

U.S. FISH AND WILDLIFE SERVICE SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

Scientific Name:

Boechera pusilla

Common Name:

Fremont County rockcress

Lead region:

Region 6 (Mountain-Prairie Region)

Information current as of:

06/01/2016

Status/Action

Funding provided for a proposed rule. Assessment not updated.

Species Assessment - determined species did not meet the definition of the endangered or threatened under the Act and, therefore, was not elevated to the Candidate status.

New Candidate

Continuing Candidate

Listing Priority Number (LPN) Change

Former LPN: 8

New LPN: 11

Candidate Removal

Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status

Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species

Range is no longer a U.S. territory

Taxon mistakenly included in past notice of review

Taxon does not meet the definition of "species"

Taxon believed to be extinct

Conservation efforts have removed or reduced threats

More abundant than believed, diminished threats, or threats eliminated.

Insufficient information exists on taxonomy, or biological vulnerability and threats, to support listing

Petition Information

Non-Petitioned

Petitioned - Date petition received: 07/30/2007

90-Day Positive:08/18/2009

12 Month Positive:06/09/2011

Did the Petition request a reclassification? **No**

For Petitioned Candidate species:

Is the listing warranted(if yes, see summary threats below) **Yes**

To Date, has publication of the proposal to list been precluded by other higher priority listing? **Yes**

Explanation of why precluded:

Higher priority listing actions, including court approved settlements, court-ordered and statutory deadlines for petition findings and listing determinations, emergency listing determinations, and responses to litigation, continue to preclude the proposed and final listing rules for this species. We continue to monitor populations and will change its status or implement an emergency listing if necessary. The "Progress on Revising the Lists" section of the current CNOR (<http://endangered.fws.gov/>) provides information on listing actions taken during the last 12 months.

Historical States/Territories/Countries of Occurrence:

- **States/US Territories:** Wyoming
- **US Counties:** County information not available
- **Countries:** Country information not available

Current States/Counties/Territories/Countries of Occurrence:

- **States/US Territories:** Wyoming
- **US Counties:** Fremont, WY
- **Countries:** Country information not available

Land Ownership:

Bureau of Land Management

Lead Region Contact:

ASST REGL DIR-ECO SVCS, Craig Hansen, 303-236-4749, Craig_Hansen@fws.gov

Lead Field Office Contact:

WY ESFO, Lynn Gemlo, 307-772-2374, lynn_gemlo@fws.gov

Biological Information

Species Description:

Boechera pusilla (Fremont County rockcress or small rockcress; hereafter Fremont County rockcress) is a perennial herb with several decumbent (lying down), unusually slender stems up to 17 centimeters (cm)(6.7 inches (in.)) long. The plant has basal leaves that are linear (at least 10 times longer than wide) and erect, with relatively sparse forked spreading hairs located on the leaves. Plants generally have three to five stem leaves that are nonclasping (not encircling the stem) and widely spaced. Flowers are small, light lavender, four-petaled, and blossom from May to mid-June. The fruits, which are present from mid-June to July, are hairless linear siliques (narrow elongated seed capsule) that spread at right angles from the drooping main stem on pedicels (small stalks) less than 3 millimeters (mm)(0.12 in.) (Marriott 1986, p. 3; Dorn 1990b, pp. 2-3; Fertig 1994, unpaginated; Heidel 2005, p. 3).

Taxonomy:

Fremont County rockcress is a member of the *Brassicaceae* (mustard) family that was described and published under the name *Arabis pusilla* (Rollins 1982 p. 194). However, studies in 2003 suggest that most North American *Arabis* species should be placed in the *Boechera* genus (Al-Shehbaz 2003, entire). This determination was based on their distinct chromosome numbers and on molecular data indicating that American and Eurasian species that were classified as *Arabis*

have more dissimilarities between them than they do with many other widely recognized genera in the mustard family (Al-Shehbaz 2003, pp. 382–383). Although some botanists do not fully support the change (Murray and Elven 2009, unpaginated), recognition of the *Boecheera* genus has been widely accepted (Holmgren et al. 2005, p. 537; Al-Shehbaz 2010, unpaginated). For the purposes of this species assessment, we refer to the scientific name of the species as *Boecheera pusilla*, rather than the synonym, *Arabis pusilla* except as used in Federal documents that pre-date this nomenclatural revision.

Fremont County rockcress is genetically closely related to *Boecheera demissa* var. *languida* (nodding rockcress), *Boecheera pendulina* var. *russeola* (Daggett rockcress), and *Boecheera oxylobula* (Glenwood Springs rockcress) and occurs in a similar geographic area as *B. demissa* var. *languida* and *B. pendulina* var. *russeola* (Dorn 1990b, p. 5; Heidel 2005, p. 2). Five additional species of rockcress occur in or near Fremont County rockcress habitat, representing a high amount of diversity within the genus (Heidel 2005, p. 2). Fremont County rockcress requires a highly specialized habitat (discussed below under Habitat) that is newly formed, which suggests the species is relatively recently derived from a common ancestor (Dorn 1990b, p. 5). Based on morphological evidence, Fremont County rockcress may be a hybrid of *B. pendulina* and *B. lemmonii* (Lemmon's rockcress) (Flora of North America 2010b, unpaginated). The hybrid origin of Fremont County rockcress is further supported by the recent detection of unique genes for this and many other *Boecheera* species (Kiefer and Koch 2012). The Fremont County rockcress is genetic hybrid with genes from three other species: *B. lemmonii*, *B. oxylobula*, and a currently undescribed taxon called “*wyomingensis*” (Windham pers. comm. 2016). Therefore, we recognize Fremont County rockcress as a valid species and a listable entity.

Habitat/Life History:

Due to the short growing season (approximately 30 days) in the area that Fremont County rockcress occupies, the plant only flowers in May and June with fruits maturing several weeks later (Marriott 1986; Fertig 1994, unpaginated; Heidel 2005, pp. 3, 15). Fruits are only evident during the short frost-free period during the middle of summer (primarily July) and shatter thereafter (Heidel 2005, p. 15). Remnant flower stalks persist through the winter and into the next flowering season (Heidel 2005, p. 15). Population census data may vary considerably from year to year due to the variation in the number of flowering and non-flowering individuals. For example, in years when many individuals have been flowering, fewer non-flowering plants are found. Conversely, in years when few flowering plants are identified, the number of non-flowering plants appear to be high (Heidel 2016 p. 6).

All Fremont County rockcress reproduction is apparently by seed (Dorn 1990b, p. 9; Heidel 2005, p. 15), and the species is apomictic (i.e., reproduces by seed with no fertilization, resulting in offspring that are essentially clones) (Flora of North America 2010b, unpaginated). Fremont County rockcress is a genetic hybrid of species that reproduce sexually and apomictically (Lovell *et al.* 2013), and similar *Boecheera* species have variation in the amount of sexual and asexual reproduction (Roy 1995, pp. 874–876), but it is not clear whether Fremont County rockcress exhibits a mixed-mating system.

Not all plants produce fruit in a particular year (Heidel 2005, pp. 15–16), which is thought to be caused by freezing conditions in spring or possibly drought (Heidel 2005, pp. 15–16). We do not know how long the species' seeds remain viable or under what conditions they germinate, but the plant has relatively few seeds per fruit compared to other *Boecheera* species (Dorn 1990b, p. 9). Reproduction of Fremont County rockcress is by nonwinged seeds that likely drop near the parent plant, with some seeds dispersed via wind or water (Dorn 1990b, p. 9). Other potential dispersal vectors are unknown (Heidel 2005, p. 15), as is some life history information, including plant growth stages, longevity, length of time it takes to flower, and whether or not an individual plant can flower more than once.

Fremont County rockcress occupies sparsely vegetated, coarse granite soil pockets in exposed granite-pegmatite outcrops, with slopes generally less than 10 degrees, at an elevation between 2,438 to 2,469 meters (m) (8,000 to 8,100 feet (ft)) (Dorn 1990b, pp. 3, 6). A pegmatite is a very coarse-grained igneous (formed from magma or lava) rock that usually occurs in dikes (sheet-like body of magma) (Heidel 2005, p. 8). The soils are sandy to loamy (mixture of clay, silt and sand), poorly developed, very shallow, and possibly subirrigated by runoff from the adjacent exposed bedrock (solid consolidated rock) (Dorn 1990b, pp. 6–8). Fremont County rockcress is likely restricted in distribution by the limited occurrence of pegmatite in the area (Heidel 2005, p. 8). A distribution model shows potential habitat could occur in an area no greater than two townships (186.5 square kilometers (km²); 72 square miles (mi²)) (Heidel 2005, p. 7). The dense nature of pegmatite does not allow for fertile soil, therefore restricting vegetation growth (Heidel 2005, p. 15). The specialized habitat requirements of Fremont County rockcress have allowed the plant to persist without competition from other herbaceous plants or sagebrush-grassland species that are present in the surrounding landscape (Dorn 1990b, pp. 6, 8).

Although the surrounding vegetation is sparse (less than 10 percent cover), Fremont County rockcress is associated with numerous mat-forming perennial herbs (e.g., *Erigeron caespitosus* (tufted fleabane)), perennial grasses (e.g., *Achnatherum hymenoides* (Indian ricegrass)), and shrubs (e.g., *Artemisia arbuscula* (dwarf sagebrush) and spikemoss (*Selaginella densa*)) (Heidel 2005, p. 9). Rolling hills with a gradual sloping impediment are the predominant landscape features in the area, which is a transition zone between the montane conifer forests and the high sagebrush desert (Heidel 2005, pp. 8–9). The adjacent vegetation consists primarily of sagebrush-grassland or open *Pinus flexilis* (limber pine) habitat (Dorn 1990b, p. 8).

Annual precipitation in the area is relatively low and averages between 30.5 cm to 34 cm (12 in. to 13.4 in.), with the majority falling in the form of winter snow (Marriott 1986, p. 9; Heidel 2016). Average minimum and maximum temperatures in this area range between -16.1 and -3.9 °C (3 and 25 °F) in January and 4.6 and 24.4 °C (42 and 76 °F) in July (Dorn 1990b, p. 6), with strong, frequent winds present year-round (Heidel 2005, p. 10). This area has a very short growing season; approximately 30 frost-free days occur between mid-June and mid-July (Marriott 1986, p. 9). Fremont County rockcress may be adapted to wide fluctuations in available moisture as the limited soil layer goes through cycles of rapid drying and saturation (Dorn 1990b, p. 6).

Historical Range/Distribution:

Historical range is unknown.

Current Range Distribution:

The only known population of Fremont County rockcress is located on lands administered by the Bureau of Land Management (BLM) Rock Springs Field Office in the southern foothills of the Wind River Range (Fertig 2000a, p. 39; Heidel 2005, pp. ii, 6). The species' range is approximately 64.8 hectares (ha) (160 acres (ac)), with occupied habitat estimates ranging from 2.4 to 6.5 ha (6 to 16 ac) (Dorn 1990b, p. 8; Heidel 2005, p. 15). Botanists have surveyed for Fremont County rockcress systematically in other areas (Marriott 1986, p. 8; Heidel 2005, p. 6) on Federal lands and discovered no additional populations, but some areas with potential habitat on private lands have not been surveyed (Heidel 2016b, pers. comm.).

Population Estimates/Status:

The single known population of Fremont County rockcress has at least eight subpopulations (Amidon 1994, unpaginated). The subpopulation with the most plants has been monitored periodically since 1988 as described below (Heidel 2005, p. 14; Heidel 2012, p. ii, 5). The other seven subpopulations are generally smaller than the subpopulation that is more consistently monitored, but in 2011, one subpopulation had more plants than any other subpopulation (Heidel 2012). In 2003, one subpopulation had 30 to 50 flowering plants, another had 10 to 15 flowering plants, and 5 of the subpopulations had less than 5 flowering plants each (Heidel 2005, p. 14).

Although population-wide counts have not been conducted every survey year, we use the estimates of total flowering plants in the entire population from the most complete census (i.e., total for Fremont County rockcress) and the total flowering plants in a plot located in the subpopulation with the most plants to estimate the population trend over time. These two indicators, the total flowering plants in both the entire population and a plot in the largest subpopulation, are the most consistently documented and best population information for this species. The number of flowering plants is used, at least in part, to ensure identification of the species (Heidel 2010d, pers. comm.). Although these estimates rely only on flowering plants, any given plant may oscillate between flowering and nonflowering conditions from year-to-year, and the ratio between flowering and nonflowering plants differs between years. This difference may mask population trends, so, starting in 2003, nonflowering plants were also counted. During some of the years with the lowest numbers of flowering plants, there was a relatively high proportion of nonflowering plants (Heidel 2016a, pers. comm.) Therefore, population and trend estimates that do not include nonflowering plants underestimate the population size or trends for the Fremont County rockcress.

Replicated monitoring in a plot in the largest subpopulation was conducted for a total of 9 years, starting in 1988, including consecutive monitoring for the 5 year period from 2008 to 2012 (Heidel 2012, pers. comm.; Heidel 2014, p. 3; Heidel 2012, p. 4; Heidel 2016 p. 2) (Figure 1 and Table 1). Monitoring was not conducted in 2005 to 2007, in 2013 or in 2014. The monitoring design developed for Fremont County rockcress in 1988 involved taking a complete census within a given

area of the largest subpopulation (Marriott and Horning 1988, unpaginated). We refer to this type of survey as the “original plot.” The 1988 original plot monitoring was replicated in 2003 and 2004 in the same subpopulation of Fremont County. From 2008 to 2012, a larger area called the “expanded plot”) was also monitored. These surveys indicated that a significant number of additional plants are located within contiguous habitat outside the original monitoring plot (Heidel 2012, p. 6), so the monitoring plot was expanded to better represent the subpopulation (Figure 1).

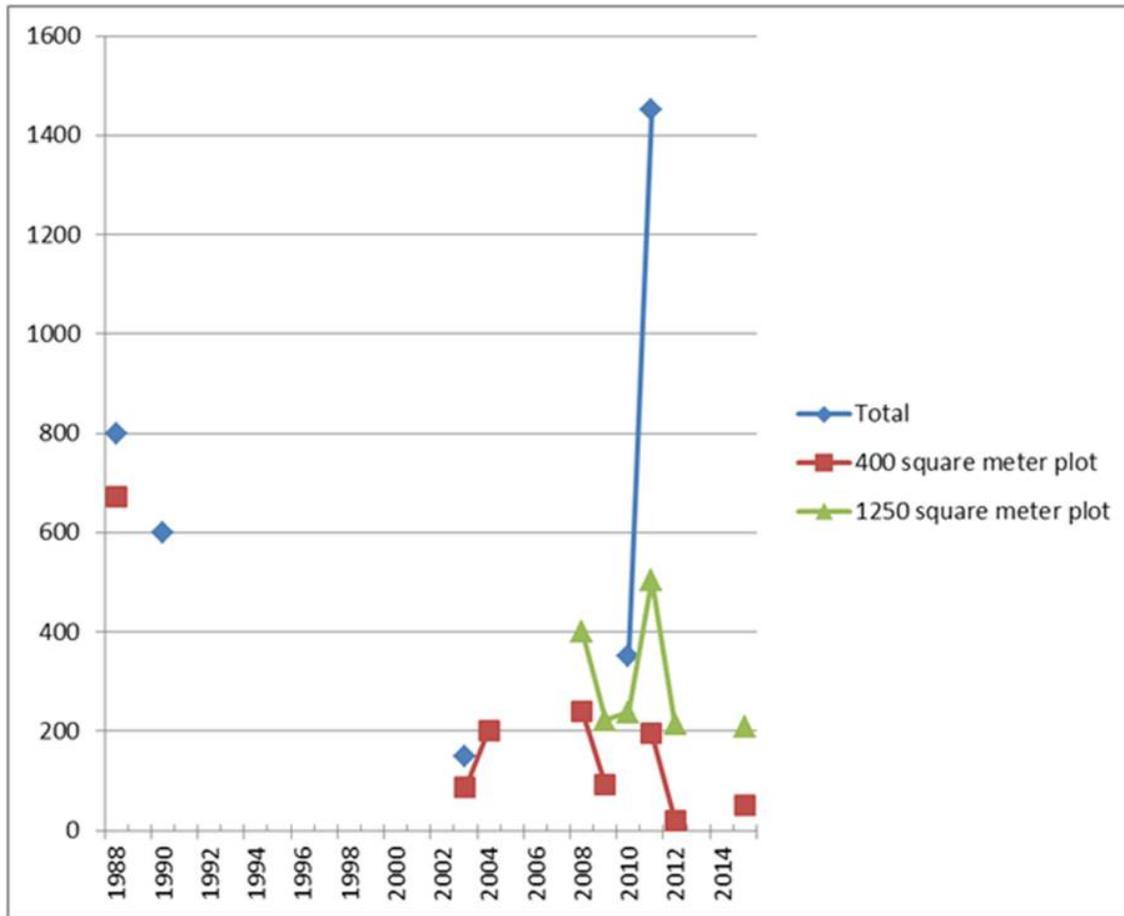


Figure 1. Flowering Fremont County rockcress plant estimates in the total population, the original monitoring plot, and the expanded monitoring plot.

Table 1. Total population, 400 m² (original) and 1250 m² (expanded) plot estimates for flowering Fremont County rockcress plants.

Year	Total pop	400 m ² plot	1250 m ² plot	Monitoring Rigor
1986	50			Incomplete estimate
1988	800-1000	671		Complete count in original monitoring plot and robust estimate elsewhere
1990	600			Estimate that included at least the monitored subpopulation area
2003	150-250	87		Complete count in the original monitoring plot and robust estimate elsewhere
2004		202		Complete count in original monitoring plot
2008		239	400	Complete count in expanded monitoring plot
2009		91	223	Complete count in expanded monitoring plot
2010	359		238	Complete count in expanded monitoring plot
2011	1451	195	505	Complete count in expanded monitoring plot and 3 largest subpopulations
2012		20	213	Complete count in expanded monitoring plot
2015		52	210	Complete count in expanded monitoring plot

Surveys in the original monitoring plot showed a drop in flowering plants from 671 flowering plants in 1988 to 87 flowering plants in 2003. Flowering plant numbers then rose slightly from 87 in 2003 to 202 flowering plants in 2004. Flowering plants increased to 239 in 2008 (Table 1). Declines in flowering plant numbers were detected in 2009 and 2010, but an increase of 195 flowering plants was counted in 2011. Another decline occurred in 2012 with 20 plants. The expanded monitoring plot shows a similar pattern of fluctuations since 2008 as compared to the original monitoring plot. Starting in 2008, the expanded monitoring plot counts showed 400 flowering plants. Similar drops in numbers occurred in 2009 and 2010 of 223 and 238, respectively. The highest counts of 505 flowering plants are reflected in 2011 numbers. The lowest counts occurred in 2015 with 210 flowering plants. Although there is no clear population trend within the last decade, since 1988 seven years of inconsistent monitoring in the original monitoring plot indicate that the number of flowering plants has decreased.

The mean density of flowering plants derived from the 1988 and 2003 surveys indicate that the density dropped from 1.68 down to 0.33 flowering plants per m² during this 15-year period (Heidel 2005, p. 14). Declines in 2003 may be attributed to severe drought conditions recorded in the Wind River Range between 2000 and 2003 (NOAA 2005 as cited in Heidel 2005, p. 14). The density since 2003 has varied between 0.05 and 0.6 flowering plants per m² (0.005 to 0.056 flowering plants per square foot). It is likely that plants within the population have moved around from the original subplot, explaining the perceived drop in density over time.

In addition to monitoring specific plots, occasional surveys have been done to estimate the total population size of Fremont County rockcress (Figure 1 and Table1). Only 50 plants were found in 1986; however, only one subpopulation had been discovered at that time (Marriott 1986, p. 15). The 1986 surveys are not comparable to 1988 plant population estimates because of different survey designs. In 1988, the total population estimate was 800 to 1,000 flowering individuals (Heidel 2005,

p. 14). Although the 1988 survey indicated no evidence that Fremont County rockcress was affected by the 1988 drought (Marriott and Horning 1988, p. B2), drought impacts (such as reduced seed fecundity or germination) may not be immediately apparent (Heidel 2010c, pers. comm.; 2010d, pers. comm.). In 1990, numbers were down to about 600 flowering plants for the entire population (Dorn 1990b, p. 8), which may be due to a pattern of short-term decline under drought conditions that occurred in this area between 1988 and 1990 (Heidel 2005, p. 14). Estimates from Dorn (1990b, entire) are not comparable to other years' estimates because of different survey design. In 2003, the Wyoming Natural Diversity Database (WYNDD) estimated total flowering plants for the entire population at 150 to 250 (Heidel 2005, p. 14). Declines in 2003 may be attributed to severe drought conditions recorded in the Wind River Range between 2000 and 2003 (NOAA 2005 as cited in Heidel 2005, p. 14). Flowering plants for the entire population in 2010 were estimated at approximately 350 individuals (Heidel 2010d, pers. comm.). Due to these fluctuations in population size, population trends are difficult to develop.

A more complete census was done in 2011, when 4 out of 8 subpopulations were monitored. This more complete census included the one subpopulation repeatedly monitored in the original and expanded plots surveyed since 2008, plus 3 additional subpopulations. The 2011 survey found an estimated population of approximately 1,451 individuals (Heidel 2012, p. ii, 5). This number is not comparable to the numbers of plants found over time during the surveys of the original and expanded monitoring plots, since those monitoring plots covered only one subpopulation, but is the best information we have on the current total population size of Fremont County rockcress for 2011. The increase in plants may be a reflection of the atypical, very moist spring and late growing season, and was the only monitoring year in which traces of snow were present. In addition, the scope of the census was expanded compared to previous years (Heidel 2012, pers. comm.), so the high number of plants may not actually represent an increase in population size. The latest monitoring results are still being prepared (Heidel 2016b, pers. comm.). Thus, these population numbers do not provide trend data over time, but provide population estimates referencing increases and decreases of plant numbers. Based on the available survey data, the plant appears to have an overall pattern of population increases and decreases between survey years, but more than likely, the population is fluctuating around an average population size that is likely stable over time.

Distinct Population Segment(DPS):

N/A (Fremont County rockcress is a plant, and designation of Distinct Population Segments does not apply to this taxonomic group).

Threats

A. The present or threatened destruction, modification, or curtailment of its habitat or range:

Recreational Activities

Fremont County rockcress' current known range is highly restricted. All known occurrences are on BLM land, which is public land managed for multiple use (Dorn, 1990, p. 10; Heidel 2005, p. 6). Prior to the development of a Habitat Management Plan (BLM 1994, entire), the closure of vehicle access in 1994 (59 FR 37258) and accompanying installation of an enclosure fence, Fremont County rockcress was more readily exposed to recreation activity from Off Road Vehicle (ORV) use associated with fishing and camping, unauthorized ORV use, horse boarding and feeding, plant collecting, mountain biking and pedestrian use. In addition, a nearby quarry, which is now inactive, may have destroyed potential habitat (Dorn 1990b, p. 11; Heidel 2005, p. 17). Previously, ORV use had been identified as a potential threat; however, conservation measures, such as the Habitat Management Plan (BLM 1997) and closure to vehicles, have been implemented to eliminate this threat. The fence has been repaired and an adaptive maintenance plan may be considered if the fence deteriorates or is damaged (Heidel 2016a, pers. comm.) Currently, the only access to the area occupied by Fremont County rockcress is by foot, but due to the rocky substrate associated with the habitat, recreational use in the area primarily occurs away from occupied habitat on adjacent riparian areas (Dana 2010a, pers. comm.). Therefore, recreational activities are not considered a threat now or in the foreseeable future.

Energy Development

The extraction of natural gas occurs in several developments in southwest Wyoming, which could be a potential threat to the habitat of Fremont County rockcress (USGS 2010, p. 3). However, the area occupied by Fremont County rockcress is incorporated into a Special Recreation Management Area (SRMA), which is closed to mineral and energy development (BLM 1997, pp. 17–18). Currently, the nearest gas development occurs approximately 2727 km (1717 mi) from the location of Fremont County rockcress (Wyoming Oil and Gas Commission 2016) and does not appear to be a threat to the plant.

On February 23, 1998, the Secretary of the Interior issued Public Land Order No. 7312, the "Withdrawal of Public Land for the Protection of *Arabis pusilla* Plant Habitat." This order pursuant to Section 204 of the Federal Land Policy and Management Act of 1976, 43 U.S.C. 1714 (1994), withdrew from "settlement, sale, location, or entry under the general land laws, including the United States mining laws (30 U.S.C. Ch. 2 (1994)), but not from leasing under the mineral leasing laws" on 412.8 ha (1,020 ac) to protect Fremont County rockcress habitat (63 FR 9012). This withdrawal expires in 50 years (2048) unless the Secretary determines that the withdrawal shall be extended. Therefore, we do not consider energy development to be a threat to Fremont County rockcress now or in the foreseeable future.

Nonnative Invasive Plants

The habitat adjacent to the area occupied by Fremont County rockcress is primarily sagebrush steppe, which is highly vulnerable to nonnative invasive species (Anderson and Inouye 2001, pp. 531–532); however, surveys conducted by WYNDD in 2003 found the area generally free of nonnative invasive species (Heidel 2005, p. 10). As noted previously, the restrictive habitat

occupied by Fremont County rockcress may limit the potential for competition from other herbaceous plants (Dorn 1990b, pp. 6, 8). We have no information that nonnative invasive plants are a threat to Fremont County rockcress. The poor soil formations in Fremont County rockcress habitats likely inhibit the colonization and establishment of nonnative invasive plants. Although cheatgrass grows nearby, it has not invaded Fremont County rockcress habitats (Heidel 2016b, pers. comm). Therefore, we do not consider nonnative invasive plants to be a threat to Fremont County rockcress now or in the foreseeable future.

Climate Change

Our analyses under the Endangered Species Act include consideration of ongoing and projected changes in climate. The terms “climate” and “climate change” are defined by the Intergovernmental Panel on Climate Change (IPCC). “Climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007, p. 78). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007, p. 78). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007, pp. 8–14, 18–19). The IPCC Climate Change 2014 Synthesis Report states that “most plant species cannot naturally shift their geographical ranges sufficiently fast to keep up with current and high projected rates of climate change on most landscapes.” (IPCC 2014, p. 13). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

Plant species with restricted ranges may experience population declines as a result of climate change. The current climate of the area where Fremont County rockcress occurs is quite variable with annual precipitation ranging from less than 20 cm (8 in.) to over 50 cm (20 in.) in a year, and with most of that the precipitation falling as snow during the winter and spring (NOAA 2016). Therefore, Fremont County rockcress may be adapted to some variation in moisture availability (Dorn 1990b, p. 6). Climate change may affect the timing and amount of precipitation as well as other factors linked to habitat conditions for this species. For example, climate models predict that by 2050, the Sweetwater watershed where Fremont County rockcress occurs will become warmer throughout the year, during all four seasons (USGS 2016 pp. 1,2), but that precipitation will increase in the winter and spring, decrease in summer, and remain the same in the fall (USGS 2016 p. 3). Snow water equivalent will decline in the winter and spring and soil water storage will decline in the summer and fall (USGS 2016 pp. 4 and 6). A combination of warmer climate and more precipitation in winter and spring could expand the growing season for the Fremont County rockcress, particularly because the growing season for this species appears to be limited by the number of frost-free days, and because population numbers appear to be higher in years with higher than average spring precipitation (NOAA 2016). However, declines in soil water storage in the summer may limit seed production, which could cause declines in recruitment. Additionally,

Fremont County rockcress may become more vulnerable to extreme weather events, which are predicted to occur more frequently worldwide (IPCC 2014, p. 53), particularly late spring snow storms if the plants have already begun their growing cycle, or if a combination of conditions are present that occur outside the species' tolerance range and during a vulnerable life history stage. The future impact to the species from possible long-term changes in the timing of precipitation and warming trends due to climate change is uncertain, because while some negative effects may occur from drier summers, these may be mitigated by lengthening of the growing season and increases in precipitation at the start of the growing season. Climate change has the potential to affect the species' habitat, but we lack scientific information on what those changes may ultimately mean for Fremont County rockcress. Therefore, we do not consider climate change to be a threat to Fremont County rockcress now or in the foreseeable future.

Drought

Limited evidence shows there may be some response of Fremont County rockcress to drought conditions, but those effects may be delayed (Heidel 2010c, pers. comm.). It is not known whether Fremont County rockcress has a seedbank that can persist through dry years to ameliorate less favorable years (Heidel 2014, p. 4). Reproductive success may vary considerably from year to year depending on climate conditions, leading to wide fluctuations in populations (Dorn 1990b, p. 10). Overall trends in population estimates correlate with precipitation levels, where the population expands during years with high precipitation (see Figure 2), particularly when the majority of the precipitation falls in the spring and summer (NOAA 2016). The potential for Fremont County rockcress numbers to rebound in 2012, made possible by high flowering plant numbers in 2011, was not realized likely due to the generally hot, dry spring conditions of 2012 (Heidel 2014, p. 4). The proportion of nonflowering plants was exceptionally high in 2015 (149 percent; 313 nonflowering plants compared to 210 flowering plants in the expanded plot). This likely reflects the back-to-back years of relatively moist, spring conditions. The high proportion and record high numbers of nonflowering plants in 2015 may reflect the wet spring conditions and will likely result in increased counts of flowering plants (Heidel 2016). The species appears to be well adapted to periodic drought (Dorn 1990b, p. 6), so we find that drought is not a threat to the species now or in the foreseeable future.

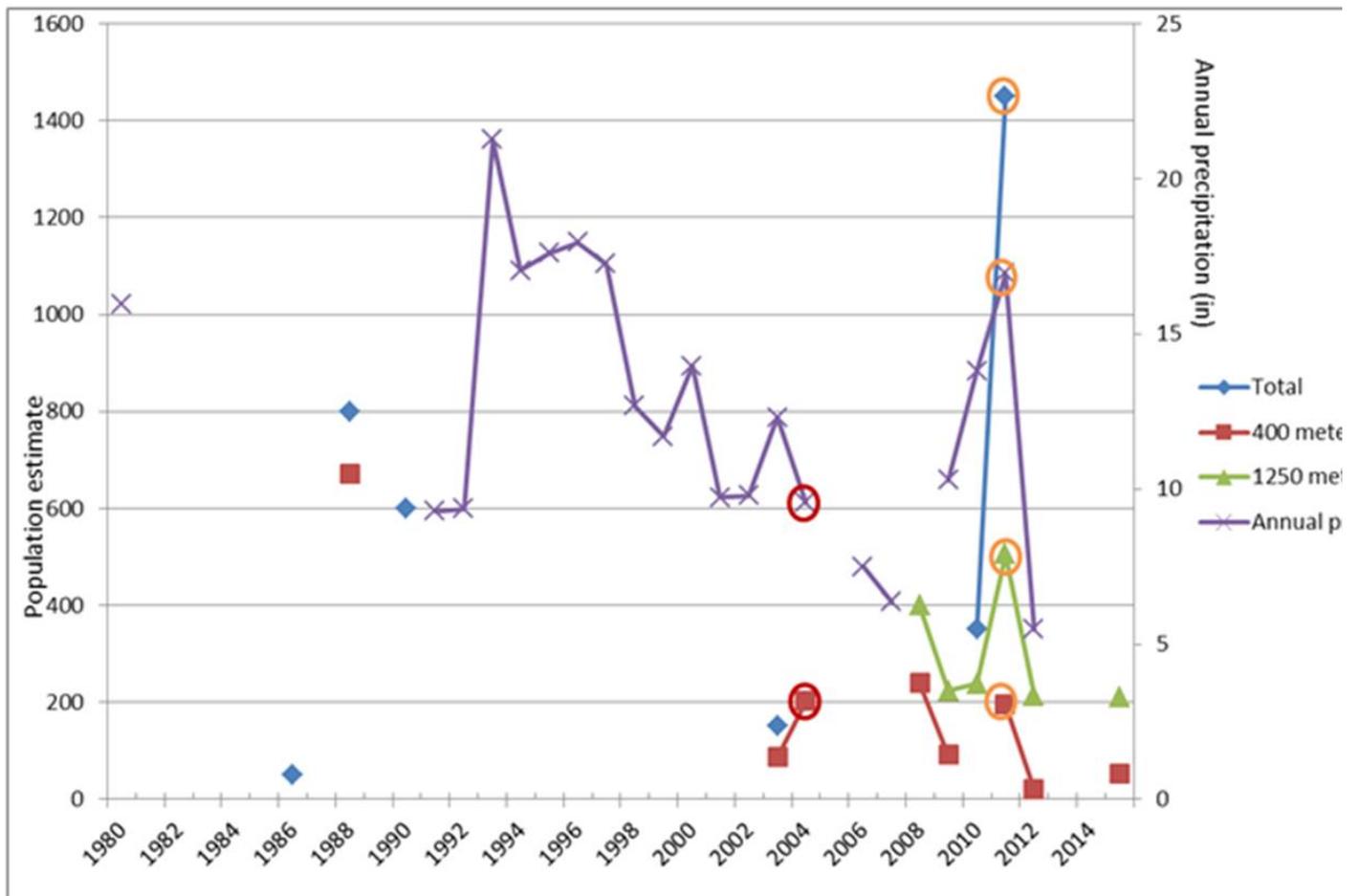


Figure 2. Population estimates for the total population, 400 m² original plot, and 1250 m² expanded plot with annual precipitation. Note in 2004 (red circles) that there was a very wet May through July, but that data for the remainder of the year is missing (i.e. the total precipitation for the year should be higher than is indicated on this graph), which correlates with an increase in the estimate of the 400 m² subplot. Also note that 2011 (orange circles) had a very wet spring with what is historically average annual precipitation, which correlates with an increase in all population estimates. A dry spring the following year in 2012 contributed to lower population estimates (NOAA 2016).

In summary, we found that numerous management actions taken previously by the BLM alleviated several potential threats to Fremont County rockcress and its habitat. These potential threats included ORV use, mining, and heavy foot traffic. The ORV use and mining are no longer permitted in the area due to the implementation of numerous regulatory mechanisms (see *Factor D. Inadequacy of existing regulatory mechanisms* below) and the construction of an enclosure. We have no information that nonnative invasive plants are a threat to the species. Although climate change may be a potential long-term stressor to Fremont County rockcress, the limited information available regarding climate change impacts on Fremont County rockcress and the species' adaptations to an already-variable climate do not suggest that climate change currently, or in the foreseeable future, will pose a threat to this species' existence. We do not fully understand the response of Fremont County rockcress to drought conditions, but limited evidence indicates that this species' population levels may fluctuate with precipitation (see *Factor E. Other Natural Or*

Manmade Factors Affecting Its Continued Existence discussion below). Therefore, we do not have sufficient information to say that drought alone, or in combination with other factors, poses a threat to the species currently or is likely to do so in the foreseeable future.

We conclude that the best scientific and commercial information available indicates that Fremont County rockcress is not in danger of extinction or likely to become so within the foreseeable future because of the present or threatened destruction, modification, or curtailment of its habitat or range.

B. Overutilization for commercial, recreational, scientific, or educational purposes:

Seeds from Fremont County rockcress have been collected for preservation on a few occasions. Field notes from 1993 suggest that Fremont County rockcress seed had been collected and sent to the Denver Botanic Gardens; however, the Denver Botanic Gardens do not have a record of receiving any Fremont County rockcress seeds (Neale 2010b, pers. comm., Heidel 2012, p. 3). Additionally, because of high fruit production in 2011, Fremont County rockcress seeds, which represented 1 to 3 percent of that year's fruit production, were collected and sent to the Denver Botanic Gardens (Heidel 2012, p. 3, Skora 2012, pers. comm.). Further, Fremont County rockcress seeds were approved by the board of the Center for Plant Conservation National Collection for inclusion in their storage (Skora 2012, pers. comm.).

In addition to seeds, specimens collected in the 1980s were provided to the Gray Herbarium of Harvard University, the New York Botanical Garden, and the Rocky Mountain Herbarium at the University of Wyoming (Dorn 1990b, p. 5, 14). We have no other indication that any collections or utilization have been made of Fremont County rockcress. In summary, we find that Fremont County rockcress is not in danger of extinction or likely to become so within the foreseeable future because of overutilization for commercial, recreational, scientific, or educational purposes.

C. Disease or predation:

Disease

Fremont County rockcress is not specifically known to be affected by or under threat from any disease. Systemic rust disease is known to affect many *Boechera* species (Ladyman 2005, p. 26). Presence of rust was noted on one Fremont County rockcress plant in the field, but it did not appear to affect fecundity or survival (Heidel 2016b, pers. comm.). Therefore, we do not consider disease to be a threat to Fremont County rockcress now or in the foreseeable future.

Predation—Grazing and Herbivory

Prior to conservation measures taken by the BLM in 1982, the habitat of Fremont County rockcress was grazed by cattle. The establishment of an Area of Critical Environmental Concern (ACEC) that

covers all known locations of Fremont County rockcress (BLM 1997, p. 34) and the presence of an enclosure fence that was built to enclose occupied habitat (Dunder 1984, unpaginated; Marriott 1986, p. 14) restricts access to the entire population. These protections are described in additional detail under Factor D below. Insects, such as caterpillars, do not appear to favor Fremont County rockcress over other vegetation (Heidel 2005, p. 10), and no known observations suggest that herbivory from wild ungulates or small mammals is a threat. Therefore, we do not consider predation to be a threat to Fremont County rockcress now or in the foreseeable future.

In summary, we do not have any information to suggest that disease or predation is a threat to this species. We conclude that the best scientific and commercial information available indicates that Fremont County rockcress is not in danger of extinction or likely to become so within the foreseeable future because of disease or predation.

D. The inadequacy of existing regulatory mechanisms:

Federal Laws and Regulations

Several regulatory mechanisms are in place to protect Fremont County rockcress, some of which were mentioned under *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range* above. The BLM has excluded grazing from the habitat area, developed a habitat management plan for the species, designated the habitat area as an ACEC, incorporated the habitat area into a SRMA, and designated Fremont County rockcress as a sensitive species (BLM 2002). Additionally, the Secretary of the Interior removed essentially the entire area with occupied habitat from mineral development under Public Land Order No. 7312. The Service had previously published a notice of review in 2000 removing Fremont County rockcress as a candidate species, largely based on protections provided by these regulatory mechanisms and land management approaches.

Bureau of Land Management

The BLM designated the Pine Creek Special Management Area in 1978 (Heidel 2005, p. 16) and built an enclosure fence in 1982 to keep cattle out of the 35.6-ha (88-ac) area where recreational activities occur (Dunder 1984, unpaginated). Fremont County rockcress occurs within this management area (Marriott 1986, p. 14). The fenced portion of the area is smaller than that of the known species range, but protects much of the occupied habitat, and in fact restricts access to the entire occupied habitat. As described under *Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range* above, the BLM provided a Habitat Management Plan for Fremont County rockcress (BLM 1994, entire) and processed an emergency closure of vehicle access to 202.3 ha (500 ac) in a Habitat Management Area for the species in 1994 (59 FR 17718). In addition to these measures, Fremont County rockcress was listed as a BLM sensitive species in 2002 (BLM 2002, p. 9).

The BLM 6840 Manual requires that Resource Management Plans (RMP) should address sensitive species, and that implementation “should consider all site-specific methods and procedures needed to bring species and their habitats to the condition under which management under the Bureau sensitive species policies would no longer be necessary” (BLM 2008, p. 2A1). The Federal Land Policy and Management Act of 1976 mandates Federal land managers to develop and revise land use plans. The RMPs are the basis for all actions and authorizations involving BLM-administered lands and resources (43 CFR 1601.0-5(n)). The 1997 RMP for the area that includes Fremont County rockcress habitat provided designation of a Special Status Plant ACEC that closed the area to: (1) direct surface-disturbing activities, (2) mining claims, (3) surface occupancy and surface-disturbance activities, (4) mineral material sales, and (5) use of explosives and blasting (BLM 1997, p. 34). Fremont County rockcress habitat also fits within an SRMA designated in the RMP, which: (1) prohibited major facilities (e.g., power lines), (2) closed the area to mineral leasing, (3) closed the ACEC to ORV use, and (4) required avoidance and extensive planning of long, linear facilities (e.g., roads) (BLM 1997, pp 17–18). All activities concerning Fremont County rockcress in the RMP have been implemented (Glennon 2010b, pers. comm.). The next RMP revision for the area is currently underway, with an estimated completion date of 2017 (Glennon 2016, pers. comm.). Existing protections for the species will likely remain in place in the revised RMP as a no-action alternative under NEPA, but we are uncertain whether additional protections for Fremont County rockcress could be useful or will be developed.

National Environmental Policy Act

The entire known population of Fremont County rockcress occurs on Federal land. All Federal agencies are required to adhere to the NEPA for projects they fund, authorize, or carry out. The Council on Environmental Quality’s regulations for implementing NEPA (40 CFR 1500–1518) state that agencies shall include a discussion on the environmental impacts of the various project alternatives, any adverse environmental effects which cannot be avoided, and any irreversible or irretrievable commitments of resources involved (40 CFR 1502). Additionally, activities on non-Federal lands are subject to NEPA if there is a Federal nexus. The NEPA is a disclosure law, and does not require subsequent minimization or mitigation measures by the Federal agency involved. Although Federal agencies may include conservation measures for sensitive species as a result of the NEPA process, any such measures are typically voluntary in nature and are not required by the statute.

Public Land Order No. 7312

On February 23, 1998, the Secretary of the Interior issued Public Land Order No. 7312 to withdraw public land from certain uses for 50 years as a measure to specifically protect Fremont County rockcress. This order withdrew 412.8 ha (1,020 ac) from settlement, sale, location of minerals, or entry under the general land laws, including mining laws; this did not eliminate the area from being leased under the mineral leasing laws (63 FR 9012).

In summary, because the entire population of Fremont County rockcress occurs on BLM lands, this agency has responsibility for the land management decisions that protect Fremont County

rockcress and its habitat. Fremont County rockcress receives adequate protection from the BLM in the form of regulatory mechanisms, designations, and the construction of animal and human exclosures. These protections greatly limit the amount of disturbance that can occur within the plant's limited range. Although these mechanisms do not entirely exclude the area from foot traffic, they have adequately reduced this potential threat. Various regulatory mechanisms are in place to address potential threats over which the BLM has control. The BLM's regulatory mechanisms and the Secretarial Order, protect the Fremont County rockcress and its habitats from direct human disturbance.

Because the primary management tool that implements regulatory mechanisms, the RMP, goes through revisions approximately every 15 years (Dana 2010b, pers. comm.), it will be important for the BLM to ensure that the protective measures are sustained in future revisions to the Green River RMP and that measures be taken to alleviate any potential vulnerabilities created by small population size. We conclude that the best scientific and commercial information available indicates that Fremont County rockcress is not in danger of extinction or likely to become so within the foreseeable future because of inadequate regulatory mechanisms.

E. Other natural or manmade factors affecting its continued existence:

Small Population Size

Fremont County rockcress occurs in relatively small numbers as discussed above in Population Estimates/Status section, with the latest total population size of 1,451 flowering plants in a 2011 census (Heidel 2012, p. ii, 5). When compared to other years' census efforts, 2011 was the most complete census to date with an expanded scope of census which may explain the higher numbers recorded in that year (Heidel 2012, pers. comm.). Data collected from the permanent monitoring plot in 2012 show a decline in flowering plants (Heidel 2014, p. ii) and a modest increase in 2015 for flowering plants (see Table 1) (Heidel 2016, p. 3). A planned population-wide census and monitoring of the permanent monitoring plots in 2016 will provide more clarity regarding population trends. In our previous reviews for this species, we described a downward trend in population numbers, using the 1988 census as a baseline, a population spike that exceeds all subsequent counts. However, populations likely fluctuate naturally due to precipitation, so using the 1988 census as a baseline likely overestimated the population decline. Additionally, the ratio of flowering to nonflowering plants also varies, so population estimates that include only flowering plants likely underrepresent the total population in any given year (Heidel 2016 p. 6). Although concerns expressed by Heidel (2012, pers. comm.) about Fremont County rockcress suggest that the species may be vulnerable to periods of prolonged drought or stochastic events, the population has rebounded from drought, which suggests that the species may be well adapted to wide fluctuations in population size over time. Additional surveys in 2016 will help clarify these fluctuations, the link to precipitation, and population trends.

Although Fremont county rockcress has been found only in one population with eight

subpopulations, the fact that the species is rare does not necessarily mean that it may be in danger of extinction now or in the foreseeable future. This entire species is protected by regulatory mechanisms as described above under Factor D. The species has likely persisted in its limited, but suitable habitat for a long period of time. Many naturally rare species have persisted for long periods within limited geographic areas, and many naturally rare species exhibit traits that allow them to persist despite their small population sizes. The apomictic reproduction of the Fremont County rockcress, where offspring are clones of the parent plant, is likely a trait that allows the species to persist despite a small population size. Although the species may not reproduce sexually, apomictic reproduction reduces risks, such as inbreeding and limited genetic diversity that may be associated with small populations. We are uncertain how long the species' apomictic seeds remain viable or under what conditions they germinate. Apomixis has been shown to reduce extinction risk if certain other variables are present, such as high levels of biomass and no soil acidity (Freville *et al.* 2007, p. 2666). However, information on what apomixis means for conservation of a species remains limited (Freville *et al.* 2007, p. 2669).

Fremont County rockcress relies on soils formed from a granite-pegmatite outcrop that is limited in extent, so the range of the species is not likely to expand beyond this area in the future. The relatively small area that Fremont County rockcress occurs within also may predispose the species to be more sensitive to stochastic events (Menges 1990, p. 53; Boyce 1992, pp. 482–484), such as a change in climate or factors that lead to reduced reproductive success (Ladyman 2005, pp. 30–31). A single unforeseen, stochastic event in a relatively small area could potentially eliminate the species. Stochastic events are, by their very nature, difficult to predict, and the effect on a narrow endemic species is additionally difficult to understand. A species that has always been rare, yet continues to survive, could be well equipped to continue to exist into the future. Additional surveys in 2016 will help clarify population trends and whether the species is adapted to stochastic events, such as drought.

Threats not yet fully identified

Previously, we considered an unknown threat to be contributing to an assumed decline of the Fremont County rockcress population. However, our current analysis of the available population and precipitation data suggest that drought cycles may affect the population size, causing the population to increase when conditions are wet and to decline when conditions are dry, especially during drought. The original 1988 census likely had a large number of flowering plants resulting from a period of greater than average precipitation, and that subsequent monitoring has occurred in drier years, so surveys have counted fewer plants ever since. This suggests that the population may not actually be declining due to some unknown threat, but that it fluctuates due to precipitation, as described under Factor A. Therefore, drought is likely the previously unidentified threat and surveys to be completed in 2016 will help clarify whether the population fluctuates around a stable, average size and if drought is a threat.

We also previously discussed a potential unknown disease that may be affecting Fremont county rockcress. However, trend information does not show a consistent decline in population numbers over time that would be indicative of a disease spreading throughout the population. Further, no disease was documented in any past monitoring reports. Although rust was documented on a single plant in 2015, it did not appear to be a threat (Heidel 2016b pers. comm.). Therefore, because no declines are apparent in this species, we no longer consider some unknown threat to be contributing to the perceived decline of the species, as was analyzed in previous years.

Conservation Measures Planned or Implemented :

The BLM has excluded grazing from the habitat area since 1982, followed a Habitat Management Plan for the species since 1994, designated the habitat area as an ACEC since 1997, incorporated the habitat area into a SRMA since 1997 (BLM 1997), and designated Fremont County rockcress as a sensitive species. On February 23, 1998, the Secretary of the Interior issued Public Land Order No. 7312 to withdraw 412.8 ha (1,020 ac) of public land from certain uses for 50 years as a measure to specifically protect Fremont County rockcress from settlement, sale, location of minerals, or entry under the general land laws.

Summary of Threats :

In summary, Fremont County rockcress has a small population size that is confined to a small area because of specific habitat requirements. The species may be vulnerable to stochastic events due to its small population size. Fremont County rockcress reproduces asexually, which may reduce some risks of a small population size, but does not fully eliminate this threat. The population has fluctuated over time and the implemented and effective regulatory mechanisms protect the species and its habitats, which helps the population size rebound during wet years. A viable population for the species may be 500 to 5,000 plants (Ladyman 2005, p. 26), and the population already falls within this range, so it is likely viable. Continued monitoring in 2016 will provide additional insight into population trends for this species and help clarify the influence of precipitation. We previously described significant declines in the species' numbers, but now believe that previous declines were the result of population fluctuations in response to drought, and that the species could be adapted to drought. Additional surveys will help clarify the influence of precipitation on population size and trends, and what precipitation-mediated fluctuations mean for the species. Therefore, we determine that drought and small population size are threats to the species.

For species that are being removed from candidate status:

_____ Is the removal based in whole or in part on one or more individual conservation efforts that you determined met the standards in the Policy for Evaluation of Conservation Efforts When Making Listing Decisions(PECE)?

Recommended Conservation Measures :

We support the continued implementation of several regulatory mechanisms currently in place to protect Fremont County rockcress by the BLM. The BLM has excluded grazing from the habitat area, developed a habitat management plan for the species, designated the habitat area as an ACEC, incorporated the habitat area into a SRMA, and designated Fremont County rockcress as a sensitive species. Additionally, the Secretary of the Interior removed essentially the entire area with occupied habitat from mineral development. We also support continued monitoring of Fremont County rockcress each year if possible. Monitoring data in the form of replicated, exhaustive searches will add to the known trend data available. Expanded monitoring to estimate the total population should be conducted as often as possible to track population fluctuations over time.

Priority Table

Magnitude	Immediacy	Taxonomy	Priority
High	Imminent	Monotypic genus	1
		Species	2
		Subspecies/Population	3
	Non-imminent	Monotypic genus	4
		Species	5
		Subspecies/Population	6
Moderate to Low	Imminent	Monotype genus	7
		Species	8
		Subspecies/Population	9
	Non-imminent	Monotypic genus	10
		Species	11
		Subspecies/Population	12

Rationale for Change in Listing Priority Number:

With drought identified as the previously unidentified threat, but a threat that could still reduce the size of the already small population in the future and increase the risk to the population from stochastic events, we now determine that the magnitude of threats to the species is low. Although the population could decline as a result of drought, the regulatory mechanisms ensure that habitat loss and fragmentation are extremely unlikely to occur, the species may be adapted to drought and stochastic events, and no other threat is likely to occur immediately so we now determine that the imminence of threats has decreased from high to low.

Magnitude:

Drought and small population size are threats to the species. Previously, we considered the threats

that Fremont County rockcress faces to be moderate in magnitude, primarily due to uncertainty regarding an unidentified threat resulting in a small population size. However, we now consider the magnitude to be low, due largely to an improved understanding of the influence of precipitation on the population size, which implicates drought as the previously unidentified threat. We previously assumed that the high population count from the 1988 census was a baseline, from which all subsequent counts represented an overall, and continuing, population decline. However, the 1988 census should likely not be used as a baseline population estimate, because there were more plants counted as a result of a particularly wet conditions and a larger survey area. Early survey data also did not account for nonflowering plants, so likely overestimated the population decline. Additionally, fully implemented and effective regulatory mechanisms protect the entire species and its habitats to reduce habitat loss and fragmentation. Therefore, populations fluctuate naturally, and do not necessarily indicate an overall decline, and , the species' and its habitats are protected by an effective regulatory mechanism , and no other impacts (e.g. drought and climate change) rise to the level of a threat, threat, we determine that the magnitude of the threat to this species to be low.

Imminence :

Previously, we considered the threats to Fremont County rockcress to be imminent, due largely to uncertainty regarding an unknown threat, which we now believe is drought. Drought reduces the size of the population and the small population size makes the Fremont County rockcress more susceptible to stochastic events. Although drought reduces the size of the population, the species may be adapted to drought, as the population fluctuates up and down within a normal range of variation in response to precipitation. The species may be adapted to drought and able to rebound following heavy precipitation and longer growing seasons and earlier spring moisture associated with climate change may benefit the species, although a stochastic change in climate could affect the species. Effective and implemented regulatory mechanisms protect the species from habitat loss and fragmentation. Therefore, because drought is the unidentified threat and no other threat is likely to occur immediately, we now consider the threats to be non-imminent.

Yes No Have you promptly reviewed all of the information received regarding the species for the purpose of determination whether emergency listing is needed?

Emergency Listing Review

No Yes Is Emergency Listing Warranted?

We determined that issuing an emergency regulation temporarily listing the species is not warranted at this time, because threats to the species would not be further controlled with a change in status.

Description of Monitoring:

Monitoring work conducted on Fremont County rockcress started in 1988 to census the population. A revised monitoring study was set up in 1993 to similarly census a slightly smaller part of the largest subpopulation but not repeated. Funding for surveys to test a new potential distribution

model was provided in 2003 and monitoring work was included with objectives. Monitoring was conducted in some of the following years (2003, 2004, 2008, 2009, 2010, 2011, 2012, and 2015) based on provisional support. The population will be monitored in 2016, which will include population-level census as well as monitoring of the original and expanded plots in one of the subpopulations.

Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment:

Wyoming

Indicate which State(s) did not provide any information or comment:

none

State Coordination:

The State of Wyoming has provided information in past years.

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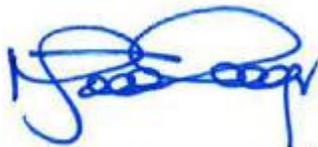
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Approval/Concurrence:

Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve:



06/02/2016

Date

Concur:



11/14/2016

Date

Did not concur:

Date

Director's Remarks: