

**2009 Status Report**  
**Demographic Monitoring and Pollination Biology for**  
*Penstemon scariosus* var. *albifluvis* and *Penstemon grahamii*  
in Uintah County, Utah

Prepared for:  
Ron Bolander  
Bureau of Land Management  
Utah State Office  
P.O. Box 45155  
Salt Lake City, UT 84145-0155



*Penstemon grahamii*, 2009 (A. Swanson)

Prepared by:  
Rita Dodge, Conservation Director  
Wendy Yates, Botanist  
Red Butte Garden and Arboretum  
285 Connor Rd.  
Salt Lake City, UT 84113

Photos property of Red Butte Garden; Taken by Amber Swanson and Wendy Yates.

This report summarizes ~~data analyzed and collected from~~ research conducted during 2009 on *Penstemon scariosus* var. *albifluvis* (White River Penstemon) and *Penstemon grahamii* (Graham's Penstemon). Work was conducted for the Bureau of Land Management under the Cooperative Agreement L08AC14473. ~~This research~~ has been conducted by Red Butte Garden (RBG) for six consecutive years, and ~~the~~ report includes summary data from all six years. Research was ~~done performed~~ during the peak flowering season of both species, from the middle of May through the middle of July. Research includes four studies: 1) demographic study for both species; 2) pollination study for *P. grahamii*; and 3) survey for *P. grahamii*; 4) Soil seed bank study for a *P. grahamii*.

### **Demographic Study**

A detailed description of methodology can be found in the RBG 2004 annual status report. Data collected included survivorship, number of flowering individuals, flowers per inflorescence, fruit per inflorescence, number of fruiting individuals, height of tallest inflorescence, woody base diameter, and herbivory.

### ***Penstemon scariosus* var. *albifluvis* (White River Penstemon)**

The study area included two sites, the White River site located on Bureau of Land Management property, and the Watson site located on private land. Demographic studies were established in 2004 in order to monitor populations of *P. scariosus* var. *albifluvis*. ~~A detailed description of methodology can be found in the 2004 annual report. Tagged individuals were relocated using a metal detector. Data collected was recorded, including the woody base diameter, number of flowering individuals, height of tallest inflorescence, number of flowers per inflorescence, number of fruit per inflorescence, number of fruiting individuals, and herbivory. We measured the diameter of the woody base to the nearest 0.5 cm.~~ Table 1 summarizes demographic characteristics of the White River site over the a six year monitoring period. Table 2 summarizes demographic characteristics of the Watson site for 2004, 2008, and 2009. The Watson site was not

accessible from 2005 to 2007; therefore results are not only available for ~~the first year~~ and the last ~~three~~two years of this project.

**White River Site:** —Survivorship of *P. scariosus* var. *albifluvis* for 2009 was 91.8% at the White River site. In 2007 survivorship was found to be lowest with 78.4% and the highest in 2006 with 94.6%. The White River population has shown a 31% decline overall, from 2004 to 2009. Initially 135 individuals were tagged in 2004, of those original ~~135~~ plants 70(52%) continue to thrive, while 32(23%) individuals have been reported as dead, leaving 33 (24%) not relocated; and therefore information for these individuals is unknown at this time. The number of individuals not relocated has increased over the past three years; however, ~~this year~~2009 shows the greatest increase with 34 individuals counted as missing. Tags ~~may~~ have been lost due to the unstable substrate, soil movement, and possible animal activity. ~~Some of the H~~loose tags were found down slope near the river, while others ~~may have fallen into the river. were not found and may have been removed by animals, buried, or fallen into the river.~~

This year 152 new recruitments were tagged and added to the study from both sites. This increase is significantly higher than the combined prior five years of research. This increase may be due to precipitation, and/or the natural cycle of abundant number of seeds germinating from the soil seed bank. 93.7% individuals flowered this year and 93.7% of these individuals produced fruit. The amount of fruit developed in 2008 and 2009 was much greater than results of the previous years. We randomly selected capsules from fruiting individuals our results show that there is an average of 14.4 seeds per a capsule at the White River site and 20.6 seeds at the Watson site.

#### Average

~~Inflorescence height and the average-woody caudex diameter have continually increased annually, until 2009. from year to year. However this year the~~ Average woody caudex diameter remained the same (7.5 cm) as reported in the previous year, ~~while. The~~ average inflorescence height showed a slight decrease. These results may indicate that adult individuals ~~surviving~~ have reached their maximum size or growth rate.

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~~Herbivory increased from In 2008 only only 18.6% of individuals in 2008 to showed herbivory while in 2009 42.4% of the plants were herbivorized in 2009.~~ It appears that herbivory ~~may be caused by is due to~~ both insects and animals. At the White River site insects seem to be more prevalent. ~~While~~ at the Watson site there is indication of heavy grazing by animals. ~~Specific However, the~~ animals eating the plants have not been ~~observed, and identified.~~ ~~It~~ is possible that rabbits and small rodents are ~~responsible-responsible~~ in addition to larger ungulates for herbivory. ~~This year 152 new recruitments were tagged and added to the study. This increase is significantly higher than the combined prior five years of research. This increase may be due to precipitation, and/or the natural cycle of abundant number of seeds germinating from the soil seed bank. 93.7% individuals flowered this year and 93.7% individuals produced fruit. The amount of fruit developed in 2008 and 2009 was much greater than results of the previous years. We randomly selected capsules from fruiting individuals our results show that there is an average of 14.4 seeds per a capsule at the White River site and 20.6 seeds at the Watson site.~~

**Watson site:** The Watson population originally consisted of 180 individuals; 72 (40%) of these plants have survived from 2004 to 2009. 17(9.4%) individuals were counted as dead and the remaining 91(50%) plants have been recorded as missing. ~~†~~The missing individuals at this site may be influenced by the heavy grazing observed at the Watson site. ~~It is likely that tags were lost during the three year period research was not conducted at this site, and tags were not stabilized. may also be due to the fact that researchers were not re-stabilizing tags for three consecutive years.~~ The survivor rate (including 2008 recruitments) is 91.2% and 74 new individuals have been added to the study.

Herbivory was 91% in 2009, ~~this-which~~ is much higher than the White River site. In 2009, 82% flowered and 75% of these produced fruit. Both of these results are lower percents than what was found at the White River location. The cause of this is unknown, however, the Watson location may be dealing with more environmental impacts related to energy development, which may decrease the possibility for pollinators to pollinate and increase the opportunity for herbivory.

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*Penstemon scariosus* var. *albifluvis* (A. Swanson) Yates

Researcher using metal detector to find tags (W. Yates)

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**Table 1. Summary of *P. scariosus* var. *albifluvis*, status over 6-year monitoring period at White River population.**

White River Site	2004	2005	2006	2007	2008	
Total # of Individuals Alive (includes new tags)	135	111	116	91	86	
New Individuals Tagged	135	0	10	0	0	152
# of Individuals not relocated	n/a	11	8	24	26	34
# of Individuals Dead	n/a	13	9	10	2	2
Percent Mortality	n/a	9.6	8.1	8.6	2.2	2.5
Percent Survivorship	n/a	82.2	95.6	78.4	94.5	91.8
Percent Herbivory	37	32.4	48.2	38.4	18.6	42.4
% of Individuals with Flowers	42	87.3	81.8	96.7	96.5	93.7
% of Individuals with Fruit	17	75.6	69	57	95.3	93.7
Average Fruit per Inflorescence	0.8	9.5	n/a	6.5	11.3	14.6
Average Inflorescence Height	18.1cm	25.2cm	20.0cm	28.3cm	31.6cm	28.3cm
Average Woody Caudex Diameter	4.0cm	4.0cm	4.2cm	4.7cm	7.5cm	7.5cm

**Table 2. Summary of *P. scariosus* var. *albifluvis*, status for 2004 and 2009 monitoring years at Watson population.**

Watson Site	2004	2008	2009
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Total # of Individuals Alive (includes new tags)	180	91	157
New Individuals Tagged	180	33	74
# of Individuals not relocated	n/a	104	112
# of Individuals Dead	n/a	18	2
Percent Mortality	n/a	10	2.4
Percent Survivorship	n/a	32.2	91.2
Percent Herbivory	n/a	72.5	91
% of Individuals with Flowers	25	71	82
% of Individuals with Fruit	18.8	68	75
Average Fruit per inflorescence	n/a	6.6	6.5
Average Inflorescence Height	10.5cm	19cm	20.6cm
Average Woody Caudex Diameter	3.2cm	6cm	5.7cm

Growth rates, measured by the diameter of the woody caudex, were monitored and results include 162 plants surviving between 2004 and 2009, from the White River and Watson sites combined. 56% increased in size class, ~~0~~ only 5.5% decreased to a smaller size class, and 24% remained the same size class (Table 3). The majority of plants range in size from 3.0-6.5cm diameter of woody caudex. Combined results indicate that ~~of the~~ approximately half of the plants are continuing to grow.

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**Table 3. Movement between basal size classes from 2005 to 2009 comparing *P.scariosus* populations as measured by diameter of woody caudex. Size classes: small = 0-2.5cm, medium = 3.0 -4.5cm, large = 5.0-6.5cm, xlarge=7.0cm+**

size class	White River (cm)	Watson (cm)
small to small	0	9
small to medium	2	13
small to large	5	6
small to xlarge	8	7
medium to small	0	5
medium to medium	6	6
medium to large	6	11
medium to xlarge	20	0
large to small	0	0
large to medium	1	1
large to large	1	3
large to xlarge	9	4
xlarge to small	0	0
xlarge to medium	0	0
xlarge to large	2	0
xlarge to xlarge	9	5
<b>Total increases</b>	<b>50 (72%)</b>	<b>41 (59%)</b>
<b>Total decreases</b>	<b>3 (4%)</b>	<b>6 (9%)</b>
<b>Total no change</b>	<b>16 (23%)</b>	<b>23 (33%)</b>

### ***Penstemon grahamii* (Graham's Penstemon)**

The *Penstemon grahamii* demographic study includes two sites: 1) Buck Canyon site and 2) Blue Knoll/Seep Ridge site, both located on BLM land. A detailed description

of methodology can be found in the 2004 annual report. ~~Tagged individuals were relocated using a metal detector. Data was collected and recorded for each individual.~~ Data collected included the rosette diameter, number of inflorescences, height of inflorescence, number of flowers per inflorescence, number of fruiting individuals, and herbivory. If there were more than one rosette per tag, diameters were summed for the total rosette diameter. Table 4 summarizes ~~year-to-year~~the annual demography of the Buck Canyon site, and Table 5 summarizes ~~year-to-year~~annual demography of Blue Knoll/Seep Ridge site.

Survivorship at the Buck Canyon site was the highest recorded to date at 95.8%, while mortality was the lowest at 4.2%. Herbivory was relatively high 54.2% compared to previous years recorded. This is likely due to the amount of caterpillars (Tiger Moth) found co-existing with *P. grahamii*. This year 43.1% individuals produced flowers and 40.3% individuals produced fruit. The average number of flowering stalks was 1.6 and the average number of flowers per ~~a~~ flowering stalk was 12.5. This is the highest fruit and flower production reported over the past six years. Randomly selected capsules were collected and ~~the seeds were~~ counted, with an average of 25.3 seeds ~~was per capsule~~ observed at the Buck Canyon site, while the Blue Knoll site had an average of 18.9 seeds per ~~a~~ capsule. Two additional sites were included in order to obtain an accurate result across the populations for the number of seeds per a capsule. ~~When all~~The four sites ~~were~~ averaged together produced 24.3 seeds per ~~a~~ capsule ~~were found~~.

The Blue Knoll/Seep Ridge site recoded 90.9% survivorship, while in 2007 the survivorship rate was relatively low at 47.4%. Herbivory was found to be high at 68.1%. ~~This result~~which was higher than the Buck Canyon site, and again likely related to the Tiger moth caterpillars. 24.6% individuals produced flowers and 23.2% developed fruit. The average number of flowering stalks was 1.6 and the average number of flowers per a flowering stalk was found to be 8.5. .

Data for both sites can fluctuate greatly from year to year, though trends remain similar between the two sites. As shown in Figure 1, survivorship trends follow the same patterns of increases and decreases annually, and are likely influenced by the same factors.



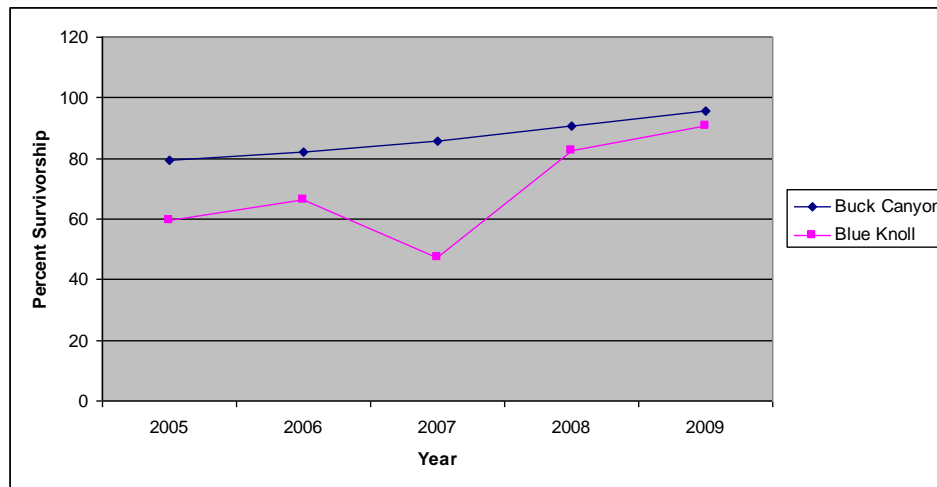
**Table 4. Summary of *P. grahamii* status over 6-year monitoring period at the Buck Canyon site.**

<b>Buck Canyon</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>
Total # of Individuals Alive (includes new tags)	77	84	77	66	72	72
New Individuals Tagged	77	23	8	0	12	0
# of Individuals not relocated	n/a	1	5	8	9	6
# of Individuals Dead	n/a	8	13	16	4	3
Percent Mortality	n/a	10.3	17.8	20.7	6	4.2
Percent Survivorship	n/a	79.2	82.1	85.7	90.9	95.8
Percent Herbivory	35	4.7	31	13.6	11	54.2
% of Individuals with Flowers	27	4.7	0	15.2	30.5	43.1
% of Individuals with Fruit	6.5	0	0	4.5	25	40.3
Average Fruit per Inflorescence	2	0	0	2.7	5.3	8.8
Average Inflorescence Height	3.7cm	2.5cm	n/a	5.6cm	6cm	8.2cm
Average Rosette Diameter	n/a	4.6cm	3.8cm	4.3cm	4.1cm	5.6cm

**Table 5. Summary of *P. grahamii* plant status over 6-year monitoring period at the Blue Knoll site.**

<b>Blue Knoll</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>
Total # of Individuals Alive (includes new tags)	69	71	59	52	66	69
New Individuals Tagged	69	30	12	24	23	6
# of Individuals not relocated	n/a	3	12	31	26	21
# of Individuals Dead	n/a	25	18	24	15	6
Percent Mortality	n/a	36.2	25.3	32.2	30.7	9.1
Percent Survivorship	n/a	59.4	66.2	47.4	82.6	90.9
Percent Herbivory	50.7	18.3	40.6	11.5	19.6	68.1
% of Individuals with Flowers	44	18	0	15	30.7	24.6
% of Individuals with Fruit	4.3	5.7	0	9.6	27.3	23.2
Average Fruit per Inflorescence	2.1	1.1	0	3.8	6.6	3.9
Average Inflorescence Height	6.1cm	2.3cm	n/a	7.9cm	6.8cm	7.7cm
Average Rosette Diameter	n/a	6.8cm	4.8cm	4.6cm	5cm	6.5cm

**Figure 1. Survivorship trends of *P. grahamii* at Buck Canyon and Blue Knoll populations.**



New recruits were not included in the size class movement analysis since two years of data is necessary for analysis. Rosette diameters were classified into four size classes. The diameter of each individual rosette was measured to the nearest 0.5cm. Diameters were summed when there was more than one rosette per an individual.

~~Individuals~~ Rosette size varied in size ranged from 0.5-12cm in basal rosette diameter.

Combined data from both sites shows that 21% of the individuals declined in plant size class from 2005 to 2009. This is an increase from 2005 to 2008 when there was only 5% declined. 48% increased size class and 31% remained the same size class. The details of movement between size classes for both sites are presented in Table 6.

**Table 6. Movement between basal size classes from 2005 to 2009 comparing *P. grahamii* populations as measured by diameter of basal rosette(s). Size classes: small = 0-2.5cm, medium = 3.0 -4.5cm, large = 5.0-6.5cm, xlarge=7.0cm+**

size class	Buck Canyon (cm)	Blue Knoll (cm)
small to small	1	0
small to medium	4	0
small to large	6	0
small to xlarge	2	2
medium to small	0	0
medium to medium	5	4
medium to large	11	0
medium to xlarge	5	0
large to small	0	0
large to medium	4	0
large to large	2	2
large to xlarge	1	3
xlarge to small	0	0
xlarge to medium	2	1
xlarge to large	7	1
xlarge to xlarge	4	4
<b>Total increases</b>	<b>29 (54%)</b>	<b>5 (29%)</b>
<b>Total decreases</b>	<b>13 (24%)</b>	<b>2 (12%)</b>
<b>Total no change</b>	<b>12 (22%)</b>	<b>10 (59%)</b>

### Pollination Study

The breeding system study conducted on *P. grahamii* was a mesh wire cage study. The study focused on determining the pollination biology of *P. grahamii*. In this study we used three pollination treatments which included autogamy, geitogamy, and xenogamy, with vector pollination as a control group. Each flower was marked with a marker to identify the three treatments and the control group. Autogamy treatment was done by selecting a flower that was almost ready to open but still unable to accept

pollinators. Xenogamy treatment was done by choosing two plants that were approximately 10 ft. apart. A cotton swab~~bp~~ was used to ~~extract~~collect pollen from one flower and deposit it on the target flower. Geitogamy treatment was conducted by randomly selecting two flowers from the same plant using a cotton swab to transfer pollen from one flower to the other. After the pollen was transferred a ~~mesh bag and wire cage~~ covered with a mesh bag was placed over the entire flowering stalk of all individuals included in the study. In order to include a control group in this study, individuals with more than one flowering stalk were selected, leaving one flowering stalk outside of the cage for open pollination. Plants included in the study with only one flowering stalk were completely covered with the mesh cage and neighboring plants were used as the control group.

This study included 61 individuals from ~~one~~4 study site, located south west of Blue Knoll. Xenogamy treatment resulted in the highest amount of developed fruit with 91% of the flowers producing fruit. Geitogamy treatment produced 64%, and the autogamy treatment produced the least with 22% developed fruit. Table ~~7~~6 summarizes the number of plants producing fruits and the treatment used. A (Y) under each treatment indicates that fruit was produced. An (N) indicates no fruit produced and (M) indicates missing flowers. We had several missing due to the amount of caterpillars (Tiger Moth) occupying individuals. Caterpillars were able enter some of the cages; this resulted in a number of unidentified treatments.

Open pollination had 39 ~~of 61~~ missing flowers of the original 61. Because open pollination was completely exposed many of the plants were affected by herbivory before fruit could develop. The overall fruit production was 34%, however, -of the 22 remaining individuals counted in the study resulted in 95% developed fruit. Open pollination appears to be the most favorable method has the highest success rate for developing fruit, when flowers are not eaten. These results identify herbivory as one of major challenges for successful reproduction of this species. These results are consistent ~~with the pollination treatments which follow the pattern~~those of the previous year (2008). ~~The most favorable was first xenogamy, second geitonogamy, and last auogamy~~



Caged plant for pollination study (A. Swanson)

plants in the study with mesh bags (A. Swanson)

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**Table 67. The Mesh Wire Cage Study: The number of developed fruit capsules produced per pollination treatment.**

Sample	Autogamy	Xenogamy	Geitongamy	Open pollination
1	M	M	M	M
2	N	Y	N	M
3	M	M	M	M
4	M	Y	Y	M
5	N	M	M	Y
6	M	Y	N	Y
7	M	M	M	M
8	N	Y	Y	Y
9	Y	Y	Y	Y
10	M	Y	M	M
11	N	M	M	M
12	N	Y	Y	M
13	N	M	N	M
14	Y	Y	Y	N
15	Y	Y	Y	Y
16	N	Y	Y	M
17	M	M	M	M
18	N	Y	Y	Y
19	M	M	M	M
20	Y	Y	Y	M
21	N	Y	N	Y
22	N	M	M	Y
23	M	Y	Y	M
24	M	M	M	M
25	M	Y	Y	Y
26	N	Y	Y	M

27	N	Y	N	Y
28	Y	Y	N	M
29	M	M	N	M
30	M	Y	N	M
31	M	Y	M	M
32	M	N	M	Y
33	M	Y	M	Y
34	N	Y	Y	M
35	Y	Y	Y	M
36	M	Y	Y	Y
37	N	Y	Y	M
38	N	Y	Y	Y
39	N	N	N	Y
40	N	Y	M	M
41	N	Y	N	Y
42	N	Y	N	M
43	N	M	N	M
44	M	M	M	M
45	M	Y	Y	M
46	M	M	M	M
47	N	Y	N	M
48	Y	Y	Y	Y
49	M	M	Y	M
50	N	Y	N	M
51	Y	N	Y	M
52	N	Y	Y	M
53	N	Y	M	Y
54	N	N	N	M
55	M	Y	Y	M
56	M	M	M	M
57	N	Y	Y	Y
58	M	M	M	Y
59	N	Y	Y	Y
60	N	Y	Y	M
61	N	Y	Y	M
<b>TOTAL</b>	<b>8(22%)</b>	<b>40(91%)</b>	<b>27(64%)</b>	<b>21(95%)</b>

### Survey for *Penstemon grahamii*

Surveys for *P. grahamii* were conducted by visiting possible habitat. Areas to be surveyed were selected by the BLM, U S Fish Wildlife ~~Sservice,~~ and the Utah State Heritage Program, and Red Butte Garden. Researchers stood approximately 10 ft. apart and walked in parallel lines while a handheld GPS devices ~~wasere~~ used to mark locations

of ~~individual the survey area and plants population areas~~. All GPS data was recorded as standard UTM coordinates using datum NAD 83. When a plant of interest was found, the area was surveyed in detail and the data recorded on data sheets. Plants were recorded as either flowering or non-flowering rosettes. Appendix A includes maps of the area surveyed and appendix B includes a list of all *P. grahamii* locations and the number of individuals found at each location. A total of 981 flowering individuals were recorded and 3,815 non-flowering rosettes were recorded. Maps of the areas surveyed are found in Appendix ~~B~~A. ~~In Appendix B, the number associated with each GPS point (red dot) on the map represents the number of individuals found at that location, not the location number.~~



▲ Researchers surveying for *P. grahamii* (A. Swanson)

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### Soil Seed Bank Study

The study ~~focused was conducted~~ on three study sites, located at the Buck Canyon and Blue Knoll monitoring sites. ~~with the~~ ~~The third site was site~~ located, south west of Blue Knoll where a dense population of *P. grahamii* exists. The community type of all three study sites is pinyon juniper and the soil is oil shale from the ~~g~~Green River formation. Disturbances ~~from such as~~ oil development, grazing, and herbivory were observed at each site.

Methodology for the soil seed bank study was based on the methods developed by Susan Meyer from her extensive soil seed bank research (Dr. Susan Meyer personal communication, May 2009). Soil samples were collected from each of the three research sites, during June of, 2009. ~~This soil seed bank study follows the same methods conducted by Susan Meyer, from her continuous soil seed bank research. Soil samples were collected~~ before this year's seeds could be dispersed into the soil seed bank. This was done to ensure ~~that the representation results represent what is found in a persistent seed bank rather than a transient seed bank of the soil seed bank was accurately consistent with the year to year soil seed bank.~~ At each site, 300 randomly selected soil samples were collected along a 100 meter transect, with a 5 meter buffer along each side. ~~line and 5m line to the right and/or 5m line to the left of the 100m line.~~ The left side of the line represented -1, -2, -3, -4, and -5. The right side of the line represented 1, 2, 3, 4, and 5. Collection coordinates were determined using a random number table. If coordinates were not suitable (i.e. on top of a rock or *P. grahamii* individual plant) then ~~????????soil~~ was collected from the closest available spot (i. e. adjacent to the rock or plant). ~~Each sample was assigned two numbers; the first number was between 1 and 100 this number was identified along the 100m line. The second number assigned was positive or negative 1-5. Soil samples were collected at the location of the two numbers. Random samples were generated by using excel random generator program.~~ All soil samples were collected at a depth of 4cm and a ~~width diameter of (Size ????)~~ 6.5cm by placing a small tin can and pressing the open end of the can into the soil, while placing a masonry small shovel trowel over the open end to remove the soil. The soil obtained was placed in a paper bags for drying and storage. Soil samples are currently being evaluated and stored at Red Butte Garden.

Soil samples ~~will are be~~ hand sorted, separating *P. grahamii* seeds from the soil. To ensure correct identification of the seeds, known pods seeds from fruiting plants collected by Red Butte Garden ~~will be have been~~ carefully observed. Seeds are black, 3-4mm in length and have a distinct twist. These characteristics will facilitate identification and extraction from soil samples. The process for evaluating the soil is; 1) sift through coarse strainer, 2) sift through 4mm strainer; 3) examine remaining soil, rock, and organic matter by hand, 4) run water over remaining soil inside the strainer and float

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seeds and organic matter to the surface; 5) dry samples individually, re-examine, and return to original paper bag.

Seeds collected from the soil seed bank study will be tested for viability via standard Petri dish germination testing, followed by ~~To determine viability, petri dish germination methods in conjunction with the standard~~ tetrazolium test will be used (Sawma and Mohler 2002). In order to stimulate germination, seeds will first be scarified by using a razor blade to break the seed coat. Seeds will be placed in petri dishes ~~between on top of two pieces of~~ blotter paper and dampened with distilled water. Seeds will be transported to a germination chamber ~~where~~ set to a 21/15°C and 14/10 hour day/night cycle. ~~a constant temperature of ??? will be held~~ After ~~a few weeks~~ 30 days germinated seeds will be counted as viable and the remaining seeds will be cut laterally exposing the embryo and peeling away the seed coat. Embryos will be marked with 1% tetrazolium solution. The seeds that turn pink or red will test positive and will be counted as viable. The results of seed density and seed viability will be available not later than ~~in~~ the 2010 status report.

## Discussion

In the past ~~T~~ there has been some concern regarding recruitment events observed for *P. scariousus* var. *albifluvis*. From 2004 to 2008 only 10 new individuals were recorded at the White River site, ~~h~~ However, this year there were 152 recruitments at White River site and 74 recruitments at the Watson site. The reason for this increase is undetermined but, may be due to precipitation, increased viability of 2008 seeds, ~~and or~~ a natural cycle of seeds ~~seeds~~ breaking dormancy and germinating from the soil seed bank. This cycle may occur every few years and, as research continues it will be interesting to report the next outburst of seedlings ~~see when another recruitment burst will occur~~. This recruitment event will be ideal for determining ~~Due to the increase of new individuals we will be able to measure~~ the seedling mortality rate of *P. scariousus* var. *albifluvis* in 2010.

A high percentage rate of fruit and seed production has continued to occur over time. This production which suggests that *P. scariosus* var. *albifluvis* would have has a rich soil seed bank. ; However, a study to determine seed density and viability on this species has not-yet been conducted.

Unlike previous years, the majority of herbivory occurring on *P. grahamii* was caused by a caterpillar (Tiger Moth). Samples of the Tiger Moth were collected in the field and later they were sent to and identified by the University of Utah insect lab. Caterpillars appeared to be aggressive, damaging the flowering and fruiting parts of the plant. In many cases the caterpillars devoured the entire flowering stems, leaving the rosette untouched. The cause of this caterpillar outbreak is undetermined, but it directly may negatively affects the production of seeds and number entering the soil seed bank. Although caterpillars were a major problem there appeared to be other insects and mammals contributing to herbivory. In previous years small rodents have been noted as those likely to have grazed on the plants. Herbivory on *P. scariosus* var. *albifluvis* continues to be affected by insects at the White River site and mammalian at the Watson site.

*-P. grahamii* experienced its most productive year over the duration of the study with the highest recorded rates for flowering and fruiting. The increase in flowering and fruiting could be due to the increased precipitation received during winter and spring, coupled with a slow spring and suitable growing temperatures throughout the season.

For *P. grahamii*, the Buck Canyon site has had consistently lower mortality rates and higher survivorship than the Blue Knoll/Seep Ridge site. This may be due to a slightly harsher and less protected environment at the Blue Knoll site. However, both sites exhibit the same trend in population survivorship over the past 5 years (Fig. 1), indicating that environmental factors effecting both sites are impacting the overall population success.

Two years of the pollination study has shown the vector pollination was the most successful at producing fruit, followed in order by xenogamy, geitogamy, and autogamy. These results indicate the importance of maintaining large enough populations to maintain genetic integrity through out-crossing and prevent in-breeding depression.

Fluctuations within a population are unpredictable from year to year. During the six years of this study there has been only one good recruitment year for *P. scariosus* var. *albifluvis*, no major recruitment years for *P. grahamii*, and only two years with enough flowering plants of *P. grahamii* for a breeding system study. These six years of data resulting from this study only represents a short-term trend in the population demography of these two species. Continued long-term monitoring study and research will assist in obtaining accurate long-term trends for these species. In order to better understand these populations dynamics; we suggest continued study of these species which will provide valuable information for the successful management of *Penstemon scariosus* var. *albifluvis* and *Penstemon grahamii*.

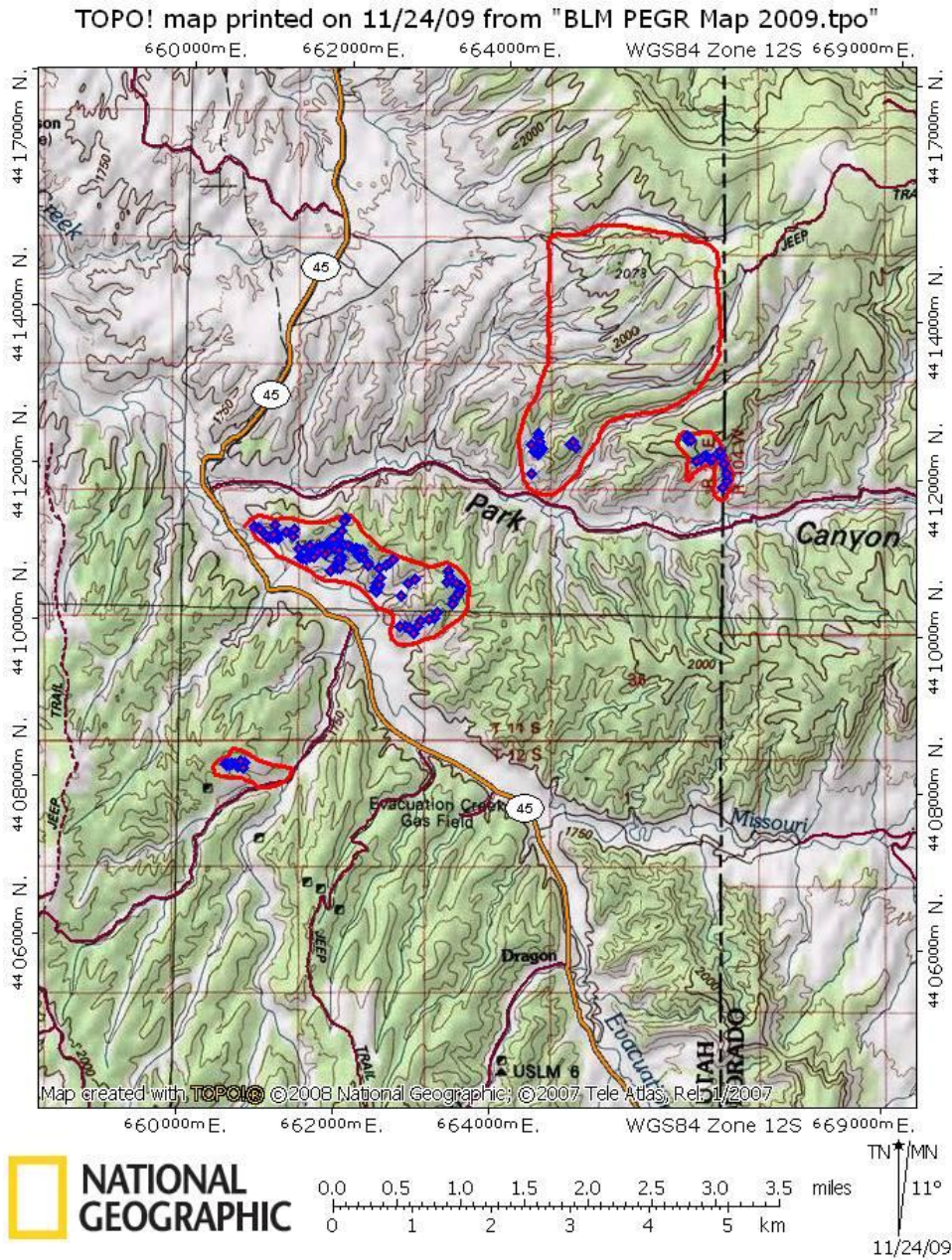
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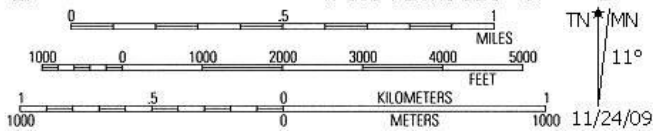
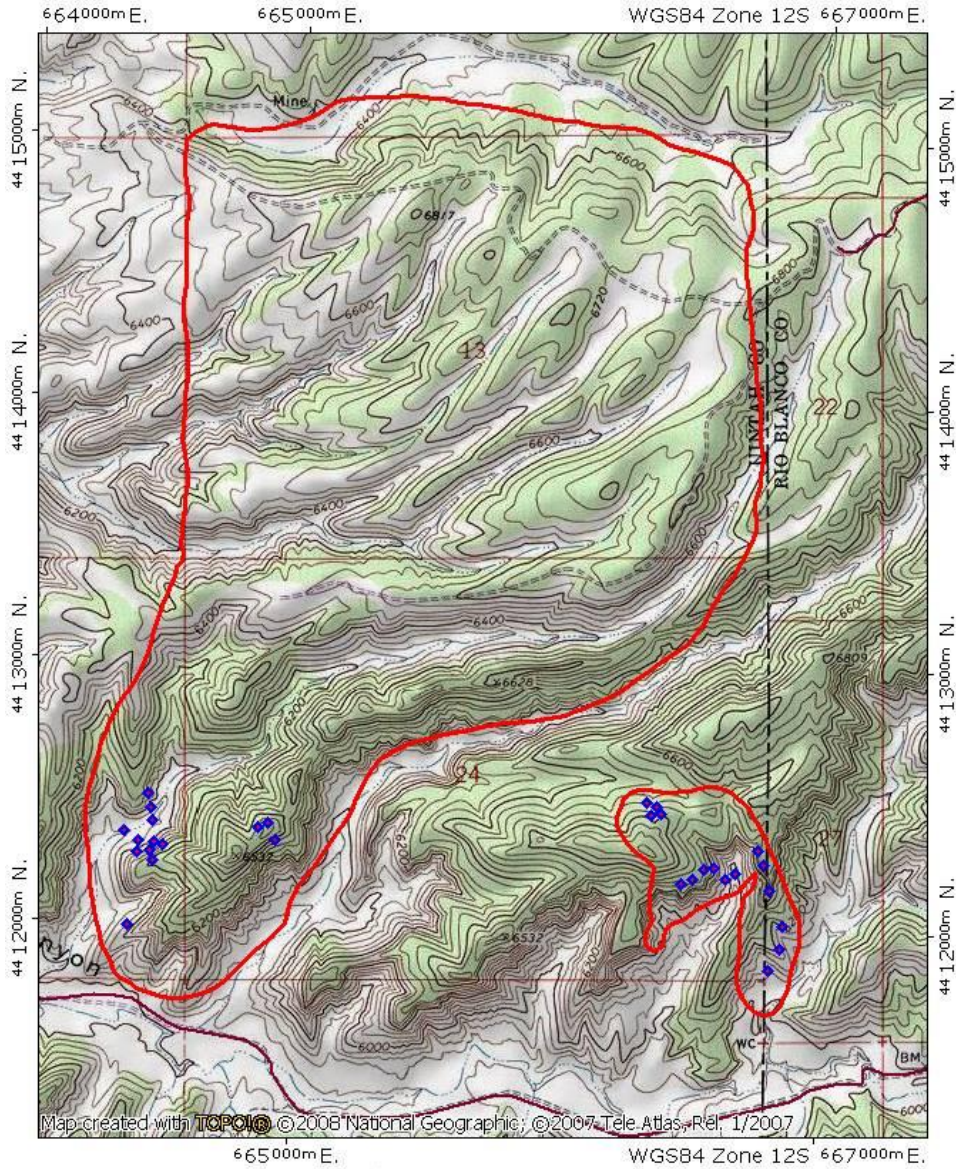
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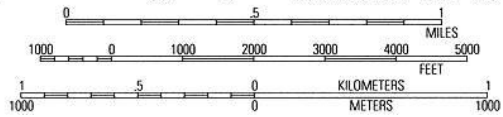
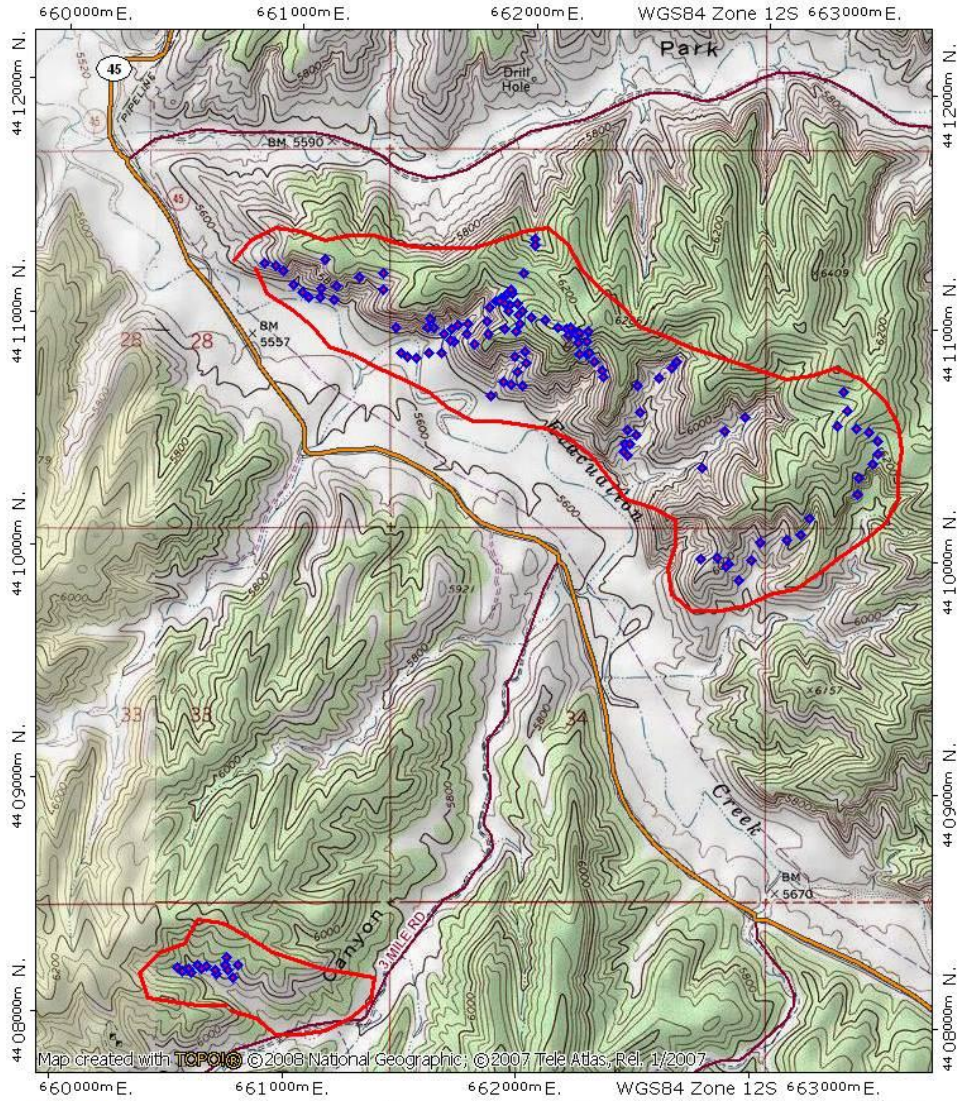
**Appendix A:** Maps of areas surveyed for *Penstemon* *grahamii*. Red lines indicate the survey boundary and blue points are GPS point locations.



TOPO! map printed on 11/24/09 from "BLM PEGR Map 2009.tpo"



TOPO! map printed on 11/24/09 from "BLM PEGR Map 2009.tpo"



TN MN  
11°  
11/24/09

**Appendix B:** UTM dData points for *Penstemon grahamii* survey.

Number	Date	UTM Data Point	# rosettes	# flowering
1	6/3/2009	12 660850 E 4411227 N	19	1
2	6/3/2009	12 660903 E 4411217 N	65	18
3	6/3/2009	12 660935 E 4411195 N	27	9
4	6/3/2009	12 660981 E 4411133 N	44	15
5	6/3/2009	12 661019 E 4411106 N	123	38
6	6/3/2009	12 661046 E 4411084 N	107	72
7	6/3/2009	12 661093 E 4411084 N	85	25
8	6/3/2009	12 661152 E 4411072 N	49	15
9	6/3/2009	12 661162 E 4411132 N	17	3
10	6/3/2009	12 661097 E 4411123 N	17	7
11	6/23/2009	12 664443 E 4412483 N	68	21
12	6/23/2009	12 664456 E 4412429 N	31	17
13	6/23/2009	12 664463 E 4412380 N	13	3
14	6/23/2009	12 664504 E 4412288 N	12	3
15	6/23/2009	12 664472 E 4412302 N	20	5
16	6/23/2009	12 664464 E 4412230 N	14	2
17	6/23/2009	12 664457 E 4412269 N	5	1
18	6/23/2009	12 664409 E 4412259 N	11	0
18	6/23/2009	12 664409 E 4412305 N	3	0
20	6/23/2009	12 664357 E 4412340 N	15	3
21	6/24/2009	12 661980 E 4410819 N	6	1
22	6/24/2009	12 661977 E 4410870 N	13	1
23	6/24/2009	12 661952 E 4410985 N	43	22
24	6/24/2009	12 661864 E 4411081 N	29	30
25	6/24/2009	12 661811 E 4410994 N	2	0
26	6/24/2009	12 661727 E 4410937 N	7	0
27	6/24/2009	12 661653 E 4410913 N	15	5
28	6/24/2009	12 661530 E 4410864 N	8	3
29	6/24/2009	12 661581 E 4410961 N	4	0
30	6/24/2009	12 661568 E 4411003 N	3	0
31	6/24/2009	12 661672 E 4410903 N	11	1
32	6/24/2009	12 661760 E 4410899 N	23	6
33	6/24/2009	12 661819 E 4410943 N	14	3
34	6/24/2009	12 661888 E 4410963 N	23	10
35	6/24/2009	12 661937 E 4410956 N	46	18
36	6/24/2009	12 661934 E 4410845 N	34	22
37	6/24/2009	12 661944 E 4410781 N	26	15
38	6/24/2009	12 661889 E 4410735 N	27	15
39	6/24/2009	12 661836 E 4410677 N	18	10
40	6/24/2009	12 661918 E 4410726 N	18	11
41	6/24/2009	12 661968 E 4410722 N	19	9
42	6/24/2009	12 661421 E 4410959 N	18	5
43	6/24/2009	12 661445 E 4410852 N	26	8
44	6/24/2009	12 661474 E 4410834 N	52	12
45	6/24/2009	12 661512 E 4410832 N	25	13
46	6/24/2009	12 661566 E 4410855 N	4	1

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Number	Date	UTM Data Point	# rosettes	# flowering
43	6/24/2009	12 661445 E 4410852 N	26	8
44	6/24/2009	12 661474 E 4410834 N	52	12
45	6/24/2009	12 661512 E 4410832 N	25	13
46	6/24/2009	12 661566 E 4410855 N	4	1
47	6/24/2009	12 661621 E 4410854 N	12	7
48	7/11/2009	12 664373 E 4411982 N	11	5
49	7/11/2009	12 664862 E 4412362 N	6	3
50	7/11/2009	12 664932 E 4412317 N	15	4
51	7/11/2009	12 664902 E 4412383 N	44	12
52	7/15/2009	12 661362 E 4411194 N	51	11
53	7/15/2009	12 661114 E 4411245 N	24	1
54	7/15/2009	12 661262 E 4411173 N	6	2
55	7/15/2009	12 661361 E 4411120 N	12	0
56	7/15/2009	12 661625 E 4410937 N	28	1
57	7/15/2009	12 661661 E 4410962 N	46	7
58	7/15/2009	12 661688 E 4410978 N	37	9
59	7/15/2009	12 661728 E 4410985 N	12	2
60	7/15/2009	12 661819 E 4411057 N	42	2
61	7/15/2009	12 661849 E 4411083 N	7	0
62	7/15/2009	12 661866 E 4411097 N	27	4
63	7/15/2009	12 661895 E 4411118 N	25	11
64	7/15/2009	12 661910 E 4411130 N	15	3
65	7/15/2009	12 661914 E 4411117 N	15	11
66	7/15/2009	12 661940 E 4411072 N	3	0
67	7/15/2009	12 661960 E 4411042 N	3	1
68	7/15/2009	12 661908 E 4411067 N	14	9
69	7/15/2009	12 661884 E 4411071 N	46	6
70	7/15/2009	12 661903 E 4411039 N	16	12
71	7/15/2009	12 661946 E 4411023 N	15	2
72	7/15/2009	12 662000 E 4411014 N	31	6
73	7/15/2009	12 662060 E 4411008 N	26	10
74	7/15/2009	12 662116 E 4410975 N	3	10
75	7/15/2009	12 662160 E 4410942 N	28	6
76	7/15/2009	12 662202 E 4410911 N	17	8
77	7/15/2009	12 662211 E 4410862 N	22	0
78	7/15/2009	12 662242 E 4410865 N	12	7
79	7/15/2009	12 662190 E 4410948 N	19	9
80	7/15/2009	12 662150 E 4410971 N	3	3
81	7/15/2009	12 662171 E 4410977 N	10	10
82	7/15/2009	12 662206 E 4410953 N	17	4
83	7/15/2009	12 662242 E 4410917 N	28	2
84	7/15/2009	12 662250 E 4410867 N	50	13
85	7/15/2009	12 662274 E 4410831 N	1	2
86	7/15/2009	12 662307 E 4410796 N	1	1
87	7/17/2009	12 666815 E 4411857 N	12	8
88	7/17/2009	12 666858 E 4411938 N	13	2
89	7/17/2009	12 666865 E 4412028 N	7	1

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Number	Date	UTM Data Point	# rosettes	# flowering
90	7/21/2009	12 662011 E 4411352 N	38	14
91	7/21/2009	12 662007 E 4411327 N	23	12
92	7/21/2009	12 661964 E 4411204 N	27	19
93	7/21/2009	12 661913 E 4411134 N	6	4
94	7/21/2009	12 662314 E 4410769 N	19	3
95	7/21/2009	12 662461 E 4410733 N	36	15
96	7/21/2009	12 662424 E 4410544 N	1	2
97	7/21/2009	12 662410 E 4410484 N	10	9
98	7/21/2009	12 662406 E 4410447 N	26	11
99	7/21/2009	12 662422 E 4410431 N	13	5
100	7/21/2009	12 662436 E 4410483 N	28	8
101	7/21/2009	12 662458 E 4410518 N	8	3
102	7/21/2009	12 662473 E 4410616 N	17	1
103	7/21/2009	12 662552 E 4410766 N	15	2
104	7/21/2009	12 662604 E 4410812 N	38	9
104	7/21/2009	12 662629 E 4410840 N	53	5
105	7/21/2009	12 662922 E 4410607 N	4	2
106	7/21/2009	12 662837 E 4410545 N	22	0
107	7/21/2009	12 662246 E 4410963 N	62	18
108	7/21/2009	12 662743 E 4410384 N	44	15
109	7/21/2009	12 663342 E 4410722 N	11	0
110	7/21/2009	12 663362 E 4410642 N	7	3
111	7/21/2009	12 663319 E 4410577 N	29	4
112	7/21/2009	12 663400 E 4410567 N	30	6
113	7/21/2009	12 663456 E 4410554 N	28	21
114	7/21/2009	12 663496 E 4410515 N	49	20
115	7/21/2009	12 663495 E 4410460 N	11	0
116	7/21/2009	12 663477 E 4410416 N	10	0
117	7/21/2009	12 663416 E 4410354 N	18	8
118	7/21/2009	12 663411 E 4410288 N	62	19
119	7/21/2009	12 663210 E 4410176 N	73	15
120	7/21/2009	12 663176 E 4410107 N	17	0
121	7/21/2009	12 663114 E 4410085 N	4	3
122	7/21/2009	12 663001 E 4410072 N	7	4
123	7/21/2009	12 662963 E 4409994 N	12	4
124	7/21/2009	12 662866 E 4409974 N	15	6
125	7/21/2009	12 662816 E 4410003 N	13	9
126	7/21/2009	12 662745 E 4409993 N	0	4
127	7/21/2009	12 662856 E 4409964 N	0	35
128	7/21/2009	12 662912 E 4409908 N	12	5
129	7/22/2009	12 666382 E 4412473 N	73	15
130	7/22/2009	12 666343 E 4412485 N	1	1
131	7/22/2009	12 666358 E 4412441 N	71	7
132	7/22/2009	12 666397 E 4412447 N	26	8
133	7/22/2009	12 666601 E 4412246 N	60	9
134	7/22/2009	12 666563 E 4412239 N	43	21
135	7/22/2009	12 666523 E 4412198 N	78	31

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Number	Date	UTM Data Point	# rosettes	# flowering
136	7/22/2009	12 666479 E 4412180 N	5	1
137	7/22/2009	12 666647 E 4412199 N	12	3
138	7/22/2009	12 666682 E 4412221 N	26	8
139	10/16/2009	12 660563 E 4408179 N	24	17
140	10/16/2009	12 660542 E 4408195 N	46	9
141	10/16/2009	12 660593 E 4408192 N	64	18
142	10/16/2009	12 660627 E 4408206 N	20	2
143	10/16/2009	12 660667 E 4408201 N	25	2
144	10/16/2009	12 660706 E 4408189 N	43	13
1145	10/16/2009	12 660748 E 4408210 N	31	14
146	10/16/2009	12 660802 E 4408214 N	6	2
147	10/16/2009	12 660750 E 4408245 N	1	1
148	10/16/2009	12 660781 E 4408156 N	30	6
149	10/16/2009	12 660761 E 4408188 N	28	7
150	10/16/2009	12 660712 E 4408173 N	15	3
151	10/16/2009	12 660644 E 4408193 N	26	9
152	10/16/2009	12 660602 E 4408177 N	33	12

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