

Monitoring of *Boechnera pusilla*
(Small Rockcress; Fremont County Rockcress)
in Wyoming – 2016 Interim Report

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ABSTRACT

Boechera pusilla was designated sensitive by the Bureau of Land Management in Wyoming, and is now a Candidate species (Category 1) recognized by the U.S. Fish and Wildlife Service. It was known from one population throughout its range, and has been the subject of concerted sensitive species protection in the state of Wyoming by the Bureau of Land Management (BLM). A monitoring study was set up in 1988 within part of the largest subpopulation. The 1988 monitoring was first replicated in 2003 and 2004; from 2008-2012, and most recently in 2015 and 2016. Monitoring results document stable trend among flowering plant numbers in the original monitoring plot (52 flowering plants) relative to recent years, though there has been no rebound to 1988 numbers. Two additional tasks were incorporated. Complete census was sought in all of the *Boechera pusilla* populations, tallying a total of 1669 plants (flowering + vegetative). Hollis Marriott, the botanist who established the original monitoring study design in 1988, was consulted to confirm monitoring plot placement and identify any habitat differences. She did this as well as locating a new location of *Boechera pusilla*. It is provisionally treated as a separate population though only 11 plants were found. Interim results are briefly discussed, recommending 2017 replication of all monitoring, and the added objective of conducting systematic surveys to produce a status report update with the final monitoring report.

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Introduction

Boechea pusilla (Rollins) Dorn (syn. *Arabis pusilla*) (Small Rockcress; also called Fremont County Rockcress) is designated a sensitive species by the Bureau of Land Management (BLM) in Wyoming (2010) and is now recognized as a Candidate species (Category 1 species) for listing under the Endangered Species Act (USDI Fish and Wildlife Service 2011). It has been known from only one population throughout its range, so is a species of very high Wyoming contribution rank having Global and State ranks of G1/S1 (Heidel 2012). The entire population is on land administered by BLM out of the BLM Rock Springs Field Office.

The species is described by Al-Shehbaz and Windham (2010). Four Wyoming status reports have been produced (Marriott 1986, Dorn 1990, Heidel 2005, 2012). The primary purpose of this project was to conduct an additional year of monitoring *Boechea pusilla* to represent 2016 monitoring data (Heidel 2005, 2012, 2014, 2016). Continuation of monitoring is recommended for at least 2017 to prepare a final monitoring report. New systematic survey work is also recommended in 2017.

There have been different definitions ascribed to plant data-collecting in Wyoming. For purpose of this report, monitoring refers to repeated data-collecting visits to specific plant populations or population segments. In this case, the repeated visits have been made once a year. Survey refers to a formal search for a species with no pre-existing locality data. Census refers to a tally of individuals by some set of standards, whether conducted in a monitoring study or a survey study.

A monitoring design suited for *Boechea pusilla* was originally established and carried out in 1988 and it involved complete census of flowering plants in a given plot area placed within a large subpopulation (Marriott 1988). It covered an area of 16 m x 25 m (400 m²). The original monitoring was conducted by laying a 25 m measuring tape at 2 m intervals along the 16 m baseline, and all flowering plants were counted and categorized within 1 m of the tape, carried out by a two-person team. The 1988 researchers mapped the subpopulation as almost fitting within a 50 m x 25 m area (1250 m²), and proposed expanding the monitoring to the 50 m x 25 m area, converting it into a random sampling design. Detailed photo documentation and notes accompanied raw data. It was recommended for annual monitoring but did not get repeated.

A separate monitoring design for *Boechea pusilla* was set up and executed in 1993 as complete census (Amidon 1993). From descriptions of its location, it was located in roughly the same area as the 1988 monitoring plot. The monitoring was reported in English units so are reported as such in this report. The monitoring spanned an area of 40 ft x 100 ft (4000 ft²; 371.6 m²). A series of tapes were spaced 5 ft (~1.5 m) apart and referred to as transects. A one-page summary copied from agency files was available for reference. It was also recommended for annual monitoring but was not marked on the ground or archived with maps, so could not be repeated.

The same subpopulation of *Boechea pusilla* monitored in 1988 and 1993 was not targeted for monitoring again until 2003 (Heidel 2005). It was readily apparent that the species was no longer in high density as reported in 1988, and was not random in its distribution but rather occurring as patches, arguing against a random sampling design. The schematic maps and photo records that accompanied 1988 monitoring were available for reference. It was possible to relocate the 16 m x 25 m original plot area (400 m²) based on photographs, field notes and a field

map (Appendix A) and the proposed 50 m x 25 m expanded plot area (1250 m²). Thus, the 1988 design was replicated, expanded, the corner points were marked, and pursued as exhaustive monitoring rather than as random sampling within a permanent plot. Additional design details made it possible to carry out the census by just one person. Two 50 m tapes were run the length of the monitoring plot on opposite sides, and two other metric tapes were stretched perpendicular at 1 m intervals to grid off the plot for conducting complete census. Rocks were used to anchor the tapes to prevent shifting with wind, and carefully laying/anchoring the lanes was required to get accurate tallies. The zero axis was in the northeastern corner, and a pair of 25 m tape measures laid across the width of the plot to divide it into 1 m bands, in which 1 m² frames were set down to record plant numbers down the length of the bands.

Monitoring of *Boechea pusilla* has been repeated for nine years since establishment in 1988 (Table 1). Questions were raised at the onset of 2003 monitoring whether trend results might be masked by shifts in the ratio of flowering-to-nonflowering conditions, or by very local shifts in distribution pattern. Therefore, the scope of monitoring was expanded by adding census of nonflowering (vegetative) plants and by expanded the scale to include the entire locale. In 1988, the number of flowering stems and rosettes per plant was also recorded but detailed information about individual plants appeared less important than expanding the scale of monitoring to include all local flowering and nonflowering plants. Any plant with a flowering stem of the current year was tallied as a flowering plant, no matter the number of stems. The challenge was to reliably discern vegetative plants. They can be smaller than the diameter of a dime, and though generally out in the open, are sometimes difficult to spot. The vegetative plant forms a small rosette, with simple hairs at the leaf margin and often a reddish coloration that are different from the two other *Boechea* species in the area (*B. microphylla* and *B. pendulocarpa*).

Starting in 2008, monitoring covered the expanded plot area, encompassing the original plot area. This 1250 m² sample area is henceforth referred to as the expanded plot area and tallies for it include the subtally in the original plot. Since 2008, both plot sizes (original, expanded) have been monitored (Table 1) and every year of monitoring – except 2008 – vegetative plants were recorded in addition to flowering plants.

Table 1. *Boechea pusilla* monitoring overview (1988-2015)

Monitoring date	Monitoring extent (400 m ² or entire 1250 m ²)	Inclusion of vegetative plants in addition to flowering plants
20 Jun 1988	400 m ²	Yes
6 Jun 2003	400 m ²	Yes
15 Jun 2004	400 m ²	Yes
2 Jun 2008	1250 m ²	No
1 Jun 2009	1250 m ²	Yes
31 May 2010	1250 m ²	Yes
6 Jun 2011	1250 m ²	Yes
31 May 2012	1250 m ²	Yes
4 Aug 2015	1250 m ²	Yes
6 Jun 2016	1250 m ²	Yes

The 50 m x 25 m monitoring plot is relocated precisely, but placement of 1 m interval bands and 1 m² frames within them is imprecise due to surface irregularities. The subpopulation is in an area that is more or less oval shaped and there are small extensions on all sides of the rectangular plot. The counts in these peripheral areas are incorporated in subpopulation tallies of 2009-2012 and 2016. The priority is placed on census in the rectangular plot area, noting whether or not census covers the fringes.

The monitoring phenology window is open once *Boecheera pusilla* plants send up mature flowering stalks. The flowering stalks are fragile so a priority was placed on conducting monitoring early in the growing season to distinguish flowering from nonflowering plants, before the fruits shattered and stem breakage was possible. In 2011 was the first time that plant monitoring overlapped with flowering, a late year when traces of snow persisted around the plot area in 2011 for the first time among recent monitoring years. The timing and duration was focused on early fruit in all the other years until 2015 when opportunistic plans for *Boecheera pusilla* monitoring were made on a trial basis in early August that proved successful. Flowering stem breakage was rare, and there was no evidence of plant mortality between early and late in the summer. So while monitoring is still ideal in early summer, conditions have been amenable for conducting late summer monitoring in the mild 2015 growing season conditions. In this report, the term “flowering plant” is used interchangeably with “reproductive plant” and “vegetative plant” is used interchangeably with “nonflowering plant”.

In 1988, there were 671 flowering plants in the original plot area. In each of the later nine years of monitoring, tallies have always been less than 25% of 1988 flowering plant numbers. In an effort to address all possible explanations, consultation with Hollis Marriott was pursued in 2016. She revisited the monitoring site and surroundings on July 15-17. She confirmed that the plot is located exactly as she had originally placed it on the ground and as mapped (Marriott 2016). She was also asked to identify any marked changes in the plot setting, including vegetation structure. She reported that none were discerned. Her observations are presented in Appendix B.

The scope of monitoring was expanded in 2011 to include a second area with high numbers of *Boecheera pusilla* plants, and it was re-censused in 2016 (see circles on the study area map, Figure 5). Census in this second area was conducted by laying tapes across occupied habitat, without an established baseline, lanes, or recording presence/absence of plants in each m². The census was conducted on hands and knees, and so vegetative plants were included in the tally. In 2016, the objective was further expanded to completely re-census of all occupied habitat (Figure 5). All of the above-mentioned work was conducted on 7 June by one person such that census of the low-density polygons was not exhaustive and nonflowering plants were no doubt overlooked.

Monitoring Results

The 2016 replication of 1988 monitoring shows that current *Boecheera pusilla* flowering plant numbers (52 flowering plants) are less than 10% of 1988 numbers (671 flowering plants). However, this is up from a record low numbers of flowering plants in 2012 (a drought year), and the modest rebound that has remained steady between 2015 and 2016 (Figure 1).

While the number of flowering plants in the original monitoring plot was steady over the past two years, the number of flowering plants in the expanded monitoring plot increased about 50% during this same time (from 210 to 326; Figure 2). Furthermore, the tally of all plants (flowering+vegetative) in the original and expanded plots show increase (Figures 3 and 4).

Figure 1. *Boechera pusilla* flowering plant numbers in original plot¹ (1988-2016; corresponds with Table 2, first column)

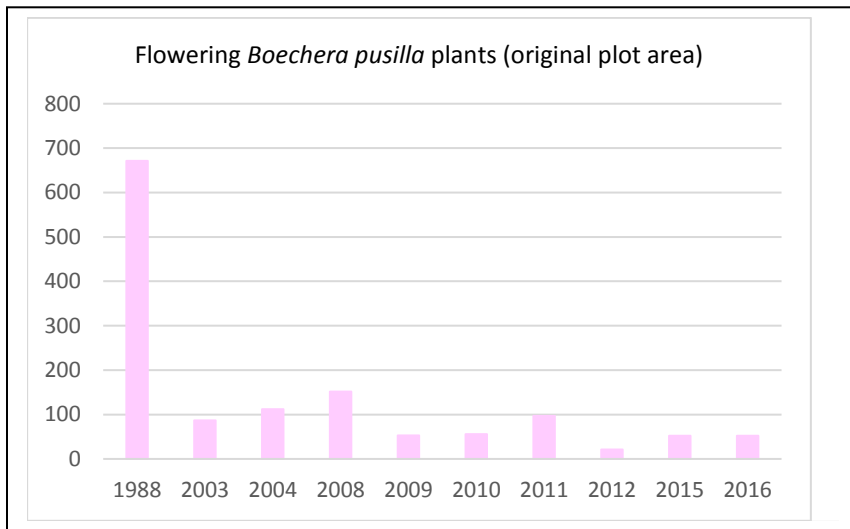
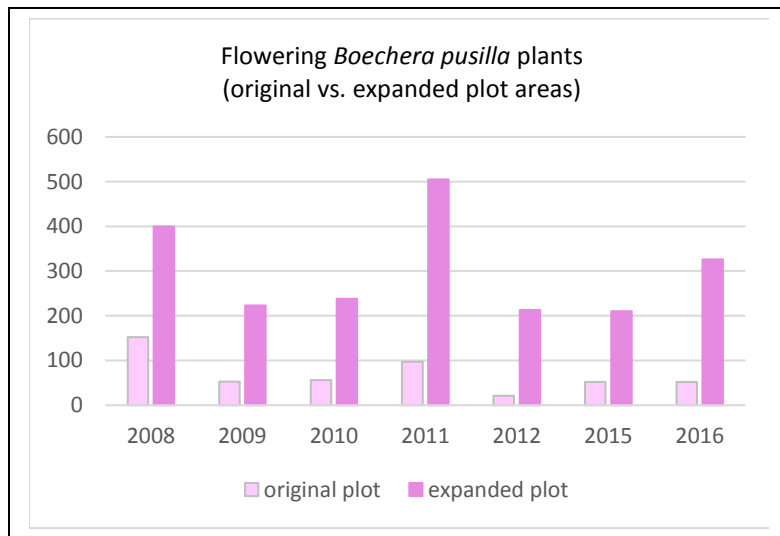


Table 2. Flowering *Boechera pusilla* plant numbers over time

	400 m ²	1250 m ²
1988	671	
2003	87	
2004	112	
2008	152	400
2009	53	223
2010	56	238
2011	97	505
2012	21	213
2015	52	210
2016	52	316

Figure 2. *Boechera pusilla* flowering plant numbers in expanded plot vs original plot (2008-2016; the dark pink corresponds with Table 2, second column)



¹ Throughout this report, monitoring results are represented by bar graphs showing just the years when monitoring was conducted. There are more years without monitoring data than with it. So the graphs are not appropriate to use for plotting trends as slope.

Figure 3. Flowering and nonflowering *Boechera pusilla* plant numbers in the original plot (2003-2016)

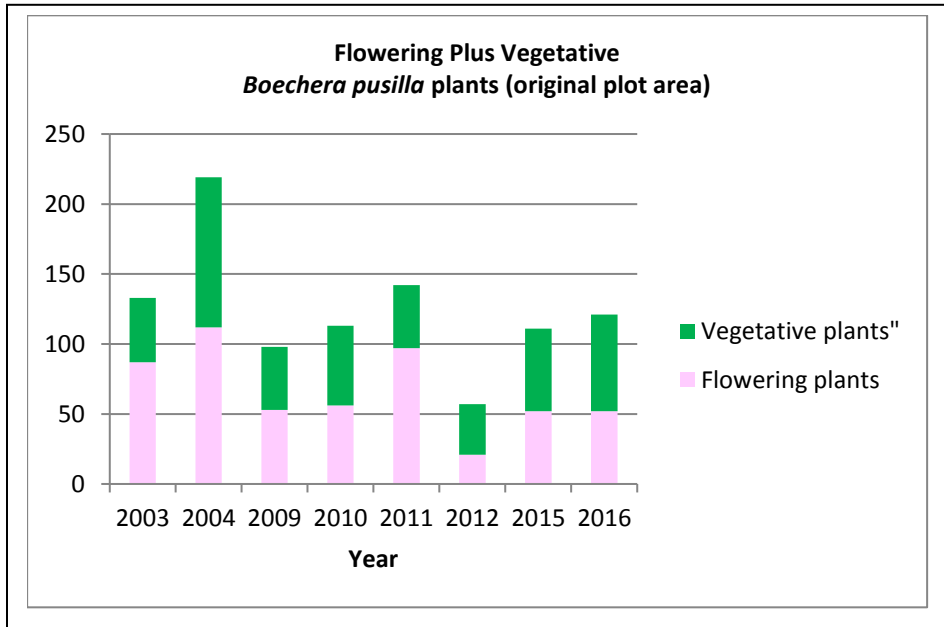
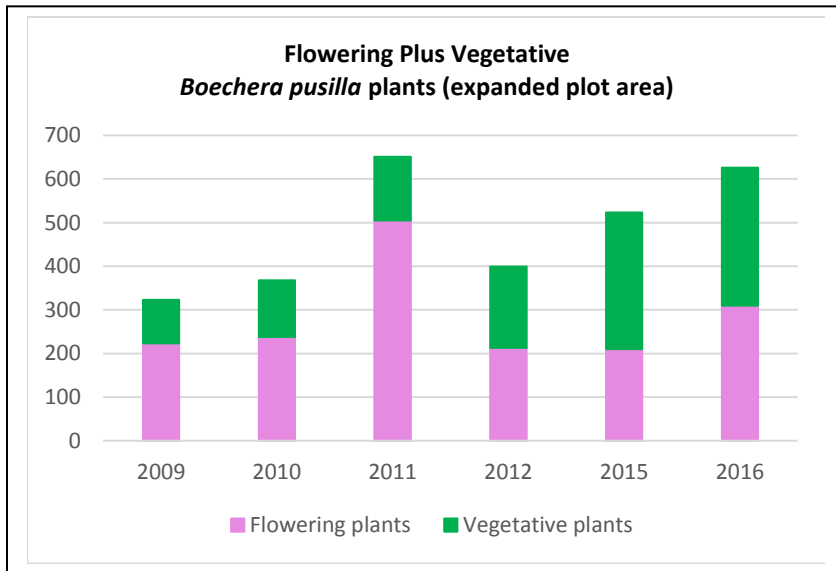
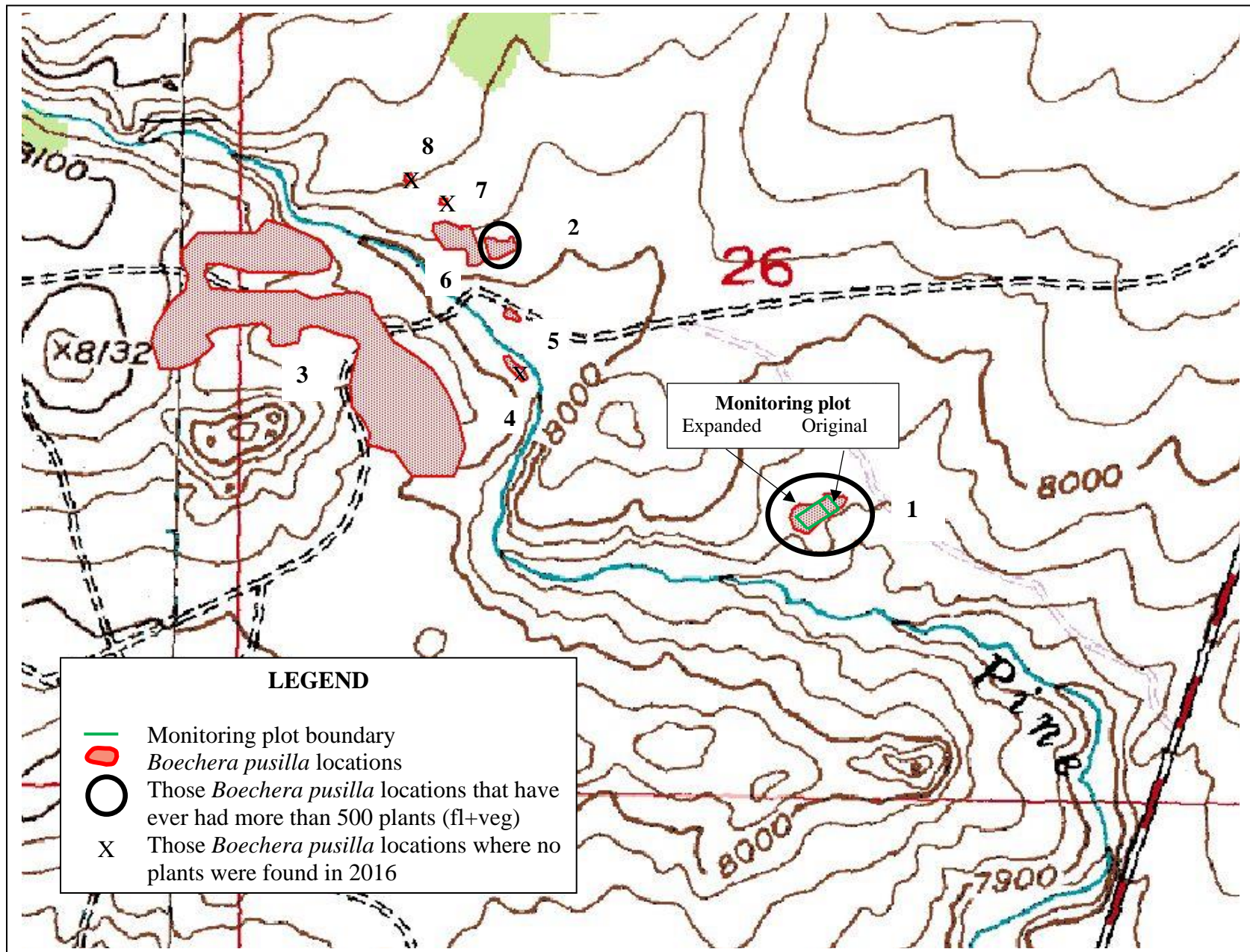


Figure 4. Flowering and nonflowering *Boechera pusilla* plant numbers in the expanded plot (2009-2016)



While the major decline between 1988 flowering plant numbers and more recent years has persisted, these results are tempered at least a little by the fact that the species is not restricted to the original monitoring plot but present in a larger area (expanded plot), and that nonflowering plants are present as well. Raw data are represented in Appendix C.

Figure 5. *Boechea pusilla* distribution and monitoring in T29N R101W Sec 26 and 27



The most significant 2016 fieldwork results was the documentation by Hollis Marriott of *Boechea pusilla* at a new location 1.8 miles (2.9 km) southeast of the known population, downstream along Pine Creek (Figure 6). Plants at the new location are treated as a separate population at present, pending systematic surveys between the two locations

Figure 6. *Boechea pusilla* distribution in T28N R101W Sec. 2², by Hollis Marriott (The map below represents the collection site. Small expansions in mapping were made later that week.)



A master spreadsheet of all monitoring results is summarized in Table 3 and detailed in Appendix B. In both 2011 and 2016, the two polygons with high numbers each had a magnitude more plants than any of the other polygons. This pattern shows every sign of being consistent between years. If there are shifts within them, this is a minor contribution to overall trends. This underscores the benefit of the three-pronged approach using both original and expanded monitoring plots, and census throughout the rest of the population. In the limited personnel time available for the 2016 work, plants were not found at the three smallest polygons (see polygons overlain by “X” on the study area map, Figure 5). Searches were not exhaustive. Each of them

² The original population is located to the upper left, outside of this view.

had fewer than 10 plants the last time they were visited, and are apt similar kinds of numbers if plants escaped detection in 2016.

Table 3. 2016 *Boechea pusilla* census results, by polygon (see Figure 5)

Polygon no.	Polygon location	2016 census
1	Circled polygon encompassing expanded monitoring plot (Easternmost polygon in SE¼)	681
2	Second circled polygon (NW¼)	925
3	Largest polygon, south of creek (SW¼)	35
4	Small polygon, south of creek (SW¼)	-
5	Small polygon bordering 2-track ()	9
6	Polygon west of second circled polygon (NW¼)	19
7	Northernmost in a pair of points within one large outcrop	-
8	Northernmost in a pair of points within one large outcrop	-
TOTAL		1669

In addition, Marriott spot-checked five other areas where it was not found (Appendix B). Finally, the author visited a site identified in 2000 by BLM personnel as potential habitat for *Boechea pusilla* in T.29N R.101W Sec. 32 NE ¼, and the species was not found. Locations of all the places where the species has been surveyed but not found were digitized, including results from this year and in the past years, as an initial step in building a negative database.

Discussion

The Category 1 designation of *Boechea pusilla* by U.S. Fish and Wildlife Service (USFWS 2011) was based in some measure on trend information, placing a premium on acquiring and interpreting the most current information. The discovery of a new population or outlier challenges the assumption that distribution has been completely documented. It is located on a very small outcrop and lies within a township and section that had previously included surveys of nearby large, prominent outcrops. So if distribution information is incomplete, then census results and trend interpretation do not reflect total numbers.

A comparison of the known location with the new location shows that the latter occupies areas of less than 10 m radius, and the habitat in it is not continuous low, relatively flat block but a patchwork of outcrop and intervening steppe. It is recommended that outcrop habitat targets be identified before the field season using the geology references cited by Marriott, including Bayley et al. (1973) and Frost et al. (2006) for setting the scope of survey. Then using digital imagery, discrete areas would be targeted and attributed with remotely-sensed attributes that may might have bearing on distribution (distance to Pine Creek, approximate extent of low outcrop

habitat, continuity of low outcrop habitat, proximity or absence of prominent outcrop habitat). Exhaustive survey of each target along Pine Creek between the new and old location would be appropriate, with extensions downstream for at least another 1 km where outcrops continue, and from there, in some organized sampling around prominent outcrops with the same geology (appearing to be limited to few townships north and south of Pine Creek).

Marriott (Appendix B) suggested that expansion of monitoring to all subpopulations might be more revealing than replicating the original monitoring plot. The monitoring plot has magnitudes more trend data than other parts of the population, so that keeping the full set of 2016 objectives is the proposed three-pronged approach for 2017 (original monitoring plot, expanded plot, and complete population census) for at least one more year. In the future, it is possible that the monitoring plot might be re-read in a streamlined approach by doing away with use of a baseline and lanes divided into exactly 1 m intervals, except to delimit and systematically cover the original/expanded/peripheral portions of the area for census.

It is possible that life history data could put monitoring results into context, requiring demographic monitoring to answer the following basic questions:

- How long can plants live and what is mean life expectancy?
- What are the critical life history stages that drive population trend?
- How many years does it take for plants to produce flowers?
- When do seeds germinate?
- What is net seed production for any given year?

Field observations point to a short-lived perennial life history with limited, but weather-related flexibility in repeated flowering over the years. It is not clear if *Boechea pusilla* forms a seed bank, i.e., dormant seeds that remain in underground storage until conditions are favorable. The paucity of soil development may limit the functional formation of a seed bank if it were physiologically feasible.

We examined SNOTEL data as potentially providing the meteorological context for population trends (Heidel 2014), even though the nearest SNOTEL station is near South Pass in a different setting and aspect. It may be more appropriate to pull together PRISM datasets that include monthly precipitation and mean monthly temperatures to look for correlations. It is possible that annual and seasonal weather conditions affect not just the numbers of plants, but the shifts between ratios of flowering-and-nonflowering plants.

We also checked literature on the species, and found a definitive genetic study of adaptive radiation in the *Boechea* genus (Kiefer and Koch 2016). The majority of the 111 species in the genus were subject to phylogenetic reconstruction and network analysis, including *B. pusilla*. The researchers tried to identify ITS types inside and outside major lineages. The genus-wide picture provides evidence of enormous reticulate evolution in the genus, supporting prior interpretations for *B. pusilla* as apomictic triploid of allopolyploid origin, though leaving unresolved its placement in major lineages.

Based on the information collected in 2016, and seeking discussions of this report with BLM, proposed plans for 2017 fieldwork include (next page):

- The three-pronged monitoring conducted in 2016.
- Use of PRISM data that spans the monitoring period to scope out meteorological correlations.
- Exhaustive survey of all potential habitat along Pine Creek between the original and new populations.
- Systematic subsample and survey appropriate pegmatite outcrops in nearby townships.

The final report will combine survey results with status and monitoring information, incorporating all of the above.

Literature Cited

Al-Shehbaz, I. A. and M. D. Windham. 2010. *Boechea*. Pages 348-412 in Flora of North America Editorial Committee, editor. Flora of North America North of Mexico. Vol. 7. Magnoliophyta: Salicaceae to Brassicaceae. Oxford University Press, New York, NY.

Amidon, B. 1993. *Arabis pusilla* monitoring notes. Unpublished information in BLM Rock Springs Field Office. Rock Springs, WY.

Bayley, R.W., P. D. Proctor and K. C. Condie. 1973. Geology of the South Pass area, Fremont County, Wyoming. U.S. Geological Survey, Professional Paper 793,

Dorn, R.D. 1990. Report on the status of *Arabis pusilla*, a candidate Threatened species. Prepared for the US Fish and Wildlife Service by Mountain West Environmental Services. Cheyenne, WY.

Frost, C. D., B. L. Fruchey, K. R. Chamberlain and B. R. Frost. 2006. Archean crustal growth by lateral accretion of juvenile supracrustal belts in the south-central Wyoming Province. Canadian Journal of Earth Science 43:1533-1555.

Heidel, B. 2005. Status of *Boechea pusilla* (small rockcress) in Wyoming. Prepared for the Bureau of Land Management. Wyoming Natural Diversity Database, Laramie, WY.

Heidel, B. 2012. Status and monitoring of *Boechea pusilla* (small rockcress; Fremont County rockcress). Prepared for the Bureau of Land Management. Wyoming Natural Diversity Database, Laramie, WY.

Heidel, B. 2014. Monitoring of *Boechea pusilla* (small rockcress; Fremont County rockcress) – 2012 Update. Prepared for the Bureau of Land Management. Wyoming Natural Diversity Database, Laramie, WY.

Heidel, B. 2016. Monitoring of *Boechea pusilla* (Fremont County rockcress; small rockcress) in Wyoming - 2015 update. Prepared for the Bureau of Land Management, Wyoming Office and

Rock Springs Field Office. Wyoming Natural Diversity Database, University of Wyoming, Laramie, WY.

Kiefer, C. and M. A. Koch. 2016. A continental-wide perspective: the genepool of nuclear encoded ribosomal DNA and single-copy gene sequences in North American *Boecheira* (Brassicaceae). PLoS ONE 7(5): e36491.

Marriott, H.J. 1986. A report on the status of *Arabis pusilla*, a Candidate Threatened species. Prepared for the US Fish and Wildlife Service by the Wyoming Natural Diversity Database, Laramie, WY.

Marriott, H.J. 1988. . TES plant species monitoring programs, Rocky Springs District, BLM, from Draft Habitat Management Plan. Prepared for the Bureau of Land Management by the Wyoming Natural Diversity Database, Laramie, WY.

Marriott, H.J. 2016. *Boecheira pusilla* assessment, 2016. Unpublished report for Wyoming Natural Diversity Database, University of Wyoming.

USDI Bureau of Land Management. 2010. Wyoming Bureau of Land Management sensitive species policy and list; Instruction Memorandum No. WY 2010 027. BLM Wyoming State Office, Cheyenne, WY.

USDI NOAA 2006. Wyoming climate summaries; NOAA meteorological data through 2006 for the state of Wyoming. Western Regional Climate Center. Posted at: <http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?wysout> .

USDI NOAA. 2016. Historic Data for Wyoming SNOTEL Site South Pass (775). Posted at: <http://www.wcc.nrcs.usda.gov/snow/> .

U.S. Fish and Wildlife Service. 2011. Endangered and Threatened Wildlife and Plants; 12 month finding on a petition to list *Abronia ammophila*, *Agrostis rossiae*, *Astragalus proimanthus*, *Boecheira (Arabis) pusilla*, and *Penstemon gibbensii* as Threatened or Endangered; Proposed Rule. Federal Register 76(111): 33924 33965 posted 9 June.