Monitoring Plan for

Flowers Penstemon

(*Penstemon flowersii*)

Prepared for: The Nature Conservancy

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Contents

List of Figures

List of Tables

List of Appendices

Introduction

Flowers penstemon (*Penstemon flowersii*) is a narrow endemic plant species located in the Myton, Utah area. The species was first documented in 1983 but little research or monitoring has been done on the species to date. Flowers penstemon habitat has been fragmented by land development, the majority of which is on private or Tribal land complicating protection of habitat. Difficulty managing habitat combined with the loss of and damage to habitat greatly increases the risk of extinction and the need for monitoring.

The purpose of this project is to establish a long-term monitoring plan for The Nature Conservancy (TNC) and to complete baseline habitat studies. The monitoring is designed to continue for at least five years with TNC overseeing annual monitoring, recording data on monitoring forms, and entering the data into Microsoft Excel for analysis.

Monitoring was started on two properties: Dude Young (owned by the Bureau of Reclamation), and Collier (owned by TNC). A total of 35 plants were tagged, each associated with a monitoring plot and a permanent transect. Monitoring was completed to measure plant survival, seedling recruitment, and population abundance. Baseline habitat studies included percent slope, aspect, associated species, and soil analysis.

Results of this project will be issued to TNC, and may also be of use to the Bureau of Reclamation (BOR), Reclamation, Mitigation, and Conservation Commission (RMCC), Ute Indian Tribe (UIT), U.S. Fish and Wildlife Service (USFWS), Natural Resources Conservation Service (NRCS), Bureau of Land Management (BLM), and the Utah Division of Natural Resources (DNR). All of these agencies manage land in or around the home range of Flowers penstemon.

Life History

Description

Family: Plantaginaceae - previously in Scrophulariaceae
Scientific name: *Penstemon flowersii* Neese & Welsh
Common name: Flowers penstemon or Flowers' beardtongue

Flowers penstemon is a perennial forb named after University of Utah botanist Dr. Seville Flowers (Neese and Welsh 1983) and was first described by Neese and Welsh in 1983. The species is endemic to Duchesne and Uintah Counties in the Uinta Basin, Utah, between Myton and Randlett (Neese and Welsh 1983).

Plants average 8-25 cm in height, with multiple stems arising from a single woody caudex. Foliage is a pale green-gray with pink flowers. Plants bloom from May to early June with seeds forming in a capsule and being released when the capsule dries in fall (American Penstemon Society 2015, Goodrich, S. and A. Huber 2014, Neese and Welsh 1983, Welsh et al. 1987).

The average number of seeds per capsule is unknown, but cold stratification is essential for germination (Red Butte Gardens 2015). Seedlings at Red Butte Gardens matured and bloomed on a low watering schedule where the soil was allowed to dry-out between watering (RBG 2015). This information would be consistent with the climate of Myton, Utah.

Climate

Myton, Utah receives an average of 162.65 mm (6.4 inches) of precipitation annually. The yearly minimum temperatures range from -15.6°C to -39.4°C (-3.9°F to -38.9°F), and the yearly maximum temperatures range from 33.9°C to 40°C (93°F to 104°F) (UCC 2015). Temperatures and precipitation vary year-to-year, sometimes greatly.

Habitat

Flowers penstemon is associated with shadscale (*Atriplex confertifolia*) and salt desert shrub communities at 1500-1600 m in elevation. Flowers penstemon grows on the pale to gray, clay soils of the Uintah and Duchesne River Formations and pediment gravels (Neese and Welsh 1983). Soils are somewhat alkaline and saline throughout the range.

Range

When Flowers penstemon was described in 1983, the range was described as an area approximately 8 km wide and 27 km long (Neese & Welsh 1983). The USFWS described multiple occurrences in an area 6.4 km wide by 32 km long (USFWS 2011). Because range is important to assess loss of habitat, range was clarified by mapping known locations from herbarium specimens and GPS data received from the Heritage Society (UNHS 2015, Intermountain biota 2015).

Using these points a polygon was created with a distance of approximately 6.4 km between the farthest north and south points, and a distance of 32 km was found between the farthest west and east points (Appendix F, map 1). The area of the polygon was 29660.59 acres. The single point near Neola, Utah was placed at that location in error and should be excluded. The collection point was near Brough Reservoir, but the point was placed at the home address of the collector instead of the collection point (J. Spencer 2015).

Examination of satellite imagery on Google Earth shows no significant development of Flowers penstemon habitat until June of 2013, when oil and gas development becomes visible. There is a visible loss of habitat due to oil and gas development between 2013 and 2015 (Appendix A).

An attempt to quantify the amount of habitat lost to oil & gas development was made by comparing past and present satellite imagery on Google Earth. Polygons were hand digitized around areas where well pads were constructed after 2011. The total area of the polygons was calculated in Arc

Map and showed a total of 4739.77 acres or approximately 16% of known penstemon habitat was developed.

These polygons do not include residential or agricultural developments, and it should be noted that these are not exact numbers, but rough estimates. However, the information may be valuable in demonstrating that the limited range of Flowers penstemon habitat is being threatened, and surveys are needed in these areas.

Additional surveys to clearly define the current range of this species and the impacts of energy development would be of value, but would be difficult to obtain where so many of the known Flowers penstemon populations occur on private and Tribal lands (USFWS 2011).

Presently, there are approximately 10 approved well sites within Flowers penstemon habitat, all occurring on private and tribal lands (BLM 2015). At least three sites were staked-out as proposed drilling areas on the Dude Young property, but no wells have been approved. According to the Utah Reclamation, Mitigation and Conservation Commission (RMCC) the most active energy company in the area, Crescent Point, has communicated a willingness to avoid the species (Mingo 2015).

However, Crescent Point has notified the RMCC of their intent to resurface Riverdell Road to access drilling sites on Windy Ridge. Riverdell Road is a county road that runs through the Dude Young property and if improved will likely impact both Flowers Penstemon and the two species of *Sclerocactus* present on the property.

The county has approved the project, but improving the road to the Dude Young property will likely increase the off-road vehicle use, and increased traffic will definitely increase dust and disturbance to the Flowers penstemon and *Sclerocactus* growing near the road.

Recommendations were made to not allow widening of the road, to request mitigation in the form of putting up signage indicating off-road vehicle use is prohibited, and strategic placing of boulders around the already highly disturbed knoll on the southwest end of the property.

Figure 1 – Google Earth imagery of OHV disturbance on Dude Young Property.

Threats

Presently there are no management plans to protect or guide agencies in decisions regarding Flowers penstemon, and there are no laws or regulations providing protection. However, management will be crucial in the future as this species is currently facing many threats such as:

- Limited range
- Loss of habitat due to
    - Energy production
    - Off-road recreation
    - Land development
- Highly variable weather patterns normal to the Uinta Basin

Flowers penstemon was considered for listing as threatened or endangered in 2010, but threats to the species were not sufficient to warrant listing, so it has no protection under The Endangered Species Act of 1973 (USFWS 2011). ESA 4(a)(1) identifies five factors that must be considered when designating a species as threatened or endangered. The factors as listed in the ESA are:

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

B. Over utilization for commercial, recreational, scientific, or educational purposes;

C. Disease or predation;

D. The inadequacy of existing regulatory mechanisms;

E. Other natural or manmade factors affecting its continued existence (ESA 1973).

The 12 month finding issued by U.S. Fish and Wildlife Service on 23, Feb 2011, found no evidence of over-utilization, disease or predation, and there were no regulations to protect the species at the time. Quantitative information was lacking regarding the species and a prediction for no increase in oil and gas development prevented listing of the species (USFWS 2011).

The Uinta Basin has since experienced a large increase in oil and gas development which threatens the available habitat for Flowers penstemon. Long-term monitoring will provide the quantitative information that was unavailable for the 2011 USFWS decision.

Methods

Flowers penstemon is widely scattered across the Collier and Dude Young properties so searching for plants and evenly spacing study plots would have been very time-consuming and difficult. To resolve this issue, maps of the Collier and Dude Young properties with GPS points were overlaid with grids (Appendix B) where each square of the grid covered approximately 100 m^2 (Elzinga et al 1998).

GPS points for Flowers penstemon were found in 50 grid squares. One GPS point was randomly selected from each grid using the identify tool in Arc GIS then a list of study points was compiled using these GPS points. There were initially to be five points on the Collier property and 45 on the Dude Young property. However, a larger sample size was desired for the Collier property so one grid was assigned two points, and one additional point was added during monitoring for a total of 7 points.

There were 15 points at the east end of the Dude Young property that could not be found, but 28 points were found and tagged for a combined total of 35 points. Of the points that could not be found, it is uncertain whether this was due to misplaced points or missing plants. Some plants were

found quite a distance from the GPS point, but others were not found at all and the area was heavily disturbed by off road vehicles.

Each tagged plant was associated with a study plot and a permanent transect, for a total of 35 tagged plants, 35 monitoring plots, and 35 transects. The monitoring of individual plants, plots, and transects on a yearly basis will allow for the collection of data on plant survival, seedling recruitment, population abundance, population health, barriers to reproduction, and invasive species.

Tagged Plants

Thirty-five individual plants were tagged for long-term monitoring of plant survival, as well as environmental impacts on plants. A numbered metal tag was secured on the north side of the plant using a drip irrigation micro stake (Figure 2).

Figure 2 – Numbered metal tag and micro stake.

Tagged plant data included a photograph, life stage, condition, percentage of canopy cover, number of stems, and herbivory. Each tagged plant was centered in a 1 m^2 quadrat aligned so the east side of the frame pointed due north (Figure 3). The number of the plant tag was also used as the plot number. A GPS point was taken and recorded for each plant tag and mapped in Arc GIS (Appendix C).

Should a tagged plant be missing or appear dead, the plot should continue to be monitored with the tag left in place to mark the center of the plot. A replacement plant can be randomly chosen in the same area (if possible) and assigned the next tag in the numerical sequence. Monitoring of the established plot should continue for at least two years after the tagged plant is not seen, to ensure the plant has not been dormant and to note recruitment. There is no data on the seed bank

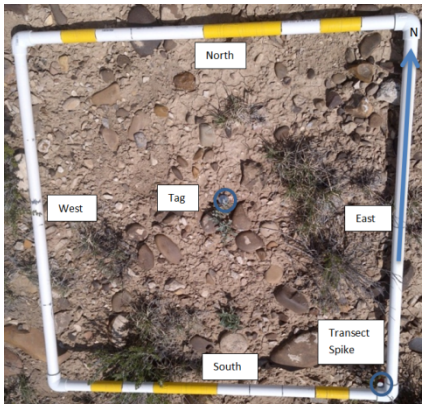


Figure 3 – Quadrat with tagged plant in center, transect spike in southeast corner and east side of quadrat frame aligned due north.

viability for this species, so continued long-term monitoring would be beneficial.

If a tag is lost, a replacement tag should be assigned to the plant and careful documentation made to ensure past data is combined with the new tag number.

Plots

Study plots were centered on each tagged plant for long-term monitoring of seedling recruitment and to provide initial baseline data. Plot data included a photo taken from the north side of the plot, and percent canopy cover for Flowers penstemon, all other vegetation, soil, rock, and litter. Comments were made on any obvious disturbance, or observations within or near the plot.

Plants were divided into four life stages, each with an abbreviation: fruiting or flowering (F), vegetative (V), seedling (S), and vegetative due to herbivory (VH). All flowers penstemon plants within the 1 m^2 quadrat were drawn on a diagram as a circle with the life stage abbreviation in the middle. A new diagram should be completed each year using the same method in the SOP (Appendix D). All new plants should be added, and plants on the diagram that are dead or missing from a previous year should be drawn as a circle with an "X" through it (Figure 4).

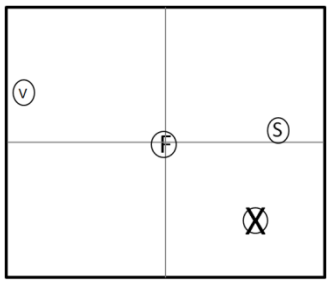


Figure 4 – Sample monitoring diagram.

Data from the diagrams should then be entered into the Microsoft Excel file: "Life Stage Tools." This file includes formulae to automatically calculate seedling survival, mature plant survival, overall plant survival, and seedling recruitment using the formulae found in the Red Butte Garden Annual Report for Graham's penstemon (*P. grahamii)* and White River Penstemon (*P. scariosus var. albifluvus*) (Appendix E).

After three to five years, the collected data could be used to construct life tables to identify critical life stages, barriers to reproduction, and to model population growth over time. This information could then be used to refine management of the species.

Transects

Belt transects 30 m long and 1 m wide were created with each study plot to provide long-term monitoring data on population abundance. To best measure abundance, the transects were deliberately run along the trajectory that would include the most plants. All but two transects originated within the $1m^2$ quadrats, because the greatest number of plants could be included that way. For plot numbers 6 and 23, the greatest number of plants was obtained by placing the origin a short distance outside the monitoring plot and running the transect through the plot.

Transects were marked with a 25.4 cm (10 inch) metal spike and a numbered tag (Figure 5). Transects 1 - 25 were marked with a red tag and transects 26 - 35 were marked with a yellow tag. A spike was used to mark both the origin and the termination point, and GPS points were logged. GPS points and transect lines were mapped in Arc GIS. Where possible, rocks were stacked around the stake to prevent detection and removal by recreationists.

Figure 5 – Transect spike.

A log was created with the plant tag number, transect tag number and color, elevation, and a GPS point for both the origination and termination point of the transect (Appendix F). Double counting was avoided by not allowing transects to cross.

Once the numbered origin point was established, the observer walked a 30 m tape measure to the termination point. Transect width was measured using a 1 m pole (one side of the 1 m^2 quadrat frame) with the center marked. Because seed is formed at the tip of the stems, thus providing the possibility of dispersal, a plant was counted if a stem of the plant could be touched by the 1 m pole when centered on the measuring tape. The total number of plants within each transect was recorded on the monitoring form.

Baseline Habitat Data

Baseline habitat data included percent slope, aspect, associated species, and soil analysis. Slope and aspect were visually estimated. Associated species were measured by recording all plant species within each study plot.

Soil analysis included pH, Munsell color (wet and dry), texture, and electroconductivity. A total of seven soil samples were obtained, three from the Collier property and four from the Dude Young property. Samples were chosen to represent the best variety of soil types.

Monitoring

Preparation and Safety

Prior to monitoring, all observers should be made aware of the presence of Pariette cactus (*Sclerocactus brevispinus*) and Uinta Basin hookless cactus (*Sclerocactus wetlandicus*), listed as threatened species and protected under the Endangered Species Act of 1973 (USFWS 2015). Observers should be taught to identify and avoid impacting these plants during monitoring activities. Juvenile *Sclerocactus* can be less than 1 cm in diameter so care should be taken to watch for young cacti when walking transects and monitoring study plots. Additionally, the study area falls within the habitat range of the midget faded rattle snake (*Crotalus oreganus concolor*) (DWR 2015) and observers should pay close attention where they step (Figure 6).

Standard Operating Procedures (Appendix B) will provide step-by-step instructions for the monitoring process. Review and explanation of the monitoring form (Appendix C) will help increase the accuracy and consistency of monitoring. Definitions and explanations of monitoring terms can be found on page 2 of the monitoring form.

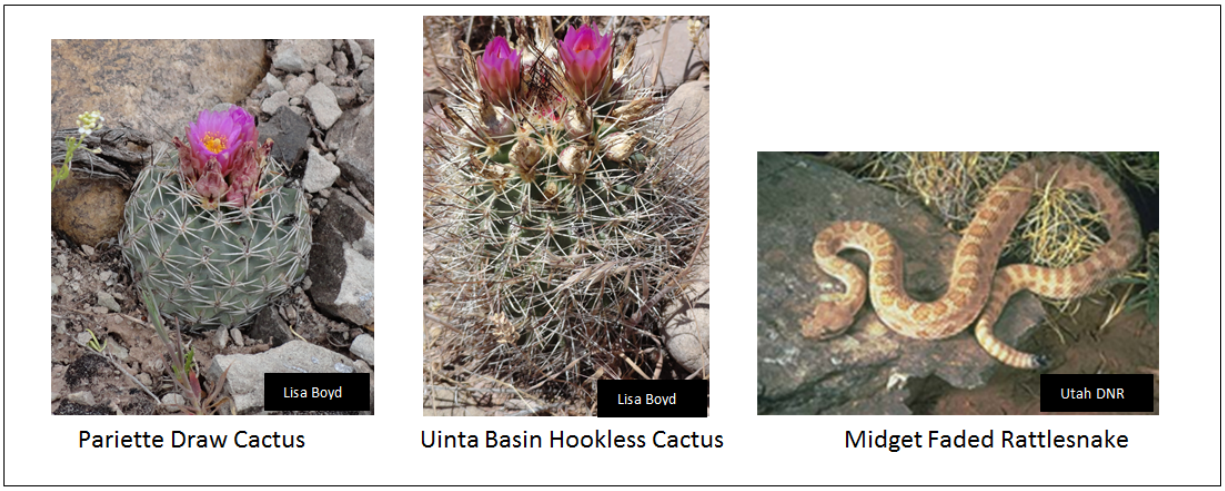


Figure 6 – Threatened cactus species found on the Dude Young property and photo of a rattlesnake.

Each monitoring form should be filled out completely with any non-applicable items being crossed out or marked "N/A" to distinguish them from missed items. Observers should review the form prior to leaving the site to make sure the form has been completed properly.

Each person should have water, snacks, and sun protection in addition to the following supplies: blank forms, copies of the previous year's forms, pencil, clipboard, measuring tape, compass, camera, GPS unit, tags, nails, and a square 1 m quadrat frame. A metal detector may be necessary if tags have been covered by soil.

Special Considerations

Special attention should be paid on the Collier property as Fremont penstemon (*Penstemon. fremontii*) occurs within the plots and transects and can be confused with Flowers penstemon when not blooming (Figure 7).

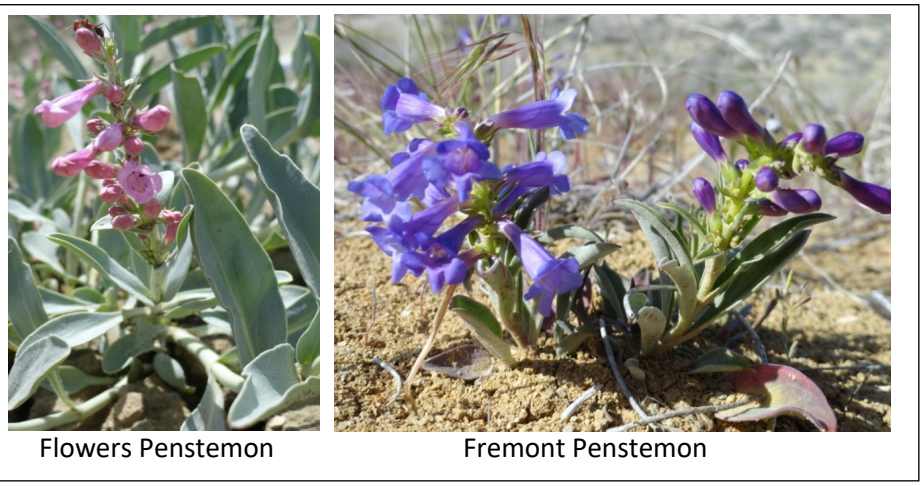


Figure 7 – The two look-alike penstemon found on the Collier property.

The key differences between the two species are the dark blue blooms and puberulent leaves and stems on the Fremont penstemon compared to the pink blooms and glabrous leaves on the Flowers penstemon. If the plants are not blooming, a hand lens or magnifying glass may be beneficial in distinguishing between the two species.

Findings and Observations

Plant Monitoring

Monitoring was done between May 1, 2015 and June 10, 2015. A total of 35 plants were tagged for long-term monitoring and assessed for life-stage, condition, and herbivory. A total of 113 plants were counted in plots with 47 fruiting, 32 vegetative, 26 seedlings, and 8 vegetative due to herbivory (Figure 8). This means that only 41.59% of the population was reproductive in 2015. Future data will help determine if this percentage is sufficient to sustain the populations.

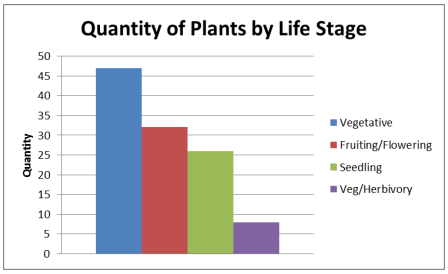


Figure 8 – Quantity of plants by life stage.

Plant Survival

There is no available information on the life span of Flowers penstemon, but the number of stems increases with age, at an unknown rate. Stems were counted partially as a means of tracking annual growth, and partially as a means of measuring reproductive potential. The number of stems ranged from 1 to 28, with an average of 6, but the majority of the plants (27) had fewer than 10 stems. Hopefully, long-term monitoring will be able to identify any correlation between the number of stems and age or reproductive potential.

Population Health

The majority of plants were in good or excellent condition. There were three plants in fair condition, and two of these also showed signs of moderate to severe herbivory. Overall, the population

appeared to be in very good condition with minimal herbivory and no signs of disease or insect infestation.

Plot monitoring

Plot monitoring used cover classes (Table 1) to assess percent canopy cover of Flowers penstemon and total vegetation, soil, litter, and rock. The average cover class for Flowers penstemon was 1, but three plots had a cover class of 2.

Table 1: Cover Classes

Canopy Cover Classes	
Class	%
1	1 - 5
2	5 - 25
3	25 - 50
4	50 - 75
5	75 - 95
6	95 - 100

Bare soil had the highest average cover class, with 5 on the Collier property and 4 the Dude Young property. This may indicate Flowers penstemon has a preference for open areas, which was observed in the field.

There was little litter in the plots with the average cover class being 1. Rock varied by site with Dude Young having more rocks in general. There were only two plots with rock at the Collier property, both a cover class of 1. The Dude Young property had rocks in 14 plots with an average cover class of 2.

Seedling Recruitment

A total of 26 seedlings were observed in 2015 and should be monitored in spring of 2016. Counting seedlings was extremely difficult because they grew in tight clumps and it was difficult to differentiate between seedlings and new growth from an established woody caudex. These clumps were frequently found in areas where water had been flowing past a large, mature plant.

Transect monitoring

Population abundance

A total of 263 plants were counted in transects with the number of plants per transect varying from 1 to 42. There were 26 transects with fewer than 10 plants, 8 transects with 11-16 plants, and one transect with 42 plants. Transect 6 was clearly unique with 42 plants. The quantity of plants located around plot 6 was very unusual and close observation of this area over time may be highly beneficial.

A pattern of possible seed dispersal by water was observed repeatedly with a large flowering plant on a higher elevation and many seedlings and young plants growing in and alongside rivulets at a lower elevation. When this was noticed in relation to a tagged plant, the transect was run along the rivulet to monitor this possibility.

Baseline Habitat

Percent slope and aspect were recorded during plot monitoring. Slope ranged from 0 to 25%, with 6 plots at 20-25%, 4 plots at 10-12%, and 25 plots less than 10%. Surprisingly, all three plots with a southeast aspect had a slope of 25%. Additional studies to include soil moisture, and GIS analysis of slope and aspect for all known points would be interesting to identify any trends.

Associated Species

There were a total of 42 plant species within the study plots, and all but one species were identified. These species were listed along with the number of plots they occurred in and the percentage of total plots (Appendix G).

The native species with the highest association were galleta grass (*Hilaria jamesii*), desert rabbitbrush (*Chrysothamnus greenei*), and woolly plantain (*Plantago patagonica*).

Other associated species were: Indian ricegrass (*Achnatherum hymenoides*), Gardner saltbush (*Atriplex gardneri* var. *garneri*), western stickseed (*Lappula occidentalis*), scarlet globemallow (*Sphaeralcea coccinea*), and dwarf gilia (*Ipomopsis pumila*).

Other interesting findings were that 5 of the 7 plots with rice grass were on the Collier property; black sagebrush (*Artemisia nova*) was found in three plots on the Collier property, but none of the plots on the Dude Young property; and all 7 plots with Gardner salt bush and dwarf gilia were on the Dude Young property.

Soil Analysis

All seven soil samples were either loam or a mixture of loam, and all were slightly alkaline. The electroconductivity showed slightly to moderately high saline soils.

Table 2: Soil sample results

Plot #	Texture	pH	EC µS/cm	Chart Dry; Wet	Munsell Dry	Munsell Wet
1	Clay loam	8.34	621	10 YR 8/2; 6/3	Pale olive	Olive gray
2	Loam	8.46	338.3	5Y 6/3; 5/2	Reddish brown	Weak red
6	Silt loam	7.67	700	5Y 5/2; 4/3	Olive gray	Olive
12	Loam	7.86	311.5	10YR 5/4; 4/6	Very pale brown	Pale brown
14	Sandy loam	8.26	638	2.5Y 5/4; 4/3	Pale Olive	Olive
21	Loam	8.57	448.0	5Y 6/3; 4/3	Light Olive brown	Olive brown
25	Loam	8.3	344	2.5YR 5/3; 4/2	Yellowish brown	Dark yellowish brown

Threats

Barriers to Reproduction

A total of eight plants or 22% of the population were vegetative due to herbivory. If these plants had been reproductive, the reproductive portion of the population would have increased slightly to 48.67%, but this is still less than half of the population. The use of life tables will help to quantify the significance of these findings over time.

Lack of winter and spring moisture may also be a significant barrier. The winter of 2014, into spring of 2015 received very little moisture. Flowers penstemon has been known to not bloom in dry years and penstemon in general do well with abundant winter and spring moisture (Spencer 2015, Brunson 2015).

Plants were revisited throughout late June and early July to check for seed production. Many plants were seen with seed pods on them, but seed counts could not be done because the majority of the pods dried before the seed matured. On the last monitoring visit (July 3rd), 10 plants were visited and 9 had either dried up completely or showed signs of severe mammalian herbivory.

Invasive species

Cheatgrass (*Bromus tectorum*) was found in 15 or 43% of the plots, and Russian thistle (*Salsola tragus*) was found in 7 or 20% of the plots. Both of these species were common throughout the study area. Halogeton (*Halogeton glomeratus*) was also common along roadsides and within the study areas, but was uncommon within the study plots.

Another invasive species of concern is Russian knapweed (*Acroptilon repens*), which is known to have allelopathic properties. While not found in any plots, this weed is abundant along the roadsides and boundaries of the study areas. Knapweed is highly aggressive in disturbed soils, but tends to prefer moist soils which may provide protection to Flowers penstemon which prefers drier soils. However, if knapweed does begin to encroach, treatment with an herbicide such as Milestone or manual removal should be considered as soon as possible.

Climate

Weather data from 1915 to 2015 were obtained and analyzed to assess any significant changes in temperature, amount and timing of precipitation (Figure 9). There were no significant changes in the amount or timing of moisture received. Rather, the pattern showed precipitation could vary substantially year-to-year, but usually remained within 10 to 18 cm (4 to 7 inches) a year (UCC 2015).

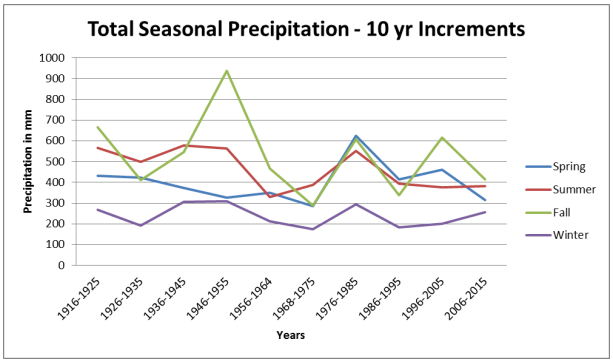


Figure 9 – Precipitation by season, in 10 year increments.

The majority of moisture is received in fall between August and October, and the majority of the remaining precipitation is received in spring between April and May. The amount of precipitation varies greatly by year and four years were excluded due to a lack of data: 1965, 1966, 1967, and 2014 (Figure 10).

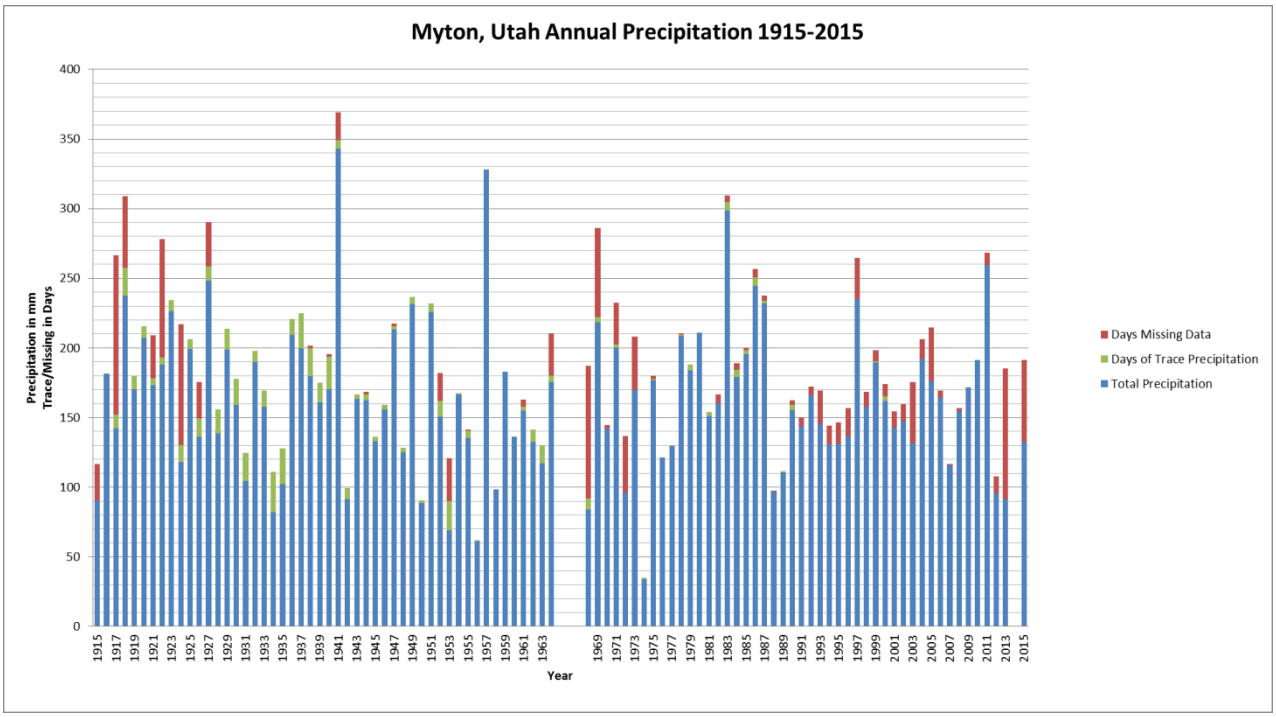


Figure 10 – Precipitation trends over 100 years, with missing data accounted for.

The maximum yearly temperatures have remained between 34°C to 40°C, a fluctuation of only 6 degrees, while the minimum yearly temperatures have varied significantly year-to-year. Minimum temperatures have ranged from as high as -15.6°C to as low as -39.4° C, a difference of nearly 24 degrees (Figure 11).

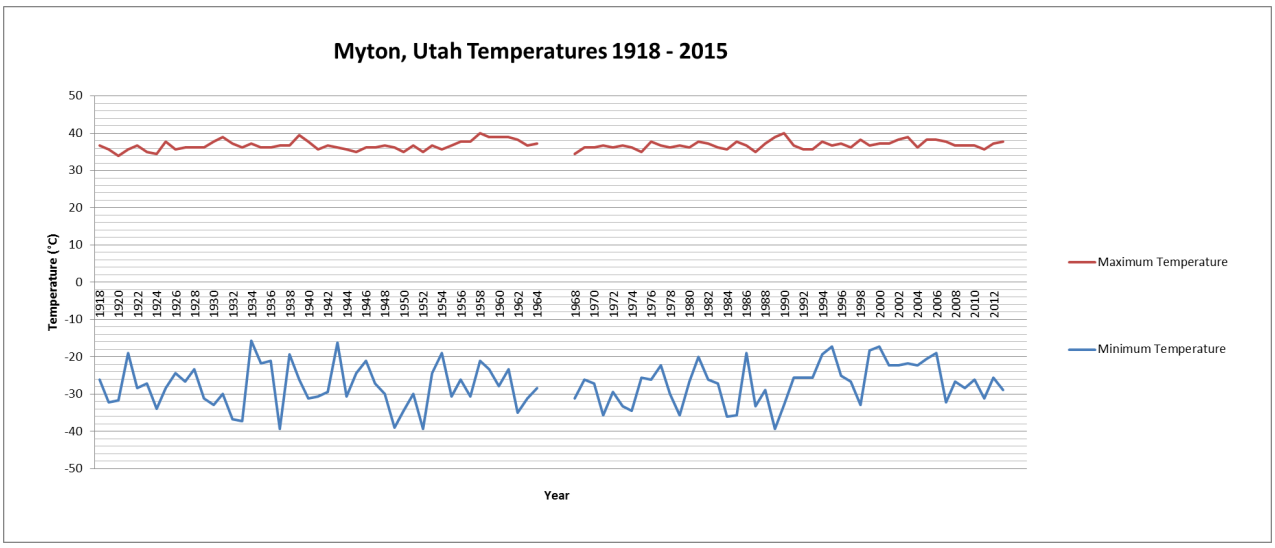


Figure 11 – Temperature trends over 100 years.

Flowers penstemon seems to be highly tolerant of this wide range of temperatures and requires cold stratification for germination. Studies at Red Butte Gardens showed 75% germination after 11 weeks of cold stratification at 6° C, and 73% germination after 46 weeks of cold stratification at 3°C. Seeds cold stratified for a shorter time and warmer temperatures had a significantly lower germination rate (RBG 2015).

Discussion

Observations

The Dude Young property was highly disturbed with multiple off-highway vehicle trails. As expected with increased disturbance, this site also had a higher density of invasive species. While the Collier property had the same invasive species, they appeared to be less dense. The plants were often seen in open areas which could indicate Flowers penstemon does not compete well for resources and increased invasive species could become a threat.

There were obvious signs of erosion on the Dude Young property, but less on the Collier property. The paths of water run-off were easily seen with seedlings occurring along the path of water. There is a high probability of water serving as a seed disperser, and the transect data should help to identify any correlation of this observation over time.

Moisture did appear to play a significant role in reproductive output. During initial monitoring on May 1st, most of the plants appeared dry and wilted with the buds withering. However, heavy rain storms over a one-week period appeared to restore vigor and most of the plants seen later in May and in early June were blooming.

Plants also showed increased herbivory later in the season which raises the question if lack of moisture not only causes reduced output, but also increases herbivory due to a lack of other available vegetation.

An additional observation was the presence of harvester ant (*Pogonomyrmex* sp.) piles near many of the plants. The ants were frequently seen on the plants, particularly on the blooms. This presents the possibility of the ants being a pollinator and seed disperser for this species (Figure 12).

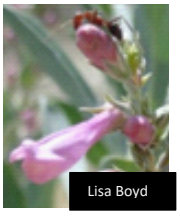


Figure 12 – Harvester ant on Flowers' penstemon bud.

Additional Research

Additional research on soil moisture and seed production would be beneficial in modeling survival and reproductive success for Flowers penstemon. As mentioned previously, many of the plants produced fruit with seed indicating successful pollination, but the seeds dried-up before maturing. Monitoring changes in weather patterns may be beneficial given the patterns of climate change being reported world-wide.

Pollinator studies would help identify any key pollinators and pollination success. Many different pollinators were noted on the plants during the monitoring season, and many fruits were seen. These studies were planned for 2015, but unfavorable weather and the resulting bad roads prevented the completion. Seed counts will also be required to develop a reproductive model.

Threats

Loss of habitat appears to be the greatest threat to this species, but negative effects due to lack of moisture, off-road vehicles, invasive species, and herbivory (deer and small mammals) were also seen. The amount of habitat lost with the most recent energy boom has been substantial and remaining populations of Flowers penstemon would benefit from protection. Management should focus on protection of mature plants with multiple stems and a higher reproductive output

Off-road vehicles are also a significant threat to the Flowers penstemon population on the Dude Young property. Signage, barriers, and fencing of the Dude Young property would be possible means of

protection. Public outreach and education about the species may also help to encourage landowners to protect populations on private property.

Recommendations

Flowers penstemon appears to be a hearty species, well adapted to its environment. Unfortunately, this species has a very limited home range which is threatened by energy development, recreation, and land development. Without protection, the continued existence of this species is definitely threatened.

Petitioning for listing as a threatened or endangered species under the ESA is an option, but would likely result in an enormous financial burden on government agencies, and would be minimally effective where this species occurs mainly on private and Tribal lands.

The developing conservation plan and a conservation agreement could more effectively protect this species and allow for continued monitoring and surveying. Because the majority of Flowers penstemon occurs on Tribal lands, involving the Ute Indian Tribe in this plan would be essential.

Conservation of mature plants with multiple stems and large patches of Flowers penstemon will likely provide the best opportunity for conservation. A joint agreement with The Nature Conservancy, Bureau of Reclamation, Ute Indian Tribe, Duchesne County, Uintah County, Natural Resource Conservation Service, Bureau of Land Management, Utah Reclamation Mitigation and Conservation Commission, and U.S. Fish and Wildlife Service would provide the best opportunity for this to occur. Key points in the agreement should include:

1. Surveys on Tribal lands and, where possible, private property, to get an accurate estimate of population size and range.
2. Monitoring of populations near well pads and roads to determine the impacts of disturbance.

3. Treatment of invasive species on and around well pads.
4. Agreement to avoid mature and large populations of Flowers penstemon in creating roads and developing well pads.
5. Mitigation for loss of habitat and plant destruction in the form of seed collection and the use of that seed in reclamation projects.
6. Protection from off-road recreation, particularly on the Dude Young property, which provides habitat for *S. wetlandicus* and *S. brevispinus*, federally listed as threatened species.
7. Ongoing monitoring and research to assess the effectiveness of management and mitigation measures.

Summary

Flowers penstemon is a perennial forb occurring in a very limited area of Duchesne and Uintah Counties, Utah. Being a rare endemic species with a narrow range increases the risk of population decline and extinction, thus the population requires long-term monitoring. This monitoring plan will allow annual monitoring to track growth rate, population abundance, seedling survival, mature plant survival, and overall plant survival. The data collected will also allow for construction of life tables to identify critical life stages and to measure the effects of herbivory on population growth and abundance.

This information will be of use to The Nature Conservancy, the Bureau of Reclamation, and U.S. Fish and Wildlife Services in developing a conservation plan and determining if the species would receive sufficient protection from a conservation agreement or if re-evaluation for listing as a threatened or endangered species under the Endangered Species Act of 1973 is warranted.

This species would benefit from future research focusing on pollinators, seed production, and reproduction specifically in relation to moisture. This species appears to have specific moisture

requirements for blooming and maturation of seed, so monitoring of weather conditions, especially total moisture from May to July, may provide significant findings.

Acknowledgements

I want to thank The Nature Conservancy for funding for this research, and Colleen Jones for providing me with the opportunity for this research. Thank you to Sherel Goodrich, Jim Spencer, Jessi Brunson, and Becky Williams for your expert advice and willingness to help with this project. Thanks to Utah Natural Heritage Program and Red Butte Gardens for sharing your research and data.

Literature Cited

American Penstemon Society (APS). https://apsdev.org/library/species_info/coerulei.doc. Accessed March 2015.

Brunson, Jessica. 2015. Botanist, Vernal Field Office, Bureau of Land Management. 170 S 500 E Vernal, Utah 84078. 435-781-4400.

Conservation Department, Red Butte Garden. 2014. *Penstemon flowersii* germination database. Unpublished data.

Elzinga, C. L., D. W. Salzer, J. W. Willoughby. 1998. Measuring and *Monitoring of Plant Populations.* Bureau of Land Management, National Business Center, Denver, Colorado, USA.

Endangered Species Act of 1973, Pg 4. Department of the Interior, U.S. Fish and Wildlife Service.

Federal Register: https://www.federalregister.gov/articles/2011/02/23/2011-3675/endangered-and-threatened-wildlife-and-plants-12-month-finding-on-a-petition-to-list-astragalus#page-10176

Goodrich, S. and A. Huber. 2014. *Uinta Flora*. USDA Forest Service-Intermountain Region Ogden, Utah. Pgs 264, 271-272.

Google Earth. Myton, Utah area. Imagery date: 6/18/2015 and historic imagery. Accessed in 2015.

Heil, K. D.; Melton, B. 1995b. Status report for Penstemon flowersii Neese & Welsh.

Intermountain Biota. www.intermountainbiota.org. Accessed August 2015.

Johnson, Ron. August 2015. Personal communication. Supervisor Weed Department, Duchesne County, Utah. PO Box 1081, Duchesne, Utah 84021. 435-738-2745.

Mingo, Richard. October 2015. Personal communication. Utah Reclamation Mitigation and Conservation Commission, 230 S 500E Ste. 230, SLC UT 84102-2045; 801-524-3416.

Nature Serve: http://explorer.natureserve.org. Accessed September 2015.

Neese, E, S. L. Welsh. 1983. A new species of *penstemon* (Scrophulariaceae) from the Uinta Basin, Utah. *Great Basin Naturalist* 43(3): 429-431.

Spencer, Jim. May – December 2015. Personal communication. Wildlife biologist with NRCS, 815 S 400 W, Roosevelt, Utah. 435-722-4621.

U. S. Fish and Wildlife Services: 2011. http://ecos.fws.gov/tess_public/reports/species-by-current-range-county?fips=49013. Accessed: May 2015.

Utah Division of Natural Resources: http://dwrcdc.nr.utah.gov/rsgis2/search/Display.asp?FlNm=crotvico - photo credit. Accessed May 2015.

Utah Climate Center. https://climate.usurf.usu.edu/mapGUI/mapGUI.php. Accessed 12 October, 2015.

Utah Natural Heritage Program. 2015. Division of Wildlife Resources, Salt Lake City, Utah 84116.

Welsh, S.L., N.D. Atwood, S. Goodrich, and L.C. Higgins. 2008. *A Utah flora, Fourth Edition revised*. Brigham Young University Press, Provo. Pg 711.

Wysong, Sheri. October 2015. Personal communication. Vernal Field Office, Bureau of Land Management, 170 S 500 E Vernal, Utah 84078. 435-781-4400.

Appendices

Appendix A – Oil and Gas Development Near Windy Ridge, Utah.

Appendix B – Maps of Monitoring Sites

Appendix C – Monitoring Form

Appendix D - Standard Operating Procedures

Appendix E - Table of GPS points

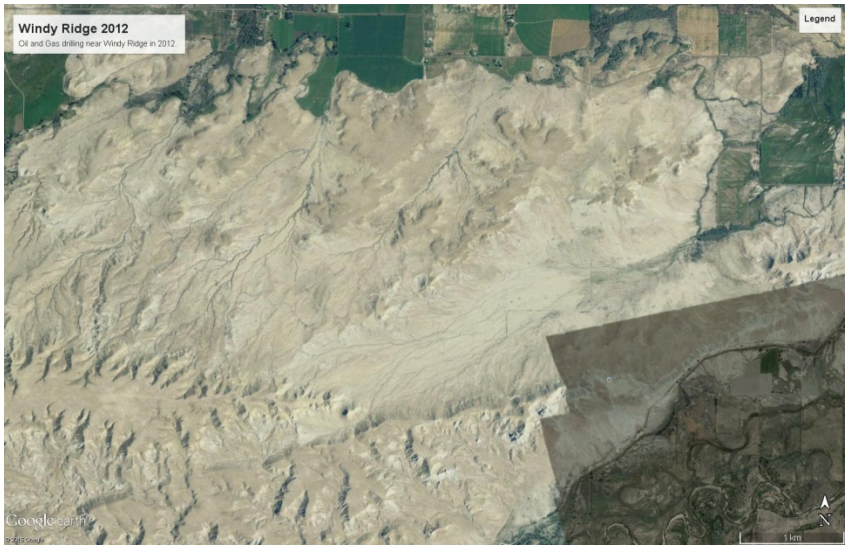
Appendix F - Formulae

Appendix G – Maps

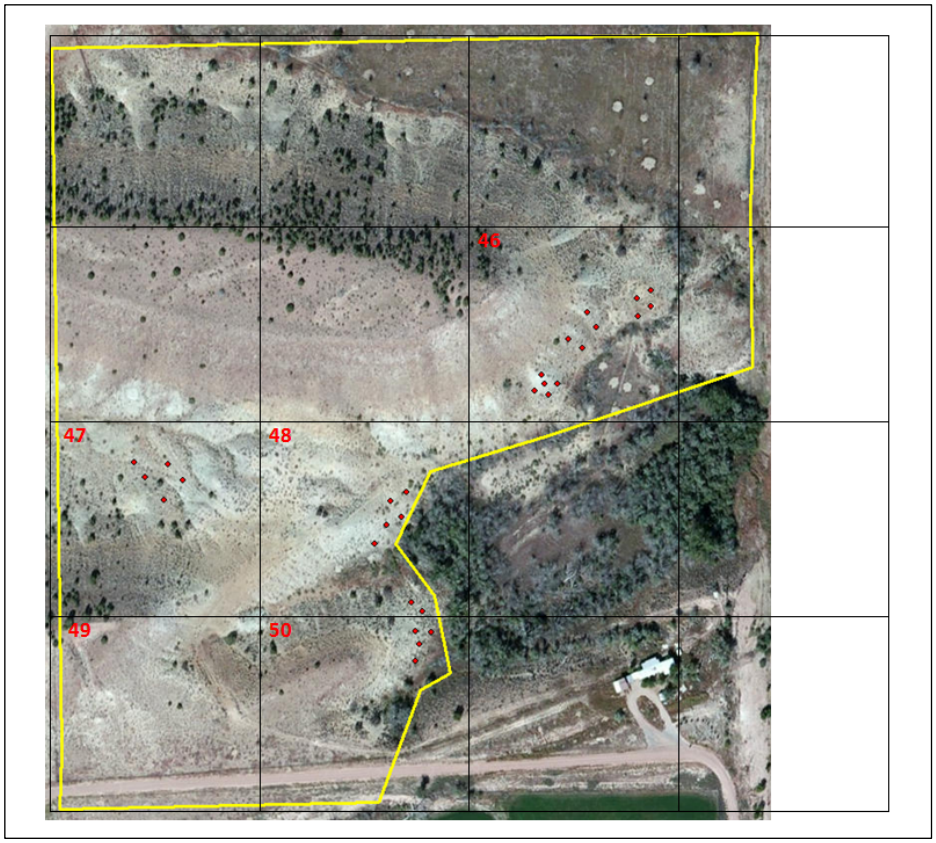
1. Potential Habitat by Soil and Known Penstemon Points
2. Flowers Penstemon Range by Known Points
3. Oil and Gas Development in Flowers penstemon habitat
4. Flowers Penstemon Study Points on Collier Property
5. Flowers Penstemon Points on TNC – Collier Property
6. Flowers Penstemon Study Points on Dude Young Property
7. Flowers Penstemon Points on Dude Young Property

Appendix H - Associated Species

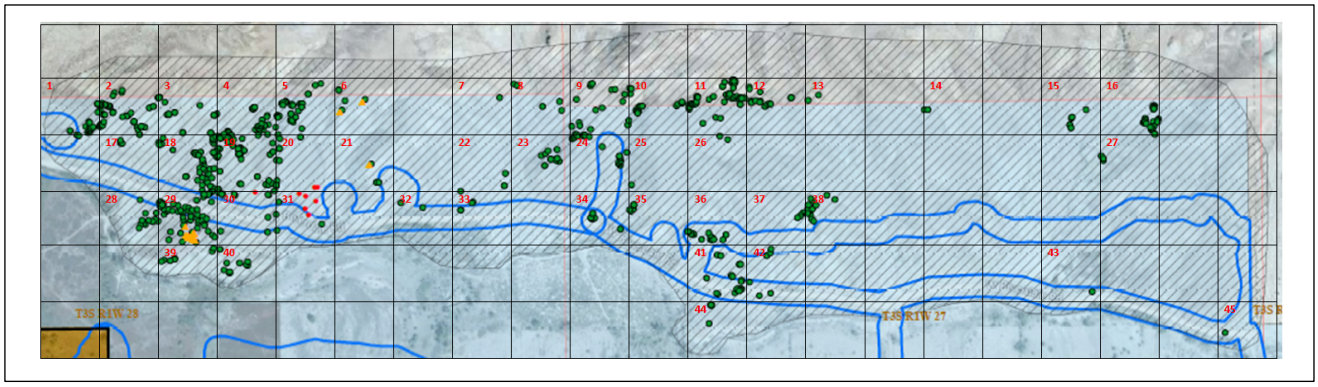
Appendix A – Oil and Gas Development Near Windy Ridge, Utah



Appendix B - Maps of Monitoring Sites



Collier Property



Dude Young Property

Appendix C - Monitoring Form

Plant/Plot #:	**Date:**	**Photo #s:** Plant / Plot	**Life Stage:** V F S VH
Cover Class:	**Stems:**	**Condition:** Dead Fair Good Excellent	
Herbivory: None Mild Moderate Severe	**Location**: Leaf Steam	**Type**: Insect Mammal	
Cover Class Plant:	Plot:	**Transect Count:**	

Cover Classes:		
1 = 0-5% 2 = 5-25%		
3 = 25-50% 4 = 50-75%		
5 = 75-95% 6 = 95-100%		

Life Stage: V = Vegetative F = Flowering/Fruiting S = Seedling VH = Vegetative due to herbivory X = Dead

Diagram - Draw penstemon locations with a circle and put life stage symbol in the center.

Notes:		

(Front)

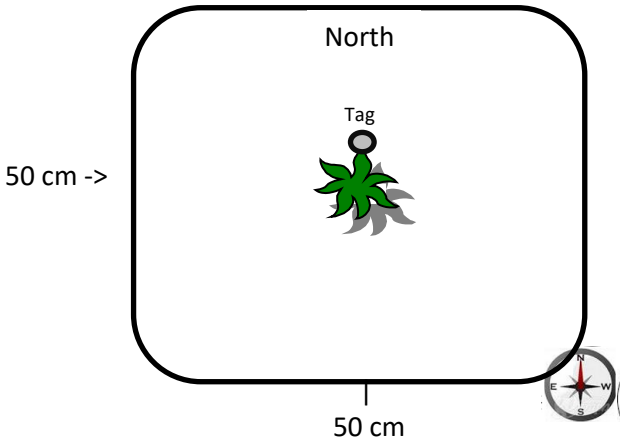
Penstemon Totals							
New: Seedlings (S):		Flowering:		Vegetative:		Total New (R):	
Seedlings last year, now:		Vegetative last year, now		Fruiting last year, now			Totals
Vegetative (V_1)		Vegetative (V_2)		Vegetative (V_3)		Total Vegetative (M_1)	
Fruiting (F_1)		Fruiting (F_2)		Fruiting (F_3)		Total Fruiting (M_2)	
Dead (D_1)		Dead (D_2)		Dead (D_3)		Total Dead (D)	
						Total Living Plants (N)	
						Total New (R):	
						Seedlings last year (S_t)	
S = Total seedlings in present year						Mature Dead = $D_{(t+1)}$	
R = Total new plants in present year						Mature Alive = $M_{(t+1)}$	
D = Total plants dead in present year						Seedlings Alive = $S_{(t+1)}$	
N = Total living plants in present year							
S_t = the number of seedlings alive last year or (S) on last year's form							
D_1 = Number of seedlings from last year NOT alive this year							
$D_{(t+1)}$ = Number of plants alive last year, but dead this year or $D_2 + D_3$							
$M_{(t+1)}$ = Total mature plants alive in present year or $M_1 + M_2$							
$S_{(t+1)}$ = Number of seedlings from last year still alive this year or $V_1 + F_1$							
Definitions of terminology and abbreviations							
Life Stage - circle one							
V = vegetative; mature plants that did not bloom.							
F = flowering; mature plants with blooms or seed pods.							
S = seedlings; new plants from seed.							
VH = vegetative due to herbivory; mature plants not blooming due to too much damage from herbivory.							
X = Dead plants on diagram should be a circle with an "X"							
Condition - circle one							
Dead = plant that is dead or missing after being recorded the previous year.							
Fair = plant with significant discoloration, wilting, loss of foliage, etc.							
Good = plant with mild to moderate discoloration, wilting, loss of foliage, etc.							
Excellent = plant extremely healthy, no discoloration, wilting, loss of foliage, etc.							

(Back)

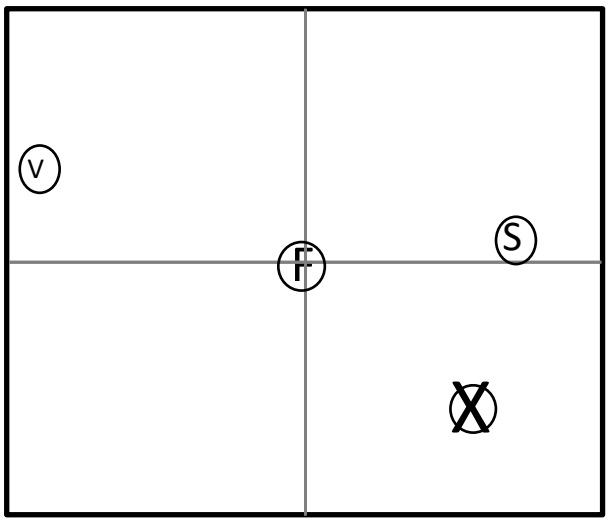
Appendix D - Standard Operating Procedures

Standard Operating Procedures
Flowers Penstemon Monitoring
Plant and Plot Monitoring

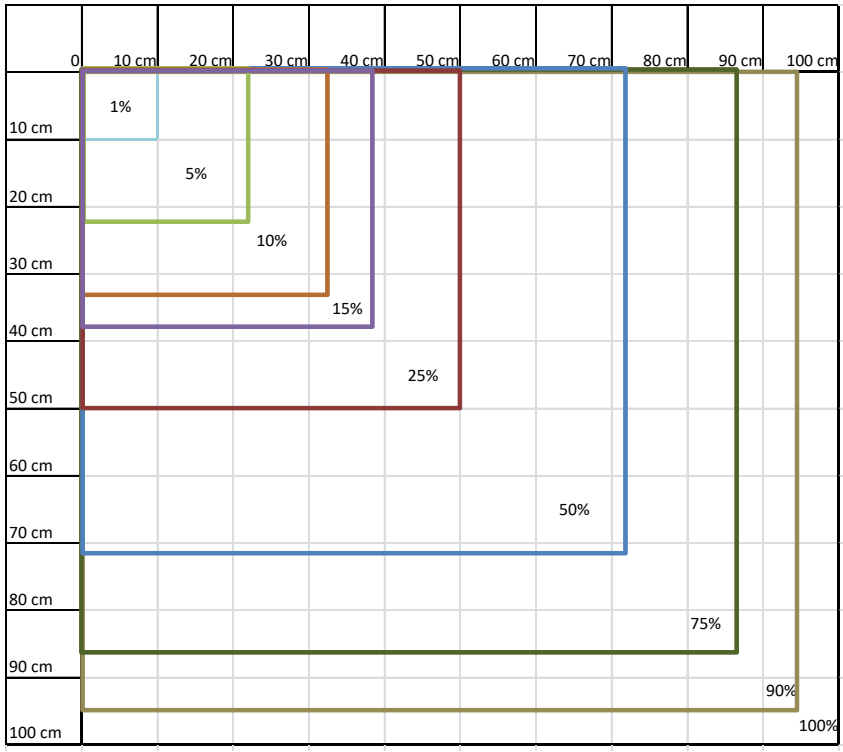
1. Locate plant tag using GPS coordinates and if necessary a metal detector. Plant tags were placed on the north side of the plant whenever possible.
2. Place the 1 m^2 quadrat frame on the ground with the plant in the center.
3. Using a compass, align the east side of the frame so that it points north.
4. Stand on the north side of the plot and photograph both the plant and the plot.
    a. DO NOT step in the study plot.
    b. Hold the camera as close to the center of the plot as possible.
    c. Be sure to get all four sides of the 1 m^2 frame in the photo.



5. Count the number of stems on the tagged plant and record on the data sheet.
6. Estimate the % of canopy cover for the tagged plant and record on the data sheet.
7. Draw a diagram of the plot using a circle to represent each Flowers penstemon plant.
    a. Inside each circle write the letter representing the current life stage of the flower.
    b. Plants that were present the previous year, but are no longer present should be drawn as a circle with an "X" through it.

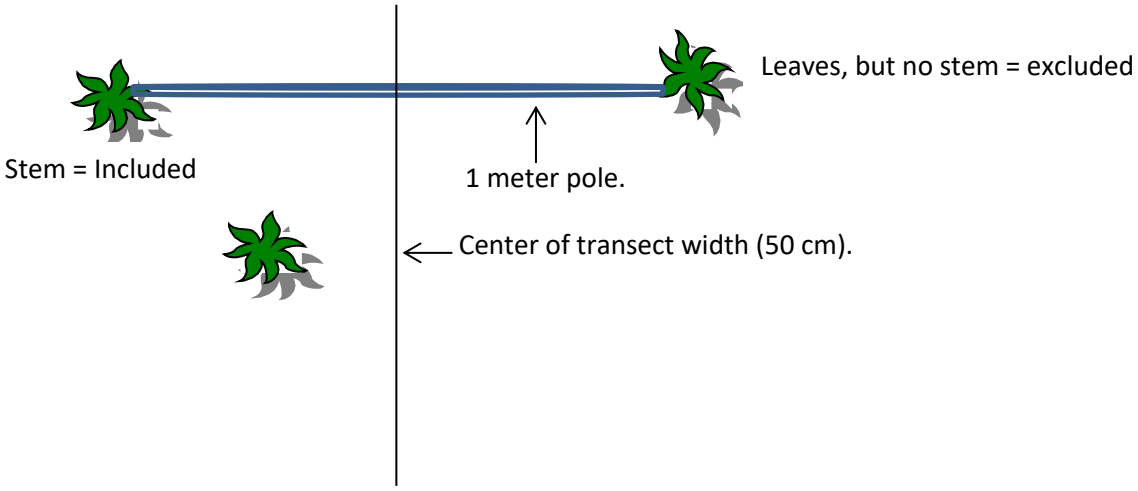


8. Estimate total canopy cover for all Flowers penstemon plants in the plot and record the number on the data sheet.
9. Complete the back of the data sheet by comparing the current diagram to the previous year's diagram.



Standard Operating Procedures
Flowers Penstemon Monitoring
Transect Monitoring

1. Find the origin transect stake using the GPS coordinates and verify the tag number on the stake. If either stake is missing replace stake using the original photo of transect as a reference.
2. Use a 30 m or longer tape measure and walk to the termination coordinate.
3. Stretch the tape straight between the two points and then lay flat on the ground.
4. Walk transect with a one meter pole marked at the center (50 cm).
5. Count all Flowers penstemon plants that have a stem touching the pole when the center of the pole is on the measuring tape.
6. If leaves touch the pole, but no stem, the plant is excluded.



Appendix E - Table of GPS Points

Study Plot and Transect Locations							
Collier		**UTM Coordinates**					
Plant/Plot ID	**Transect Tag**	**Transect Origin**		**Transect Termination**		**Elevation**	**Elevation**
		Easting	**Northing**	**Easting**	**Northing**	**Ft**	**M**
1	Red 1	579016	4455706	578999	4455732	5360	1634
2	Red 2	578989	4455821	578972	4455845	5322	1622
3	Red 3	579085	4455807	579061	4455789	5327	1624
4	Red 4	579180	4455878	579160	4455855	5312	1619
5	Red 5	579242	4455928	579231	4455956	5232	1595
6*	Red 6	579239	4455924	579209	4455932	5282	1610
	Plant	579235	4455925				
7	Red 7	579114	4455746	579103	4455720	5315	1620
Dude Young							
Plant/Plot ID	**Transect Tag**	**Easting**	**Northing**	**Easting**	**Northing**	**Ft**	**M**
8	Red 8	585108	4450325	585121	4450298	5032	1534
9	Red 9	585122	4450310	585150	4450318	5041	1536
10	Red 10	585145	4450312	585174	4450310	5045	1538
11	Red 11	585117	4450283	585098	4450304	5053	1540
12	Red 12	584972	4450454	584942	4450459	5067	1544
13	Red 13	585007	4450485	584991	4450509	5064	1544
14	Red 14	585110	4450474	585129	4450451	5058	1542
15	Red 15	585124	4450483	585098	4450495	5061	1543
16	Red 16	585352	4450501	585333	4450521	5100	1554
17	Red 17	585215	4450379	585187	4450377	5049	1539
18	Red 18	585210	4450407	585213	4450434	5045	1538
19	Red 19	585178	4450410	585145	4450412	5047	1538
20	Red 20	585246	4450436	585223	4450440	5061	1543
21	Red 21	585300	4450406	585279	4450426	5083	1549
22	Red 22	585293	4450366	585307	4450340	5084	1550
23*	Red 23	585295	4450287	585308	4450263	5059	1542
	Plant	585302	4450278				
24	Red 24	586124	4450190	586151	4450182	5039	1536
25	Red 25	585926	4450313	585901	4450294	5026	1532
26	Yellow 1	585805	4450401	585804	4450426	5124	1562
27	Yellow 2	585741	4450526	585767	4450508	5046	1538
28	Yellow 3	585830	4450466	585851	4450479	5057	1541
29	Yellow 4	585875	4450427	585902	4450439	5055	1541
30	Yellow 5	586099	4450532	586070	4450529	5072	1546
31	Yellow 6	586163	4450504	586133	4450515	5063	1543
32	Yellow 7	586449	4450488	586475	4450491	5059	1542
33	Yellow 8	586692	4450471	586702	4450499	5052	1540
34	Yellow 9	586805	4450466	586834	4450465	5045	1538
35	Yellow 10	586833	4450471	586840	4450499	5052	1540

* Tagged plant not at transect origin; separate GPS coordinates given.

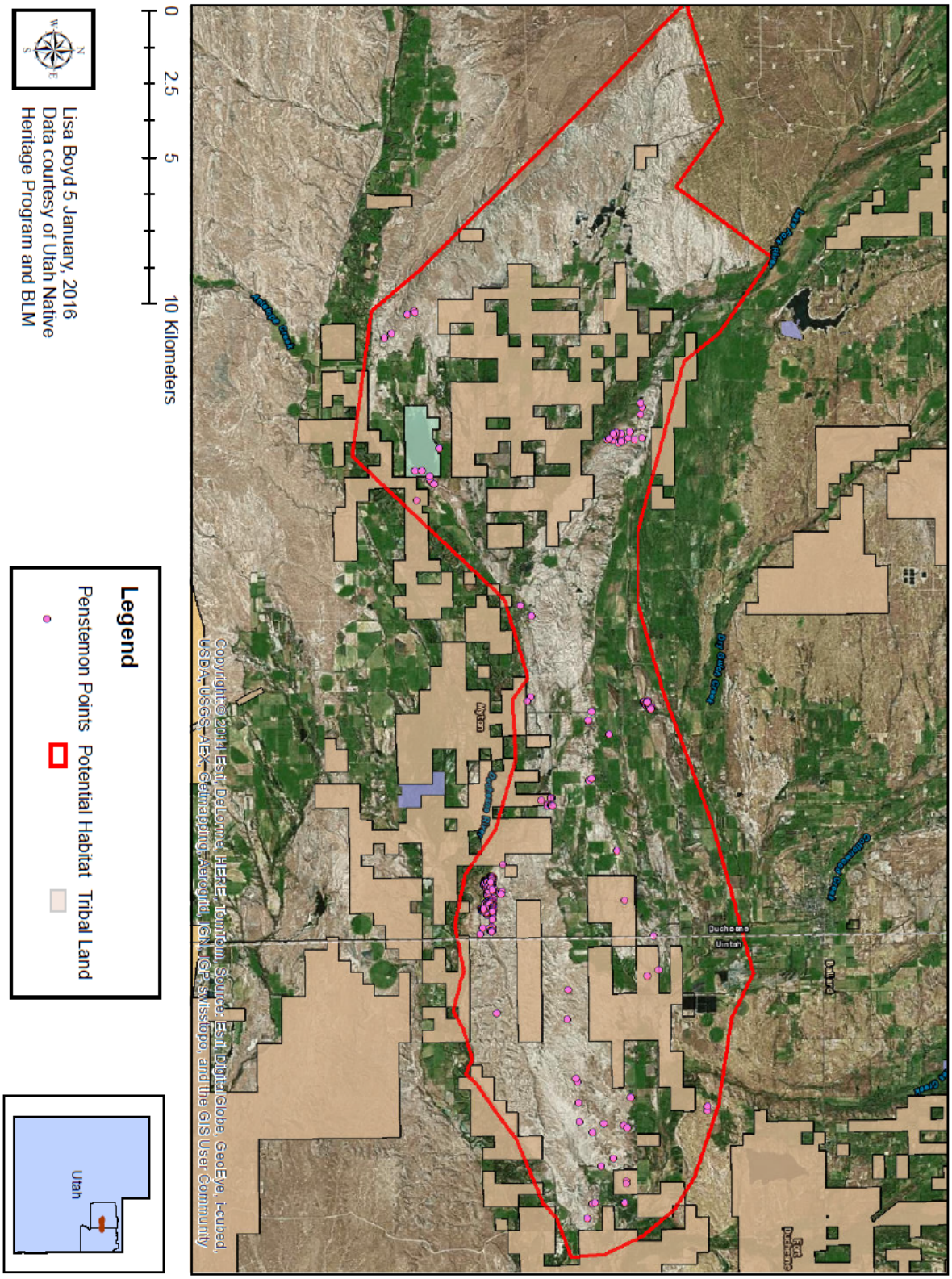
Appendix F - Formulae

Red Butte Garden Formulae for survivorship	**Abbreviation Format**
Overall annual survivorship from year t to year t+1: (# alive in year t+1) – (# new plants in year t+1) _____ (# alive in year t+1) – (# new plants in year t+1) + (# dead in t+1)	$\frac{N-R}{N-R+D}$
Seedling annual survivorship from year t to year t+1: (# seedlings alive year t+1) – (# new seedlings year t+1) _____ (# seedlings alive year t) – (# seedling MIA in year t+1)	$\frac{(V_1+F_1)-S}{S_t-D_1}$
Mature annual survivorship from year t to year t+1: (# mature alive in year t+1) – (# new plants in year t+1) _____ (# mature alive in year t+1) – (# new plants in year t+1) + (# mature dead in t+1)	$\frac{M_{(t+1)}-R}{M_{(t+1)}-R+D_{(t+1)}}$

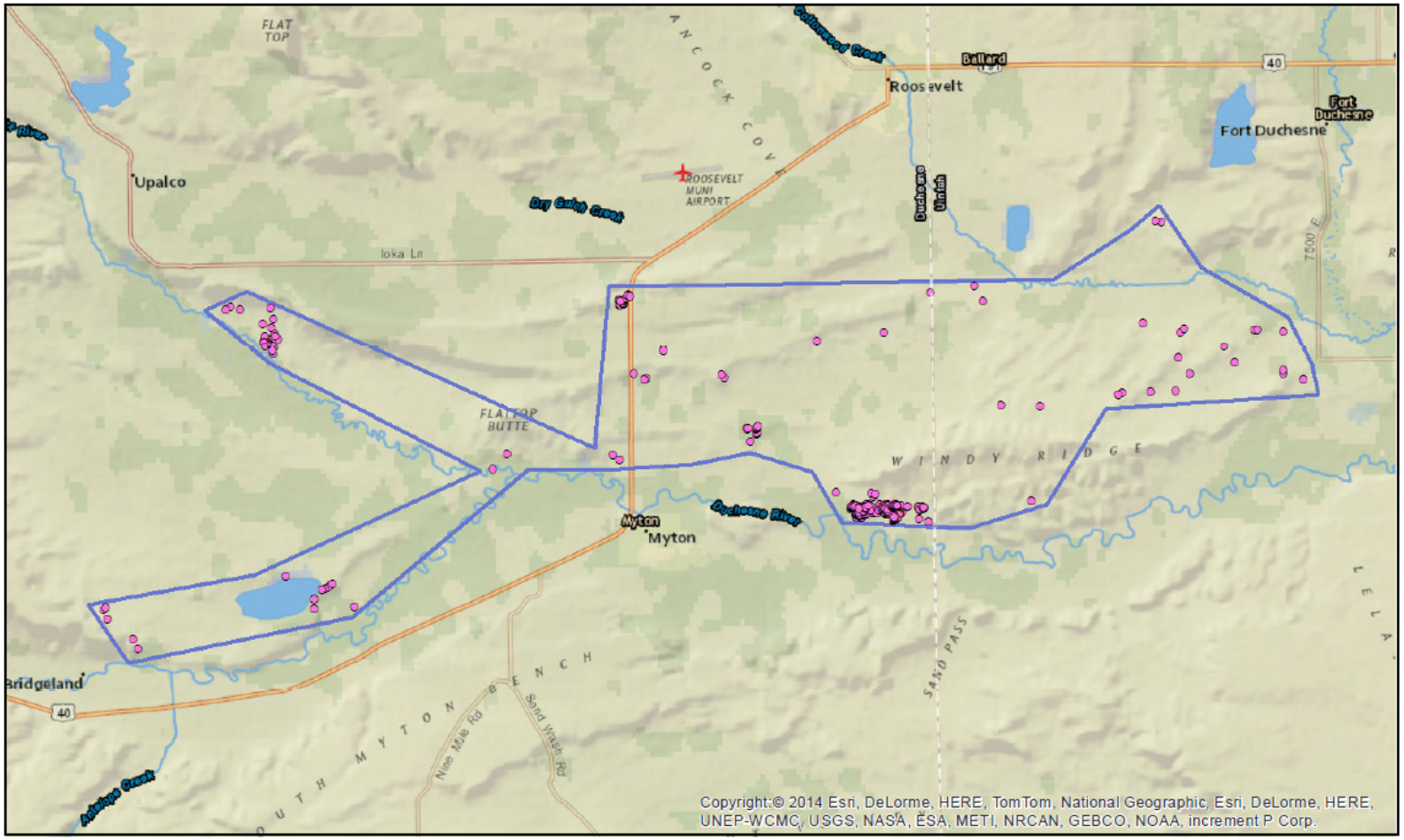
Appendix G - Associated Species

Species	Common Name	Number of Plots	% of Plots
Achnatherum hymenoides	Indian rice grass	7	20
Artemisia nova	Black sage brush	3	9
Artemisia tridentata	Big sagebrush (Basin big sagebrush)	3	9
Astragalus convallarius	Lesser rushy milkvetch	1	3
Astragalus chamaeleuce	Cicada milkvetch	1	3
Astragalus geyeri	Geyer's milkvetch	2	6
Atriplex confertifolia	Shad scale	1	3
Atriplex corrugata	Mat salt bush	2	6
Atriplex gardneri	Gardner salt bush	7	20
Bromus tectorum	Cheat grass	15	43
Chaenactis stevioides	Esteve's pincushion	1	3
Chrysothamnus greenei	Greene's rabbitbrush	2	6
Cryptantha flava	Yellow cryptanth	2	6
Cymopterus bulbosus	Bulbous springparsley	1	3
Descurainia pinnata	Western tansymustard	1	3
Ephedra torreyana	Torrey's jointfir	10	29
Eriogonum microthecum	Slender buckwheat	4	11
Gutierrezia sarothrae	Broom snakeweed	4	11
Halogeton glomeratus	Halogeton	1	3
Hilaria jamesii	Galleta grass	11	31
Ipompsis pumila	Dwarf ipomopsis	5	14
Lappula occidentalis	Western stick seed	7	20
Lepidium densiflorum	Common pepperweed	1	3
Lepidium montanum	Mountain pepperweed	2	6
Lichen	Lichen	1	3
Macaerantha canescens	Aster	2	6
Oenoethera pallida	Primrose	2	6
Opuntia polyacantha	Prickly pear cactus	2	6
Phacelia crenulata	Cleftleaf wildheliotrope	1	3
Platyschkuhria integrifolia	Basin daisy	3	9
Plantago Patagonia	Wooly plantain	9	26
Salsola tragus	Russian thistle	7	20
Sarcobatus vermiculatus	Greasewood	2	6
Sphaeralcea coccinia	Scarlet globemallow	6	17
Sphaeralcea parviflora	Scarlet globemallow	2	6
Stephanomeria runcinata	Desert wirelettuce	2	6
Sisymbrium linifolium	Tumble mustard	1	3
Stipa comata	Needle and thread grass	1	3
Tetradymia nuttalli	Nuttall's horsebrush	2	6
Townsendia incana	Townsend's incana	1	3
Unknown		1	3
Xylorhiza venusta	Charming woodyaster	1	3

Appendix H - Maps



Flowers Penstemon Range by Known Points

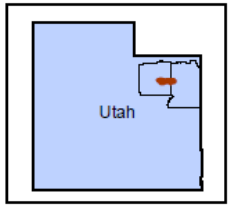


0 2 4 8 Kilometers

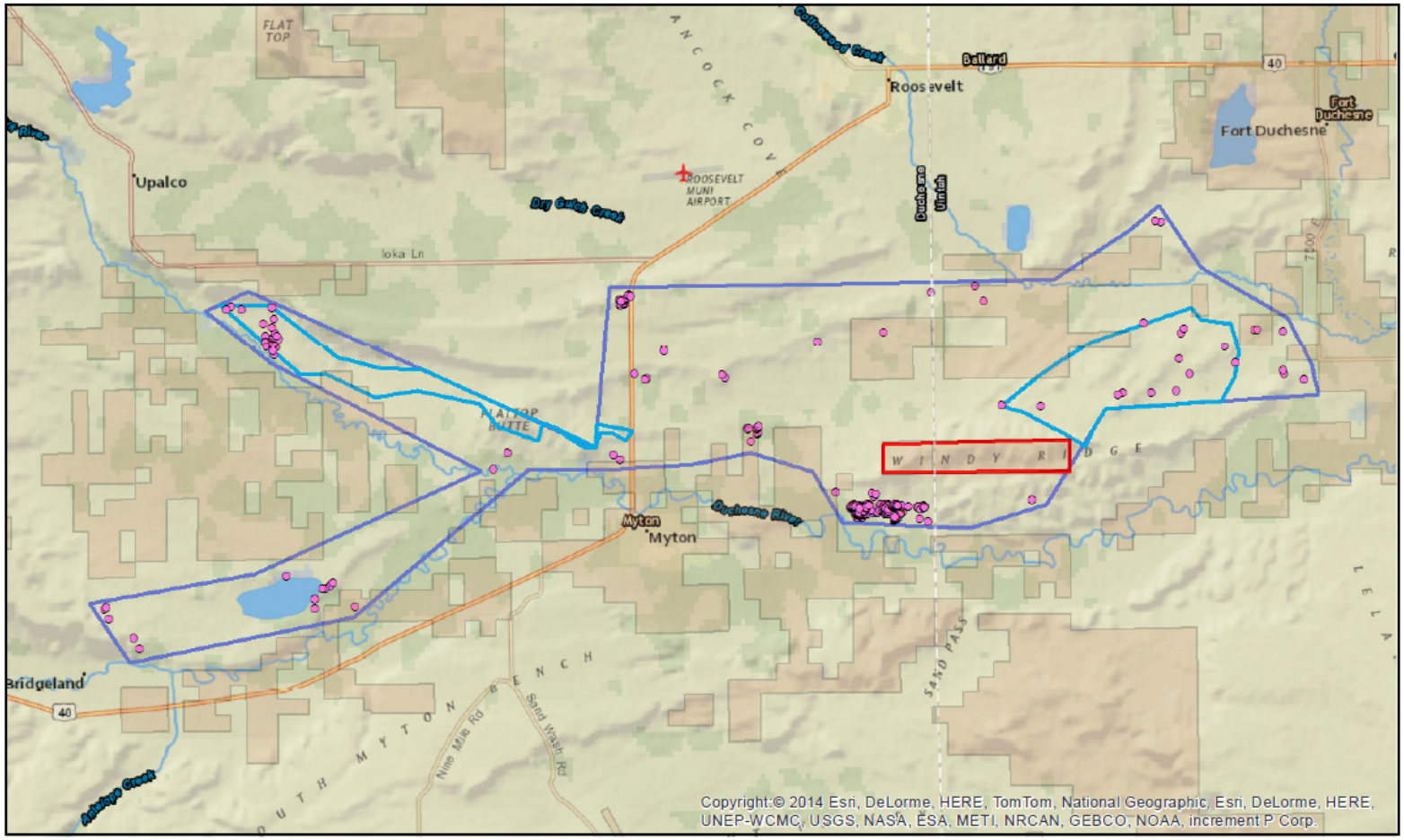
Lisa Boyd 5 January, 2016
Data courtesy of Utah Native Heritage Program and BLM

Legend

Penstemon Points Known Points Polygon



Oil and Gas Development in Flowers Penstemon Habitat



0 2.5 5 10 Kilometers

Lisa Boyd 5 January, 2016
Data courtesy of Utah Native Heritage Program and BLM

Legend

Penstemon Points

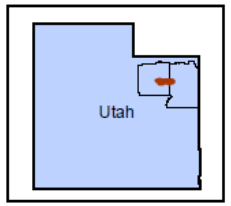
Known Points Polygon

Tribal Land

Oil & Gas Development

Permitted Wells

Well Pads Established after 2011



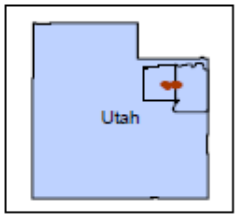
Flowers Penstemon Study Points on Collier Property

0 0.025 0.05 0.1 Kilometers

Lisa Boyd 5 January, 2016
Data courtesy of Utah Native Heritage Program and BLM

Legend

- Collier Property
- **Study Points**
  - Transect Origin/Plant
  - Transect Origin/Plant
  - Transect Termination

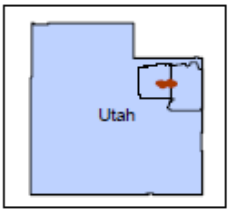


Flowers Penstemon Points on TNC - Collier Property

0 0.025 0.05 0.1 Kilometers

Lisa Boyd 5 January, 2016
Data courtesy of Utah Native Heritage Program and BLM

Legend
TNC Site
Penstemon Points



Flowers Penstemon Study Points on Dude Young Property

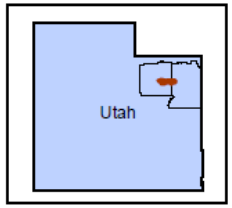
0 0.125 0.25 0.5 Kilometers

Lisa Boyd 5 January, 2016
Data courtesy of Utah Native Heritage Program and BLM

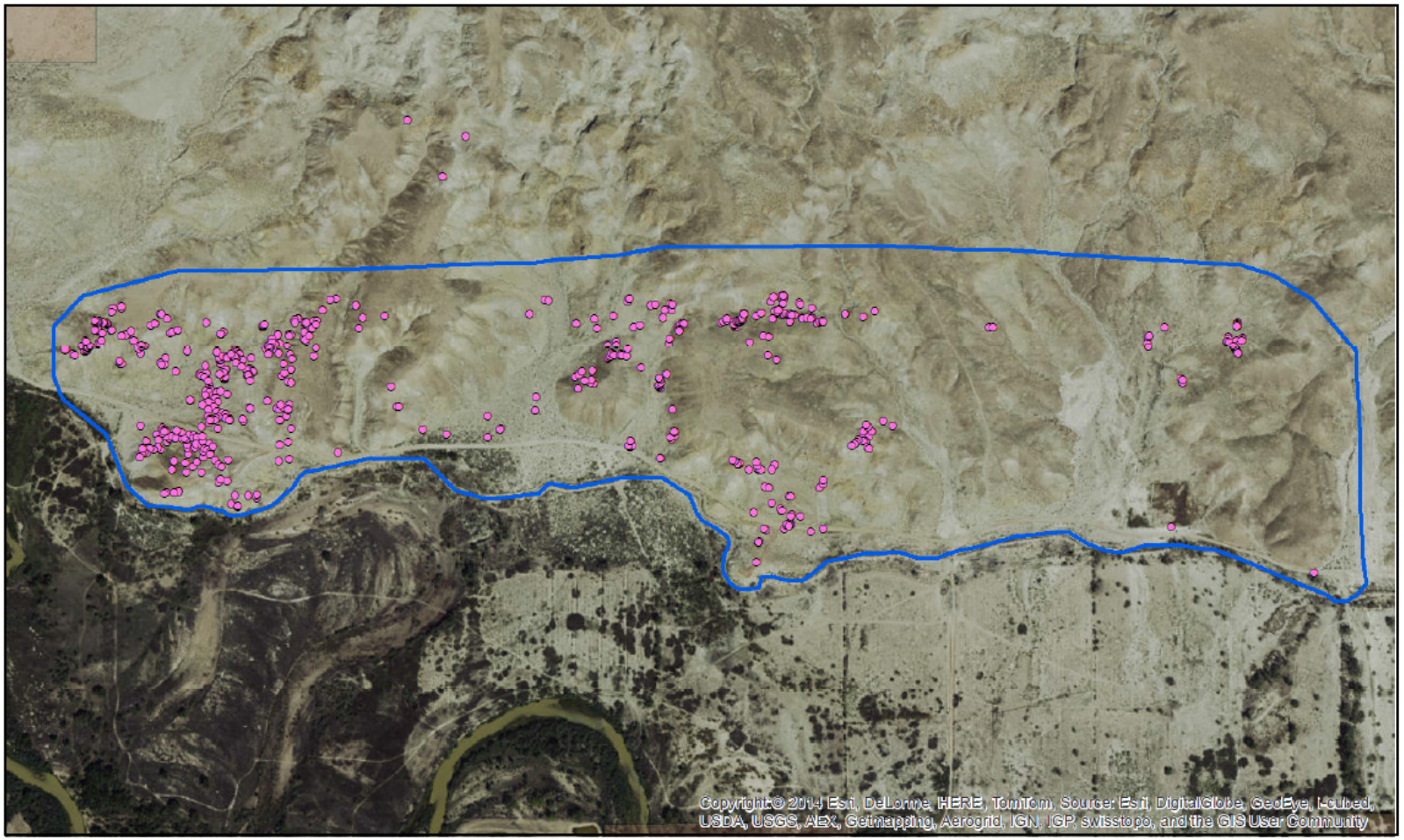
Legend

Dude Young Property

Study Points
- Transect Origin/Plant
- Transect Origin/Plant
- Transect Termination



Flowers Penstemon Point on Dude Young Property



0 0.25 0.5 1 Kilometers

Lisa Boyd 5 January, 2016
Data courtesy of Utah Native Heritage Program and BLM

Legend

Penstemon Points

Dude Young Property