Monitoring of *Boechera pusilla* (Small Rockcress; Fremont County Rockcress) in Wyoming – 2015 Interim Report

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ABSTRACT

Boechera pusilla is 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 is 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 repeated in 2003 and 2004; and then from 2008-2012, and most recently in 2015. While the major decline between 1988 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 more numerous in contiguous habitat, and that there is a year-to-year shift in flowering-to-nonflowering ratios with higher proportions of nonflowering plants when flowering plant numbers are at their lowest.

ACKNOWLEDGEMENTS

Boechera pusilla monitoring work was supported as a joint project of the Bureau of Land Management (BLM) and the Wyoming Natural Diversity Database (WYNDD). This study draws heavily from the previous monitoring work of Hollis Marriott and the status review work of Marriott and Robert Dorn. This monitoring would not have been conducted without the support of Chris Keefe, BLM, for promoting 2015 work. It was conducted under a challenge cost-share agreement between BLM and WYNDD.

Literature citation:

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Introduction

Boechera 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 recognized as a Candidate species (Category 1 species) for listing under the Endangered Species Act (USDI Fish and Wildlife Service 2011). It is known from only one population throughout its range, so is a species of Very High Wyoming contribution rank, and has 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 primary purpose of this project was to conduct an additional year of monitoring *Boechera pusilla*. This interim report presents 2015 monitoring data, updating the prior information in reports (Heidel 2005, 2012, 2014) and files. Continuation of monitoring is planned through at least 2016. Reviews of this report and ensuing results are appropriate for deciding a monitoring threshold and culmination. A final report will be prepared at the culmination, identifying any framework or contingencies for the possibility that monitoring would be resumed in the future.

Monitoring Methods

A monitoring design suited for *Boechera pusilla* was established and carried out in 1988 as complete census in a given plot area placed within the largest subpopulation (Marriott 1988). It covered an area of 16 m x 25 m (400 m^2). The census 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 m^2), and proposed expanding the monitoring to the 50 m x 25 m area, converting it into a random sampling design. Detailed photo documentation of the 50 m x 25 m area and monitoring notes accompanied the raw data. It was recommended for annual monitoring but did not get repeated.

A separate monitoring design for *Boechera pusilla* was set up and executed in 1993 as complete census covering nearly the same area of the largest subpopulation (Amidon 1993). 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 ft^2; 371.6 m^2). 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 otherwise recorded, and was not repeated.

The same subpopulation of *Boechera pusilla* was next monitored by the author in 2003. It was readily apparent that the species was no longer in high density, and nowhere random in its distribution. The schematic maps and photo records that accompanied 1988 monitoring were available for reference. It was possible to relocated the proposed 50 m x 25 m expanded plot area (1250 m^2) and relocate the 16 m x 25 m original plot area (400 m^2) within it based on photographs, field notes and a field map. 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 set off lanes 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, so the first lane was the northernmost, the first lane (0-1 m) was called Lane 1, and lane numbers increased to the south.

Monitoring of *Boechera pusilla* has been repeated for eight years since establishment in 1988 (Table 1). One big question was raised at the onset of 2003 monitoring. Are the low densities of *B. pusilla* reflecting just a shift in the ratio of flowering-to-nonflowering conditions? So the scope of monitoring was expanded in 2003 by adding census of nonflowering (vegetative) plants to that of flowering (reproductive) plants. Any plant with a flowering stem of the current year was tallied as a flowering plant, no matter the number of stems or phenological stage. 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 especially if beside mat-forming vegetation such as *Selaginella densa* (spikemoss). The vegetative plant forms a small rosette, with undivided leaf margin hairs, simple hairs at the leaf margin and often a reddish coloration that are different from other *Boechera* species in the area.

Starting in 2008, monitoring covered the expanded plot area, not just the original plot area. Tapes were stretched off of the entire 50 m baseline (50 - 1 m lanes) and the number of plants in each m² area was recorded separately. This 1250 m² sample area is henceforth referred to as the expanded plot area. 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. *Boechera pusilla* monitoring overview (1988-2015)

Monitoring date	Monitoring extent (400 m² or entire 1250 m²)	Inclusion of vegetative plants in addition to flowering plants
20 Jun 1988	400 m²	Yes
6 Jun 2003	400 m²	Yes
15 Jun 2004	400 m²	Yes
2 Jun 2008	1250 m²	No
1 Jun 2009	1250 m²	Yes
31 May 2010	1250 m²	Yes
6 Jun 2011	1250 m²	Yes
31 May 2012	1250 m²	Yes
4 Aug 2015	1250 m²	Yes

The 50 m x 25 m monitoring plot covers perhaps over 90% of the *Boechera pusilla* subpopulation area. 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. The priority is placed on census in the rectangular plot area, noting whether or not census is addressed on the fringes.

The monitoring phenology window is open once *Boechera 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. The 2015 growing season began with cool, moist conditions. Monitoring was not originally planned for 2015, and there were competing demands early in the growing season. When project work scaled back late in the summer of 2015, opportunistic plans for *Boechera pusilla* monitoring were made on a trial basis in early August. 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 appropriate in early summer, conditions were 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" as compared to vegetative (i.e., nonflowering) plant.

In 1988, the number of flowering stems per plant was recorded. In later monitoring, this and the number of rosettes per plant have been tallied some years. The flowering stem numbers were high in 2011 when the number of stems was used as a criteria in targeting plants with high stem numbers for collecting seeds from just one stem per plant for conservation storage through Denver Botanical Garden.

Monitoring Results

A replication of 1988 monitoring shows record low numbers of *Boechera pusilla* flowering plants in 2012 (a drought year) and modest rebound in 2015 (Figure 1). A master spreadsheet of all monitoring results is presented in Appendix A. It contains the greatest amount of detail available for data that were collected. Context for these results are in Figures 2 and 3.

Figure 1. Flowering *Boechera pusilla* plant numbers over time[1] (corresponds with Table 2, first column)

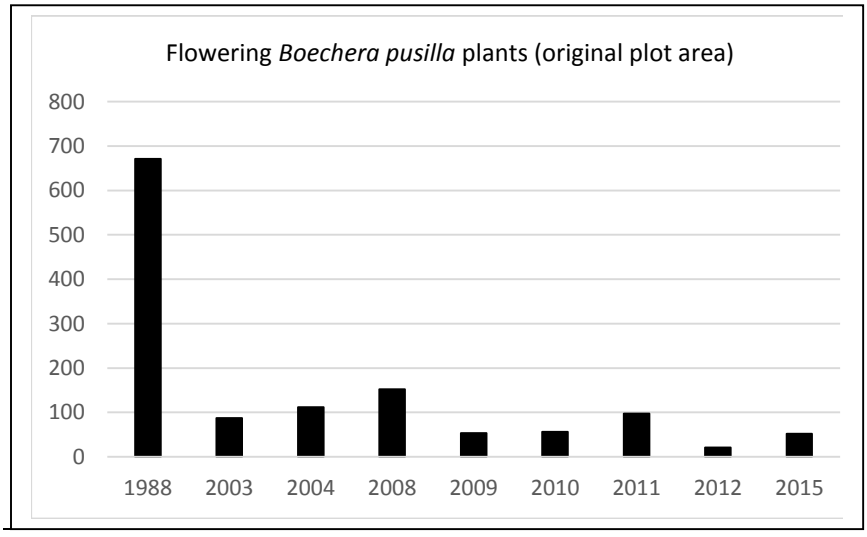


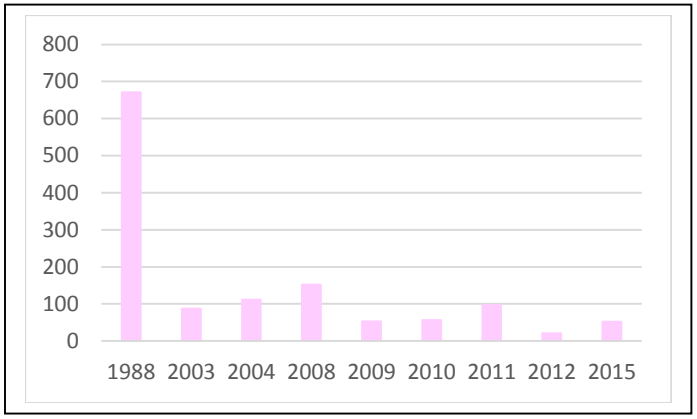
Table 2. Flowering *Boechera pusilla* plant numbers over time

	400 m²	1250 m²
1988	671	
2003	87	
2004	112	
2008	152	400
2009	53	223
2010	56	238
2011	97	505
2012	21	213
2015	52	210

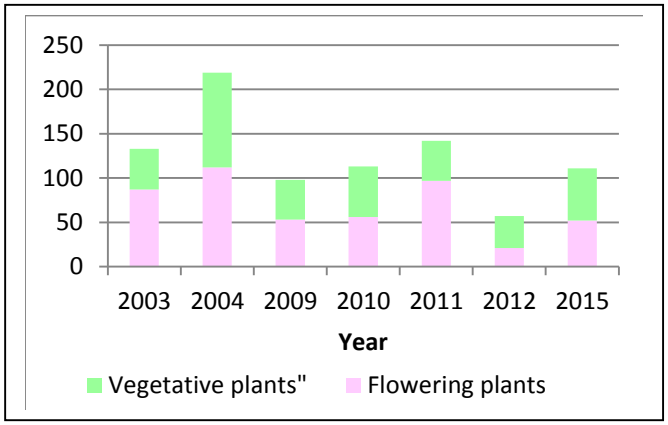
[1] Throughout this report, monitoring results are represented by bar graphs showing just the years when monitoring was conducted. There are more years without monitoring data than with it. So the graphs are not appropriate to use for plotting trends as slope.

Figure 2. Flowering *Boechera pusilla* plant numbers over time and with expanded context [2]

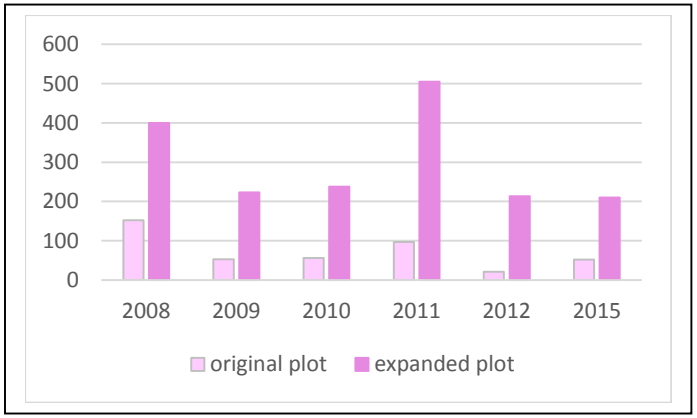
Flowering *Boechera pusilla* plant numbers over time in original plot (same as Figure 1, but color-coded)



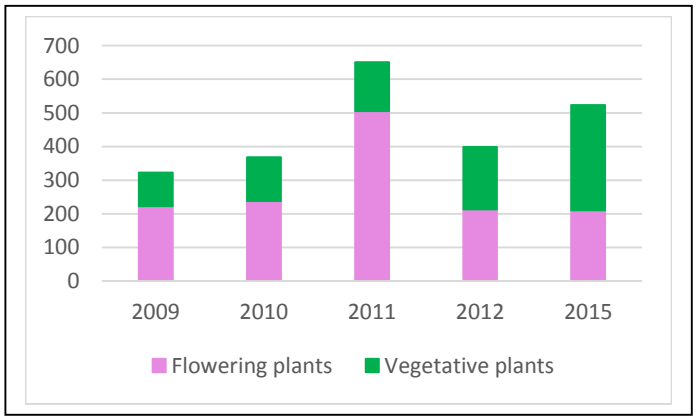
Flowering **and nonflowering** *Boechera pusilla* plant numbers in original plot[3]



Flowering *Boechera pusilla* plant numbers over time in original **and in expanded** plots



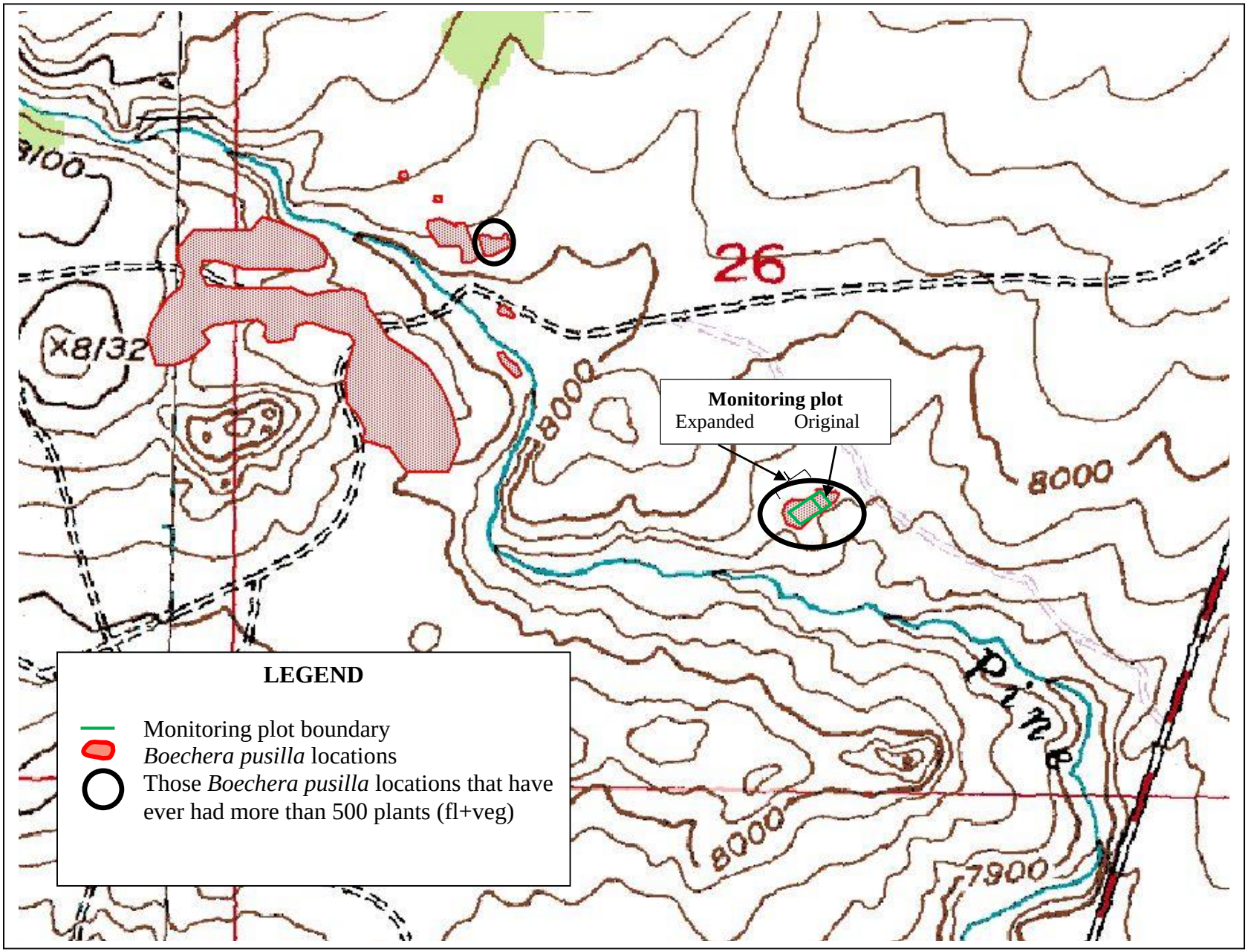
Flowering and nonflowering *Boechera pusilla* plant numbers over time in expanded plot



[2] Pale colors – original plot area; Dark colors – expanded plot area
Pink color – flowering plant numbers; Green color – nonflowering plant numbers

[3] Vegetative plants were not censused in 2008

Figure 3. *Boechera pusilla* distribution and monitoring



The overall trend among flowering plants in the original plot area shows a sharp decline. None of the subsequent years has come close to 50% of the flowering plant numbers documented at the time that the monitoring was established in 1988 in the original plot area.

While the major decline between 1988 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 more numerous in contiguous habitat, and that there is a year-to-year shift in flowering-to-nonflowering ratios with higher proportions of nonflowering plants when flowering plant numbers are at their lowest.

For example, in 2011, the expanded plot numbers of *Boechera pusilla* flowering plants (505 flowering plants) approached the tally of 1988 (671 flowering plants). If patterns of recruitment and mortality are localized, then it is possible that the species moves around within a 1250 m^2 area over time. If this were the case, then collecting monitoring data from the more complete plot boundary would be more representative of trend than the smaller plot and therefore suggest a rebound year in 2011. This is treated further in discussion.

Also for example, if most of the population monitored in 1988 was flowering, then documentation of shifting ratios between flowering-to-nonflowering plants in the subsequent years of monitoring provides a caveat to interpreting population size. The total numbers of plants in 2015 (523 flowering+nonflowering plants in the expanded plot) also approached the flowering plant number tally of 1988. This also is treated further in discussion.

Discussion

The Category 1 designation of *Boechera pusilla* by U.S. Fish and Wildlife Service (USFWS 2011) was based in some measure on trend information, making it important to collect current, accurate trend data. The relatively mild, moist 2015 growing season had *B. pusilla* numbers of flowering and nonflowering plants that, in combination, approached the flowering plant tally of 1988. If the vegetative plants of 2015 are surviving, it seems likely that there should be an appreciable increase in flowering plant numbers in 2016.

The proportion of nonflowering plants was exceptionally high in 2015 (149%; 313 nonflowering plants compared to 210 flowering plants in the expanded plot). It is hypothesized that this reflects the back-to-back years of relatively moist spring conditions and survival between them. The mean annual precipitation at South Pass (1915-2005) is 13.4 in (34.0 cm). In 2014, by the end of May, the water year total (a 12-month period from 1 Oct – 30 May) was already at 19.4 in (49.3 cm). In 2015, by the end of May, the water year total was already at 20.6 in (52.3). The high proportion and record high numbers of 2015 nonflowering plants may reflect these conditions and bodes well for future flowering plant numbers.

To determine whether or not the shifts between flowering-and-nonflowering plant numbers show a weather response to conditions that maximize seed production, more life history information would be needed to interpret those numbers and more thought into the evaluation of meteorological information is needed. How many years does it take for plants to produce flowers? When do seeds germinate? How long can plants live? What is net seed production for any given year? What are the critical life history stages that drive population trend? 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 *Boechera 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.

Any of the discussion topics on the previous page might be addressed in expanded studies. One of the most encouraging developments of recent years was documenting that a second location of *Boechera pusilla* had over 700 plants in 2011 (Figure 3); the first time that this known location had been included in a systematic census. Monitoring this additional subpopulation would be important to understanding total population numbers.

With the information collected in 2015, and recent discussions on species' status, plans for 2016 fieldwork are taking shape to include the following steps:

1. We will replicate the monitoring conducted in 2015 and include systematic census of the second location that has had high numbers.
2. Furthermore, we will census all subpopulations, no matter their numbers to produce a robust population total.
3. We will invite consultation of the botanist, Hollis Marriott, to review replication of the original location and methods and to visit the site for any impressions regarding habitat change or lack of change.
4. We will survey the location that was recommended after the most recent 2003 survey, and populate a negate database of all locations that have been surveyed for it.
5. We will quantify any phenomena that may or may not be relevant for understanding trend (presence/absence of rust, present/absence of seedlings) and collaborate with all partners and consider any additional tasks identified to interpret trend.

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