Figure 8).

Figure 8. Sandstone bluffs above Red Bluffs Creek, Fremont Co. (concentrated on open, south-facing slopes, apart from juniper), by B. Heidel



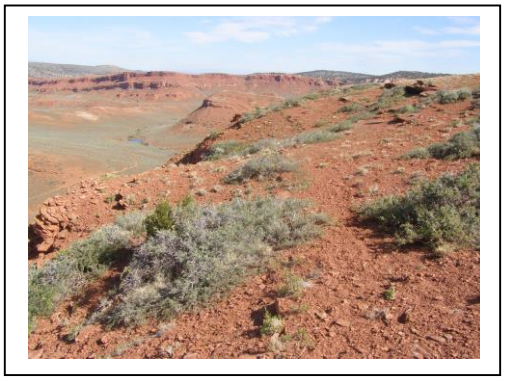


Figure 9. Sandstone rim east of Sheep Mtn., Fremont Co., by B. Heidel

Figure 10. Limestone and siltstone ridgetop above Enos Cr., Park Co., by B. Heidel

Figure 11. Sandstone slopes at Red Butte, Fremont Co., by B. Heidel

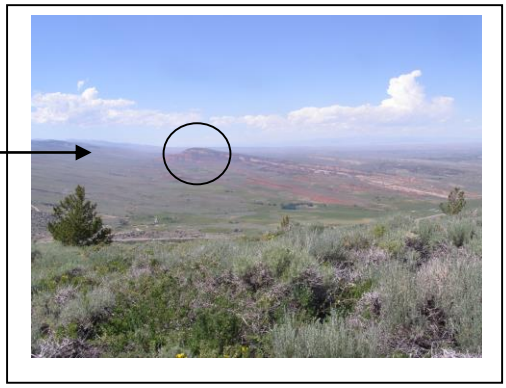


Figure 12. View of Red Butte from Table Mtn., by B. Heidel

Regional climate: Climate data from two of the nearest meteorological stations are summarized below (USDI NOAA 2006).

The meteorological station at Lander (485390) has data from 1948-2006, and is at an elevation of 1695 m (5560 ft). Mean annual temperature is 7.1° C (44.8° F) with mean January temperature at 0 C (32.0° F) and mean July temperature at 30.2° F (86.3° C). Mean annual precipitation is 33.0 cm (12.98 in), with peak precipitation in May at 6.2 cm (2.45 in).

The meteorological station at Thermopolis (488875) has data from 1948-2006, and is at an elevation of 1325 m (4350 ft). Mean annual temperature is 17.4° C (63.4° F) with mean January temperature at 2.6° C (36.6° F) and mean July temperature at 32.8° C (91.0° F). Mean annual precipitation is 28.8 cm (11.33 in), with peak precipitation in May at 5.1 cm (2.02 in).

Local microclimate: The microhabitats occupied by *Physaria saximontana* var. *saximontana* tend to be the driest, most exposed habitats in local gradients.

Population biology and demography

Population size and condition: Populations of *Physaria saximontana* var. *saximontana* may be small and sparse to large and locally abundant. There were no locales surveyed in 2013 that were found to support over 100 plants within 0.5 mi of habitat except for the new population at Red Butte (est. 700-800 plants), but collective population numbers are high and magnitudes larger than 100 where it repeats across the landscape at Beaver Rim, Red Canyon and Sheep Mountain. As part of 1995 surveys, the Red Canyon population was estimated to support over 10,000 plants across 180 acres. In 2013 surveys, seedlings were only noted at two occurrences, where they were rare, and seedlings were included as part of the populations tallies and estimates.

Detailed surveys were conducted for *Physaria saximontana* var. *saximontana* in 1989 in the Beaver Rim Area of Critical Environmental Concern (ACEC). The level of detail and the site protection were reasons it was not a survey priority in 2013. Its population patterns and associated habitat were described at the Beaver Rim ACEC by Jones (1989) saying: "Rocky Mountain Twinpod is nearly as widely distributed as Beaver Rim phlox [at Beaver Rim], occurring in small groups throughout the ACEC and adjacent land. This species grows on all substrates except extremely clay-rich layers in the hills below the Beaver Rim excarpment, although it appears to be more common on siltstones than on coarse substrates derived from the cobbly Miocene rocks. Groups comprising up to a dozen individuals can be found on sparsely-vegetated hills facing any direction. All the Rocky Mountain Twinpod in and near the ACEC is included in one element occurrence ["population"]."

In general, where population numbers of *Physaria saximontana* var. *saximontana* were lowest, there tended to be the lowest proportion of flowering plants. The vegetative plants were

sometimes, but not always, smaller than flowering plants present at the same locale. Their size difference may reflect age difference.

Trend data are not available for *Physaria saximontana* var. *saximontana*, although it has been inferred to be stable at large populations such as Red Canyon. Its growing and flowering period coincide with the peak of the annual wet cycle (Glisson 2004). It is hypothesized that the numbers documented in 2013 were depressed by weather conditions, namely, consecutive hot and dry conditions early in the 2012-2013 growing seasons as influencing seed production, germination and survival of plants at all life history stages. The 2013 observations indicate that the taxon is subject to oscillations with multi-year climate patterns.

Type of reproduction: Members of the *Physaria* genus reproduce strictly by sexual reproduction. Pollination biology: Species in the *Physaria* genus are generally bee-pollinated, consistent with flower color (yellow) and symmetry. Some members of Brassicaceae have self-incompatible genes (Franklin-Tong 2008). Essentially, these genes prevent ovule fertilization and fruit production in flowers where pollen from the plant comes in contact with the stigma of the same plant. Species with self-incompatible genes seem to require outcrossing by pollinators for successful fruit and seed set. This hypothesis of self-incompatibility and dependence on outcrossing was documented for *Physaria obcordata* (Tepedino et al. 2012) and for *P. congesta* (Clark 2012), two threatened species in Colorado.

In pollen load assay determinations on rare species of *Physaria*, the bee genera *Andrena, Dialictus*, and *Lasioglossum* contained multiple species shown to carry 50-100% rare plant pollen. In addition, bees in the genus *Dialictus, Halictus*, and *Lasioglossum* also spent the longest time foraging per rare *Physaria* flower. In the *Dialictis* genus in particular, the early flowering of *Physaria* may correspond with spring emergence of females to found new colonies that are reliant on spring forage. In 2013, aborted fruits of *Physaria saximontana* var. *saximontana* were noted sporadically, whether a result of depressed pollination activity or plant stress.

Seed dispersal and biology: Seeds of *Physaria saximontana* var. *saximontana* remain in the papery, balloon-like fruit at the time of dehiscence. The fruit is adapted to be carried by wind (Rollins 1983). It is likely that seeds are mucilaginous, based on the statement of O'Kane (2010) that *Physaria* species with mucilaginous seeds typically occupy unstable habitats, such that when wetted, they can "glue" onto optimal, local habitats. This dispersal might account for the clustered pattern of plants observed in the field. Seedlings were noted at only a few of occurrences surveyed in 2013 (Figures 13-14).

Population ecology:

General summary: *P. saximontana* var. *saximontana* is a perennial that appears to be short-lived. This is based on observing that there is limited amount of dead leaf material from previous years remaining at the base of plants, and on unpublished monitoring literature of species in the *Lesquerella* and *Physaria* genera.

Competition: *P. saximontana* var. *saximontana* appears to be a poor competitor because it is restricted to areas of low vegetation cover.

Herbivory: No signs of livestock or wildlife herbivory were noted in 2013. The *Physaria* genus in general has a combination of glucosamine (sulfur-containing compounds) and leaf hairs that deter herbivory. Individual plants were often found in small groups, as would be expected from their dispersal mechanism. A few times, they were found in dense clusters that might result from seed-caching by small rodents (Figure 17).

Figure 13. Relatively high clusters of seedlings by B. Heidel

Figure 14. Vegetative plants and seedlings, eastern Beaver Rim outlier, by B. Heidel

Figure 15. Aberrant habitat of eastern Beaver Rim outlier, below rim (near strip mine), by B. Heidel

Figure 16. Recovering ridge above abandoned wellpad, used by mountain bikers, bordering occupied habitat (left side of frame), by B. Heidel

Figure 17. Dense rosette clusters may indicate that multiple plants germinated from a seed cache, by B. Heidel

Hybridization: No hybridization is reported in the genus and no intermediates were noted in 2013 surveys.

ASSESSMENT AND MANAGEMENT RECOMMENDATIONS

Potential threats to currently known populations

Potentially threatened by mining, road work, and off-road vehicles. It may be affected by uranium mining (Heidel et al. 2014). According to Glisson (2004), the greatest threats are probably environmental stochasticity and natural catastrophes, with the most foreseeable rangewide threats being prolonged weather-related variability and potential climate change.

Grazing: Throughout the range of *Physaria saximontana* var. *saximontana*, livestock grazing is the dominant land-use. Surrounding range management may promote spread of weeds as a secondary affect but there are rarely any developments that concentrate use on the rugged slopes. Some populations are on rims that are fenced off from grazing. Few signs of grazing and trampling were observed in 2013, and few range management features that concentrate movement and use, such as stock dams, fences and salt blocks, were observed in the immediate vicinity.

Water Developments: None known.

Oil and Gas Development: In a recent analysis, distribution of *Physaria saximontana* var. *saximontana* was overlain with existing and projected statewide oil & gas developments, and no overlap was found (Heidel et al. 2014). One population (#012) is located almost directly above an abandoned wellpad. In Colorado, oil & gas impacts on a Threatened species of *Physaria* generally appear to be limited (Kurzel and Alward 2012).

Wind Energy Development: In a recent analysis, distribution of *Physaria saximontana* var. *saximontana* was overlain with existing and projected statewide wind energy developments, and no overlap was found (Heidel et al. 2014).

Roads and ORV Use: The primary threats to individual populations may result from off-road vehicle (ORV) activity and surface disturbance associated with road construction or extractive industry (Glisson 2004). Even rugged sites and sites outside of rights-of-way are potentially impacted by roadwork if re-contouring is involved, such as along Wyoming Highway 28. One population on BLM lands, located near Lander, has been developed for recreational use by mountain bikers and horsemen. The trails used by mountain bikers run on the ridge top that skirts the occupied ridge slope (#012; Figure 16).

Weeds: Exotic species were notably scarce or absent in surveying *Physaria saximontana* var. *saximontana.* Cheatgrass is at early stages of invasion in much of the area, possibly exacerbated by wildfire as at the new Enos Creek population (#037). Noxious weeds have been surveyed in great detail by Richard Scott across the Red Canyon area (Scott and Sato 1998) and control of species that are uncommon at present would ideally be made a high priority to circumvent their spread, including leafy spurge (*Euphorbia esula*) and spotted knapweed (*Centaurea maculosa*).

Mining and Quarrying: *Physaria saximontana* var. *saximontana* distribution may overlap with uranium mining activity (Heidel et al. 2014). The easternmost occurrence in Fremont County adjoins the Gas Hills Lucky Mac deposit where uranium was strip mined over large areas (#021). Elsewhere, rock has been quarried in occupied habitat at roadside hill excavations for use in local road work, but there are no signs of ongoing or recent activity.

Commercial Use: There is no known collecting pressure on *Physaria saximontana* var. *saximontana.* It and other members of the *Physaria* genus have been under investigation because of their potential as industrial oilseed crops (Rebman, J.P. USDA Agricultural Research Service. 1996, pers. commun. to L. Gianakos, WYNDD). The seeds in particular contain hydroxy fatty acids that have been used as a source of specialized, high-quality lubricants (O'Kane 2010).

Other Threats: The study area was in critical drought condition by the time of 2012 surveys (National Drought Mitigation Center 2012). Bordering the new occurrence on Enos Creek was an extensive, recent wildfire. It is not known if prolonged drought and fire pose threats.

Conservation recommendations

Recommendations regarding present or anticipated activities: Most occurrences are in multiple-use land management. Two occurrences of *Physaria saximontana* var. *saximontana* are

protected on the BLM Beaver Rim Area of Critical Environmental Concern (ACEC), and the Red Canyon ACEC and the contiguous Red Canyon Preserve of The Nature Conservancy.

Notification of BLM personnel of locations on BLM lands: To evaluate impacts to known populations of *Physaria saximontana* var. *saximontana*, all appropriate BLM personnel involved in on-the-ground management activities that include roads, quarrying, weed control and travel planning should have access to location data for *P. s.* var. *saximontana*. The updated state species abstract (Appendix C) and this report will also be submitted and posted on-line for reference.

Status recommendations: *Physaria saximontana* var. *saximontana* remains ranked G3/S3 after the 2013 surveys. It is on the Wyoming Species of Potential Concern list. It remains on this list as a state endemic and, though threats are limited, it can be affected by management actions.

Summary: *Physaria saximontana* var. *saximontana* is a state endemic of central Wyoming now known from 32 extant occurrences, including three very extensive ones. These three populations have occupied habitat area, if not total population numbers, that approach or exceed most of the rest of populations combined. Five new populations were documented that all fell within high- and medium-potential distribution polygons, including a new county record in Park County. Results generally support the merit of the potential distribution model as applied in the study area, despite overprediction. The status of the taxon in Carbon and Natrona counties as represented by two specimens has yet to be resolved. Putative patterns of sympatry with three other *Physaria* species (*P. acutifolia, P. didymocarpa* and *P. eburniflora*) need closer investigation.

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