A FIFTH YEAR OF MONITORING CHRIST'S INDIAN PAINTBRUSH (*CASTILLEJA CHRISTII*) ON THE SAWTOOTH NATIONAL FOREST: 2002 RESULTS

by

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April 2003

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Challenge Cost-Share Agreement No. 00-CS-11041401-022

ABSTRACT

The global distribution of Christ's Indian paintbrush (*Castilleja christii*) is restricted to a single population on Mount Harrison at the north end of the Albion Mountains, in Cassia County, Idaho, on land administered by the Sawtooth National Forest. This species is currently a federal candidate for listing as Threatened or Endangered. A population and habitat monitoring program was initiated for *Castilleja christii* in 1995. The monitoring transects were resampled in 1996, 1997, 2000, and again in 2002. This report summarizes the 2002 results and makes comparisons to results from previous years. In 2002, the total number of *Castilleja christii* plants tallied at the 20 original transects was lower than any of the previous four monitoring years. This was largely due to a decline in *Castilleja christii* abundance at several of the snowbed community transects. Five years of population monitoring reveals that the annual abundance of *Castilleja christii* is dynamic, and large fluctuations in plant density do occur. The total reproductive stem tally was much lower than previous years. The lack of obvious disturbances, pathogens/disease, or largescale herbivory leads me to suspect dry conditions played a leading role in the low 2002 reproductive output. Overall, plant community habitat data collected in 2002 was similar to 2000 results, which in turn, were similar to the 1995 baseline. Pocket gopher activity was the most common ground disturbance at every transect. Unknown or native ungulate prints and frost heaving action were other relatively common disturbances. No transects had prints that could be positively attributed to cattle, and none had evidence of motor vehicle-related disturbance. Two weed species, *Bromus inermis* (smooth brome) and *Taraxacum officinale* (common dandelion), were encountered at low cover along several transects. Two new transects were established in 2002 in areas potentially vulnerable to recreation-based disturbances. Monitoring for the separate Electronic Line Habitat Recovery transect indicates re-vegetation continues to progress along the 1996 trench line dug through a portion of the *Castilleja christii* population. 2002 was the first year the trench pathway was difficult to visually discern in some sections.

ACKNOWLEDGEMENT

I want to thank Kim Pierson, Deb Taylor, and Dena Santini with the Sawtooth National Forest, and Jenae Dixon with the Idaho Conservation Data Center, for their cheerful assistance sampling the *Castilleja christii* transects in 2002. Their help allowed monitoring to be conducted in an efficient, accurate, and enjoyable manner. I also want to acknowledge the U.S. Fish and Wildlife Service's Snake River Basin Field Office for providing funding for this project.

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INTRODUCTION

Christ's Indian paintbrush (*Castilleja christii*) is currently a candidate for listing as Threatened or Endangered under the Endangered Species Act (U.S. Fish and Wildlife Service 2002). It is one of Idaho's rarest plant species, consisting of a single population that covers approximately 200 acres on Mount Harrison, the highest peak at the northern end of the Albion Mountains, south of Burley, in Cassia County. This population is located entirely on public land managed by the Burley Ranger District, Sawtooth National Forest (NF). Detailed information concerning the distribution, abundance, habitat, and conservation status of *Castilleja christii* has been outlined previously (Moseley 1993).

Due to its rarity and the numerous disturbances that take place on the summit plateau of Mount Harrison, a Conservation Agreement for *Castilleja christii* was signed between the Sawtooth NF and the U.S. Fish and Wildlife Service (USFWS) specifying several conservation actions to protect the species and its habitat (U.S. Fish and Wildlife Service 1995). One of the agreed upon actions in the original Conservation Agreement was for the Sawtooth NF to establish a monitoring program for *Castilleja christii*, especially in regards to recreation-related impacts atop Mount Harrison. Under contract from the Sawtooth NF, the Idaho Department of Fish and Game's Conservation Data Center (IDCDC) established and implemented a monitoring program for *Castilleja christii* in 1995 (Moseley 1996). The monitoring transects were resampled in 1996 (Moseley 1997), 1997 (Moseley 1998), and 2000 (Mancuso 2001). They were sampled again during the summer of 2002 with funding provided by the USFWS. This report summarizes the 2002 monitoring results.

My primary objectives in 2002 were: (1) to collect population monitoring data at the 20 transects originally established in 1995; (2) to resample the habitat plots and re-take photo point photographs associated with each transect; (3) to establish additional transects in portions of the population previously not monitored, but potentially vulnerable to recreation-based disturbances; (4) to design and implement an addition to the protocol allowing disturbance factors to be monitored; and (5) to resample the separate Electronic Line Habitat Recovery transect originally established in 1996.

METHODS

The original protocol has three main components: population monitoring, habitat monitoring, and photo points. Moseley (1996) provides a detailed discussion regarding transect establishment, as well as the methods for each component of the monitoring protocol. This earlier report also has maps and directions to the transects and their associated reference monuments. A fourth component was added to the protocol in 2002, to monitor disturbance factors. Twenty permanently marked monitoring transects were established throughout the *Castilleja christii* population in 1995. Two new transects were established in 2002, bringing the total number of monitoring stations to 22. A brief review of the methodology is presented here.

Population monitoring

The monitoring transects are 20 meters long, with the beginning and end points marked by a rebar stake protruding from the ground. Having the transects "permanently" marked helps ensure they are accurately re-established each monitoring year. The transects are distributed in each of the three habitats supporting *Castilleja christii*: graminoid, snowbed, and mountain

big sagebrush/Idaho fescue (*Artemisia tridentata vaseyana/Festuca idahoensis*). Eight rock or rock outcrop monuments are used as reference points to help relocate the transects. One of the outcrop monuments is new for 2002.

The transects are divided into 20 one-meter-square "stations" or microplots, forming what is essentially a continuous one-meter-wide belt transect. The number of *Castilleja christii* plants and the number of reproductive stems for each plant are recorded at each microplot. These two attributes are used as measures of above-ground abundance and reproductive output. The 2002 dataset represents the fifth year this population attribute information was collected for *Castilleja christii*.

Habitat monitoring

Plant community information is used to document and monitor changes and trends in *Castilleja christii* habitat. It is also used to assess habitat condition. This information is collected in 10 x 10 m macroplots established along each transect using the beginning stake as one of the plot corners. Plant community monitoring is based on changes in composition and/or ocular estimates of cover class values for all vascular plant species occurring in the macroplot (Bourgeron et al. 1992). Cover class estimates are also made for several ground cover categories, including bare soil, rock, wood, litter, moss/lichen, and basal vegetation. Changes in the species list or their associated cover values from one sampling period to the next are used to assess changes in the plant community. The sampling method has an acceptable accuracy standard of +/- one cover class. An increase or decrease of two or more cover classes is indicative of a measurable change. The 12 cover classes and their associated values used in the protocol include:

1 = <1%	30 = 25 – 34.9%	70 = 65 – 74.9%
3 = 1 – 4.9%	40 = 35 – 44.9%	80 = 75 – 84.9%
10 = 5 – 14.9%	50 = 45 – 54.9%	90 = 85 – 94.9%
20 = 15 – 24.9%	60 = 55 – 64.9%	98 = 95 – 100%

Baseline species composition and cover class values were reported in 1995 (Moseley 1996). Plant community information was collected again in 2000 (Mancuso 2001) to meet the habitat monitoring protocol recommendation that macroplots be resampled every five years. A decision was made to resample the plant community macroplots again in 2002 for habitat monitoring purposes.

Photo points

Photo point photographs provide a visual record of the vegetation and other habitat conditions at each monitoring transect. Repeat photo monitoring is useful to document site-specific change or lack of change to landscape features of interest (Hall 2001). Over time, photographs may be useful to document events and impacts related to wildfire, weed invasion, livestock use, recreational use, or other disturbances. They may also serve to document successional changes, and to corroborate information collected for the plant community component of the monitoring protocol. Photos taken in 1995, or 2002 for the two new monitoring transects, serve as the baseline to compare and evaluate future photographs.

Two photographs were originally taken at each transect in 1995. One photo looks down the transect belt, while the other provides an overview of the plant community plot area. Repeat photographs were taken in 2000 to meet the monitoring protocol recommendation that photos be retaken every five years (Mancuso 2001). In 2002, transect and plant community photographs were taken for transects 21 and 22. The photos for these newly established transects are in Appendix 1. Repeat photos were not taken for the other transects. An original set of the 2002 photographs are archived at the IDCDC office in Boise.

Disturbance factor monitoring

The collection of disturbance factor information was added to the monitoring protocol in 2002. Disturbance factor information is collected for each of the 20 microplots comprising the population monitoring transect and recorded on separate data sheets designed for the protocol. Information is collected for motor vehicle, cattle, pocket gopher, or unknown ground disturbing activities, as well as for weed species.

1) Motor vehicle disturbance – the type of vehicle tracks (e.g., motorcycle) and its associated cover class value is recorded for each microplot. Cover class is an estimated measure of how much (what percentage) of the microplot surface is disturbed. The five cover classes used for all portions of the disturbance factor protocol are: 0 = 0; 1 = <1%; 2 = 1-10%; 3 = 11-25%; 4 = 26-50%; and 5 = >50%.
2) Cattle disturbance – the number of cattle prints and cow pies within each microplot are counted and recorded. Only prints that can be definitely assigned to cattle are recorded here. Notes on whether the disturbance is fresh (current year/season) or old should also be recorded.
3) Weed disturbance – the name of the weed species and its associated cover class value are recorded for each microplot. Multiple weed species/microplot are possible.
4) Pocket gopher disturbance – a cover class estimate is made for the amount of microplot surface affected by pocket gopher activity. Notes on whether the disturbance is fresh or old should also be recorded.
5) Unknown/other disturbance – ground disturbances of unknown, unclear, or other sources are recorded in this field. Examples would include disturbances from an identified source (e.g., deer prints; frost heaving) or unidentified source (deer prints?). A cover class estimate is made for each microplot.

Electronic line habitat recovery monitoring

In 1995, a new cable line was buried by Raft River Electric to service several electronic sites on Mount Harrison. In 1996, a permanent transect was established to monitor recovery of the vegetation along a segment of cable route that passed through occupied and potentially suitable *Castilleja christii* habitat. The 325 m long transect is sampled at 25 m intervals using a 1 m^2 plot frame placed directly over the middle of the two-meter-wide trench path marking the cable route. Cover class values are then estimated for all vascular plant species in the 13 microplots along the transect. Baseline data were collected in 1996 (Moseley 1997). The transect was resampled in 1997 (Moseley 1998), 2000 (Mancuso 2001), and again in 2002. Photographs of each sample station along the transect were not taken in 2002.

New transects

Two new monitoring transects were established in 2002. They were subjectively located in portions of the population known or suspected to be vulnerable to motor vehicle or recreational disturbances. Transect establishment followed the same protocol as used in 1995 (Moseley 1996). Transect information, including transect azimuth, sampling information, directions, and monument location, is in Appendix 2. Map locations and GPS coordinates for the two sites are also in this appendix.

RESULTS

Population monitoring

Castilleja christii monitoring results for 1995, 1996, 1997, and 2000 have been discussed in previous reports (Moseley 1996; 1997; 1998; Mancuso 2001). Results for this report are based on comparison of the 2002 dataset against population information collected these four previous years. *Castilleja christii* abundance and density information for the five monitoring years is summarized in Table 1. Table 2 summarizes reproductive stem data during this period. Table 3 compares 2002 population data to averages from the previous four monitoring years. Copies of the 2002 population monitoring field data sheets are in Appendix 3. Appendix 4 contains the five year plant and stem datasets for each transect in a Microsoft Excel spreadsheet format. *Castilleja christii* plant and reproductive stem abundance results for 2002 are summarized below.

Plant abundance/density

- The total number of *Castilleja christii* plants tallied in 2002 was lower than any previous year. Although a total of 1,918 plants were recorded for all 22 transects, only 1739 were tallied along the original 20 transects (1-20) having four prior years of comparative data. The 1,739 plant tally was 30 fewer than recorded in 1995; 377 fewer than 1996; 659 fewer than 1997; and 406 fewer than 2000.

- Six transects had fewer plants in 2002 than any of the four previous monitoring years. No transects had more plants in 2002 compared to any other year.

- Ten transects had more plants, and ten had fewer plants in 2002, compared to the previous four year average. In 2002, plant abundance along transects ranged from a high of 175% of this average (transect 2), to a low of 32% of average (transect 14).

- In 2002, the number of plants tallied for the group of seven transects located in the mountain sagebrush community type was 115% of the 1995-2000 average. In contrast, the group of eight snowbed community type transects had only 68% of this average. The group of five graminoid community type transects tallied 95% of this average in 2002. The relatively low total for 2002 was largely due to a decline in *Castilleja christii* abundance at several of the snowbed community transects.

- The number of *Castilleja christii* plants tallied in 2002 was within 25% of the previous four year average for 13 (65%) of the 20 monitoring transects. The snowbed community type had the most transects more than 25% below this four year average. Only two transects had counts greater than 25% of the four year average.

- On average, *Castilleja christii* had its highest density at transects within the graminoid community type, followed by the snowbed, and then the mountain sagebrush types. This pattern has been consistent over the five monitoring years, as shown in Figure 1.

Reproductive stem data

- The *Castilleja christii* 2002 total reproductive stem tally was much lower than any of the previous four monitoring years. A total of 1,620 reproductive stems were recorded for all 22 transects. A subtotal of 1,381 reproductive stems were tallied for the 20 transects with four years of comparative information. For these transects, reproductive stem production was 85% less than in 1995; 88% less than in 1996; 91% less than in 1997; and 54% less than in 2000. Correspondingly, the average number of reproductive stems/plant in 2002 was lower compared to each of the previous years.

- Fifteen transects had fewer reproductive stems in 2002 than any of the other four monitoring years. Thirteen of these transects had less than half as many stems as in 2000, when the lowest number of stems was recorded at all transects prior to 2002.

- The average number of reproductive stems/plant has been highest in the snowbed and lowest in the mountain sagebrush community types each of the five monitoring years. Figure 2 shows the average number of reproductive stems/plant for each transect by community type and year.

- In 2002, 1,039 (54%) of all plants recorded did not have reproductive stems. Most of these plants were represented by a vegetative cluster of basal leaves. Plants with stems, but no (aborted) flower/fruit production were also counted as non-reproductive. Plants without reproductive stems represented the majority of plants at 14 (64%) of the 22 transects. Only five (23%) transects averaged more than one reproductive stem/plant, and all averaged less than two stems/plant. Only 90 plants (5%) had more than three reproductive stems, and of these, only 20 (1%) had five or more. By comparison, plants averaged 5 or more reproductive stems/plant in the first three monitoring years.

- The number of plants/transect that were vegetative varied from a low of 35% (transect 15) to a high of 83% (transect 9). Figure 3 shows the percentage of plants without reproductive stems by transect and community type for 2002. The community with the highest percentage of non-reproductive plants was the mountain sagebrush type with 67%, followed by the graminoid type at 56%, and the snowbed type with 50%. This pattern was demonstrated in 2000 as well.

Table 1. Five years of plant abundance and density data for *Castilleja christii* by community type.

Transect	**Total # plants**						**Plant density # plants /m^2 (+/- 1 s.d.)**				
	1995	**1996**	**1997**	**2000**	**2002**		**1995**	**1996**	**1997**	**2000**	**2002**
Graminoid community											
1	122	130	168	212	186		6.1 (5.1)	6.5 (6.0)	8.4 (6.4)	10.6 (6.7)	9.3 (5.7)
6	175	193	196	140	184		8.7 (5.0)	9.7 (5.6)	9.8 (5.3)	7 (6.2)	9.2 (7.6)
13	179	206	251	260	259		9.2 (6.5)	10.3 (7.1)	12.5 (7.0)	13 (4.8)	13.0 (4.0)
17	78	88	86	110	77		3.9 (3.1)	4.4 (3.6)	4.3 (3.3)	5.5 (3.1)	3.9 (2.2)
18	192	181	218	127	75		9.6 (6.9)	9.1 (7.9)	10.9 (10.1)	6.4 (4.6)	3.8 (3.3)
Average	149	159	184	170	156		7.5	8.0	9.2	8.5	7.8
Snowbed community											
4	66	88	129	98	52		3.2 (4.4)	4.5 (6.6)	6.4 (8.0)	4.9 (4.1)	2.6 (2.5)
5	36	53	69	116	108		1.8 (1.5)	2.8 (2.1)	3.5 (2.3)	5.8 (4.4)	5.4 (5.0)
7	145	165	190	206	192		7.2 (3.8)	8.3 (3.9)	9.5 (4.3)	10.3 (7.3)	9.6 (9.9)
12	46	55	108	69	46		2.3 (3.1)	2.7 (2.4)	5.4 (5.7)	3.5 (2.7)	2.3 (1.8)
14	148	178	182	109	49		7.4 (6.4)	8.9 (8.3)	9.4 (6.7)	5.5 (2.8)	2.5 (1.8)
15	223	384	317	181	97		11.1 (4.7)	19.2 (9.7)	15.1 (7.1)	9.1 (5.1)	4.9 (3.3)
16	43	27	40	41	36		1.9 (2.5)	1.4 (2.1)	2.0 (2.4)	2.1 (1.7)	1.8 (2.1)
20	174	220	246	232	164		8.6 (8.2)	11.0 (7.3)	12.3 (8.5)	11.6 (5.6)	8.2 (6.4)
21	-	-	-	-	60		-	-	-	-	3.0 (2.6)
22	-	-	-	-	119		-	-	-	-	6.0 (4.7)
Average	110	146	160	132	92		5.4	7.4	8.0	6.6	4.6
Mountain sagebrush community											
2	23	21	23	61	56		1.1 (2.2)	1.1 (2.4)	1.2 (2.2)	3.1 (4.5)	2.8 (4.3)
3	26	36	38	35	34		1.3 (1.6)	1.8 (2.5)	1.9 (3.0)	1.8 (1.8)	1.7 (1.7)
8	14	21	43	58	36		0.6 (0.9)	1.1 (1.4)	2.2 (3.4)	2.9 (2.9)	1.8 (2.1)
9	49	39	55	24	46		2.5 (4.4)	2.0 (4.2)	2.8 (4.3)	1.2 (1.9)	2.3 (4.2)
10	10	7	11	12	8		0.5 (1.1)	0.4 (0.8)	0.6 (1.2)	0.6 (1.4)	0.4 (0.9)
11	8	11	15	33	13		0.4 (0.7)	0.6 (1.1)	0.5 (1.3)	1.7 (2.9)	0.7 (1.4)
19	12	13	13	21	18		0.6 (1.3)	0.7 (0.9)	0.7 (1.3)	1.1 (1.6)	0.9 (1.3)
Average	20	21	28	35	30		1.0	1.1	1.4	1.8	1.5
Sum	1769	2116	2398	2145	1918						
Average	88	106	120	107	87		4.4	5.3	6	5.4	4.4

Table 2. Five years of reproductive stem data for *Castilleja christii* by community type.

Transect	**Total # Stems**						**Average # Stems/Plant (+/- 1 s.d.)**				
	1995	**1996**	**1997**	**2000**	**2002**		**1995**	**1996**	**1997**	**2000**	**2002**
Graminoid community											
1	630	728	982	127	117		5.2 (3.4)	5.7 (2.8)	5.8 (1.7)	0.6 (0.4)	0.6(0.5)
6	916	1194	1067	104	133		5.3 (1.4)	6.2 (1.7)	5.8 (1.5)	0.7 (0.4)	0.7 (0.7)
13	1013	1076	1847	586	285		6.0 (1.9)	5.2 (1.3)	7.4 (2.2)	2.3 (1.3)	1.1 (0.4)
17	360	479	472	53	61		4.6 (1.4)	5.4 (2.0)	5.4 (1.7)	0.5 (0.5)	0.8 (2.1)
18	920	853	1284	87	26		4.8 (1.4)	4.8 (1.1)	5.9 (1.7)	0.7 (0.5)	0.3 (0.7)
Average	768	866	1130	191	124		5.2	5.5	6.1	1.0	0.7
Snowbed community											
4	264	432	963	161	60		4.1 (1.7)	4.8 (2.0)	7.5 (4.1)	1.6 (1.2)	1.2 (0.6)
5	152	291	505	171	81		4.0 (1.3)	5.3 (2.1)	7.3 (2.9)	1.5 (0.9)	0.8 (0.8)
7	918	1091	1352	482	133		6.4 (2.2)	6.6 (2.2)	7.1 (2.4)	2.3 (1.1)	0.7 (0.4)
12	223	233	613	88	43		4.8 (1.6)	4.3 (2.0)	5.8 (2.6)	1.3 (0.9)	0.9 (1.1)
14	791	945	1220	92	41		5.4 (1.7)	5.3 (1.7)	6.7 (1.3)	0.8 (0.5)	0.8 (0.7)
15	1050	2120	2440	351	136		4.7 (1.3)	5.5 (1.3)	7.7 (1.9)	1.9 (1.0)	1.4 (0.6)
16	262	218	268	94	30		6.9 (6.7)	8.1 (3.7)	6.7 (1.7)	2.3 (2.1)	0.8 (0.6)
20	791	1419	1835	451	137		4.5 (1.3)	6.5 (2.6	7.5 (2.1)	1.9 (0.7)	0.8 (0.4)
21	-	-	-	-	60		-	-	-	-	1.0 (1.0)
22	-	-	-	-	179		-	-	-	-	1.5 (2.1)
Average	556	844	1150	236	90		5.1	5.8	7.0	1.7	1.0
Mountain sagebrush community											
2	112	112	152	33	18		5.5 (2.3)	5.3 (2.5)	6.6 (2.7)	0.5 (0.4)	0.3 (0.6)
3	151	221	223	24	24		5.8 (2.0)	6.1 (2.5)	5.9 (2.2)	0.7 (0.9)	0.7 (0.4)
8	57	86	169	10	27		4.5 (1.3)	4.1 (1.6)	3.6 (1.6)	0.2 (0.3)	0.8 (0.5)
9	165	142	144	5	9		3.4 (0.9)	3.6 (0.8)	2.6 (0.9)	0.2 (0.3)	0.2 (0.4)
10	30	30	36	13	4		3.0 (1.6)	4.3 (1.0)	3.3 (2.4)	1.1 (1.1)	0.5 (0.5)
11	52	52	111	22	7		6.5 (3.6)	4.7 (1.9)	7.4 (5.0)	0.7 (1.8)	0.5 (0.5)
19	60	91	66	20	9		4.7 (6.8)	7.0 (2.6)	5.1 (0.9	1 (0.5)	0.5 (0.5)
Average	90	105	129	18	14		4.8	5.0	4.9	0.6	0.5
Sum	8917	11813	15749	2974	1620						
Average	446	591	787	149	74		5	5.6	6.6	1.4	0.8

Table 3. Comparison of 2002 *Castilleja christii* plant and reproductive stem abundance to the 1995 - 2000 average.

Transect	**Avg. # plants 1995-2000**	**# plants 2002 (% of 1995-2000 avg.**	**Avg. # repro. stems 1995-2000**	**# repro. stems 2002 (% of 1995-2000 avg.)**
Graminoid community				
1	158	189 (120)	617	117 (19)
6	176	184 (105)	820	133 (16)
13	224	259 (115)	1131	285 (25)
17	91	77 (85)	341	61 (18)
18	180	75 (42)	786	26 (3)
Average	166	157 (95)	739	124 (17)
Snowbed community				
4	95	52 (55)	455	60 (13)
5	69	108 (157)	280	81 (29)
7	177	192 (108)	961	133 (14)
12	70	46 (66)	289	43 (15)
14	154	49 (32)	762	41 (5)
15	276	97 (35)	1490	136 (9)
16	38	36 (95)	211	30 (14)
20	218	164 (75)	1124	137 (12)
Average	137	93 (68)	697	85 (12)
Mountain sagebrush community				
2	32	56 (175)	102	18 (17)
3	34	34 (100)	155	24 (15)
8	34	36 (106)	81	27 (33)
9	42	46 (110)	114	9 (8)
10	10	8 (80)	27	4 (15)
11	17	13 (76)	59	7 (12)
19	15	18 (120)	59	9 (15)
Average	26	30 (115)	85	14 (16)

Figure 1.
Average plant density for *Castilleja christii* by community type (plants/sq.m.)

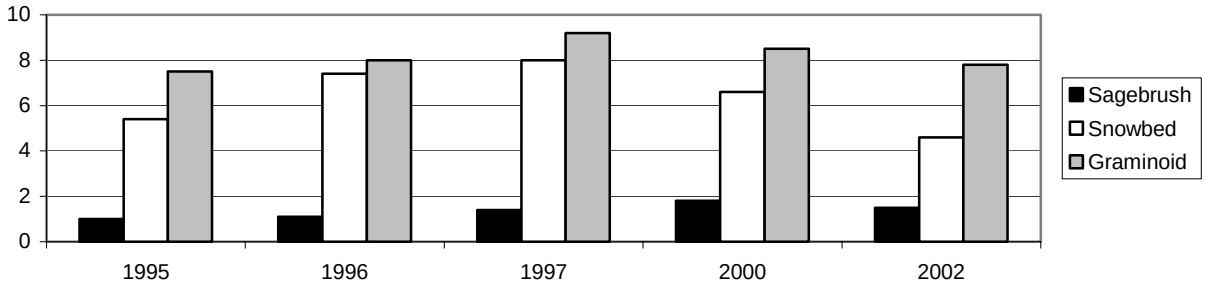


Figure 2.
Average number of *Castilleja christii* stems/plant by community type

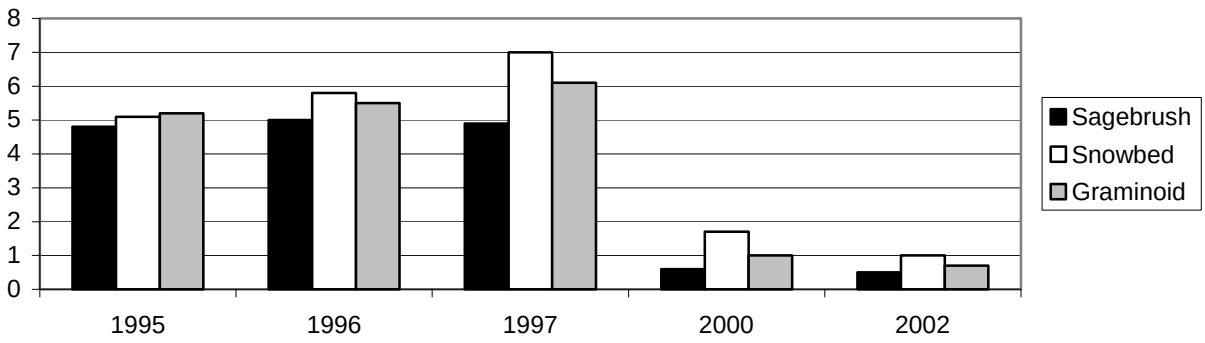
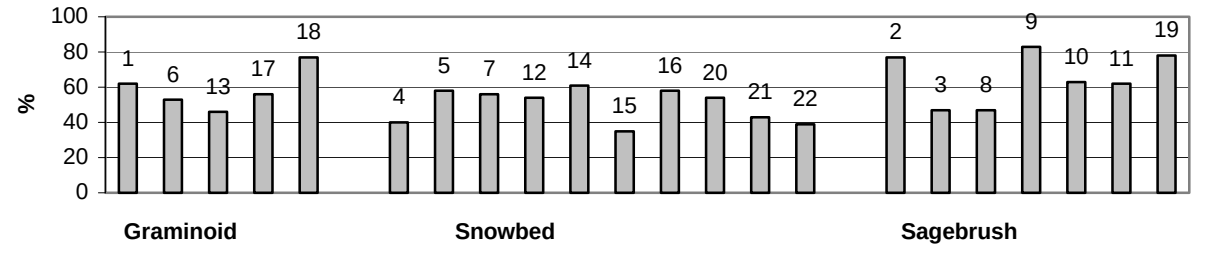


Figure 3.
% of *Castilleja christii plants* without reproductive stems in 2002
(1-22 = transect number)



Habitat monitoring

The monitoring protocol recommends plant community sampling be conducted every five years. Although plant community information was collected in 2000, plots were resampled in 2002 to help interpret future, long-term habitat monitoring results. Comparing results separated by only two years, may provide insight into the short-term natural range of variability concerning composition and cover attributes within *Castilleja christii* habitat. A Microsoft Excel spreadsheet in Appendix 5 contains plant community information collected at each transect in 1995, 2000, and 2002. Plot information is grouped by plant community type and includes composition, cover class, and constancy attributes. Copies of the 2002 plant community field data sheets are in Appendix 6.

Based on subsequent sampling values that have consistently been at least 20% lower, it is my judgment that some vegetation plot cover class estimates were too high when originally made in 1995. I suspect the following two cover value estimation errors were consistently made in 1995: (1) Cumulative graminoid life form cover values were estimated to be at least 20% too high for the graminoid community type transects. Most of the overestimation was made for *Festuca idahoensis* cover; and (2) Cumulative forb life form cover values were estimated to be at least 20% too high at all of the snowbed community type transects. Most of the overestimation was made for the one or two most common forbs in the plot. Interpretation of habitat monitoring results for 2002 reflect this re-evaluation of the 1995 results. Table 4 lists the total shrub, graminoid, and forb cover class values for the three year habitat monitoring dataset.

Overall, plant community data collected in 2002 was similar to 2000 results, which in turn, were similar to the 1995 baseline. This is not a surprise, because no pervasive, large-scale disturbances have occurred atop Mount Harrison since the monitoring plots were established. However, measurable increases or decreases for several common plant species and in some cases for life forms, were recorded at one or more monitoring sites. Results are summarized below.

- Total graminoid species cover between 2000 and 2002 was unchanged at most transects, although a decrease was detected at two transects (transects 10, 11), and an increase at two others (transects 1, 19). Cover values for individual graminoid species was stable except for an increase in *Festuca idahoensis* cover at one graminoid and one sagebrush transect, and a decrease at one sagebrush transect. Cover of the aggressive, introduced grass, *Bromus inermis* (smooth brome), did not change at the transects where it occurs. A trace amount was recorded at one of the new transects (transect 22) established in 2002. Based on subsequent sampling, the “unknown” graminoid recorded for transects 17 and 18 in 1995 was almost certainly *Bromus inermis*. This species has been recorded at six (27%) of the 22 transect sites.

- Total forb cover was unchanged at all but transect 20. This snowbed community transect had a decrease in forb cover from cover class 50 to cover class 30. The decrease can be attributed to a large decrease in the abundance of *Achillea millefolium* (common yarrow) within the plot in 2002. Individual forb species which had an increase or decrease of two or more cover classes occurred seven times. *Aster foliaceus* (leafy aster) was the only forb to have a measured change in more than one transect. All species that had a measurable cover class change in 2002 are listed in Table 5. All of the forb changes occurred in snowbed community types.

Table 4. Total shrub, graminoid, and forb cover class value estimates for plant community plots, 1995 - 2002. Cover values are explained in the text.

Transect	Shrub cover values			Graminoid cover values			Forb cover values		
	1995	2000	2002	1995	2000	2002	1995	2000	2002
Graminoid community									
1	0	0	0	40	30	50	50	20	20
6	3	3	3	80	60	60	20	20	30
13	0	0	0	80	30	30	40	30	40
17	0	0	0	90	40	40	20	30	30
18	0	0	1	80	40	30	30	30	30
Snowbed community									
4	0	0	0	1	3	10	90	60	60
5	0	0	0	1	3	3	80	40	30
7	0	1	1	3	1	10	90	70	60
12	0	0	0	1	1	1	90	70	60
14	0	0	0	3	3	10	50	30	30
15	0	0	0	10	10	10	70	20	30
16	0	0	0	3	3	3	80	50	50
20	0	0	0	1	1	1	70	50	30
21	-	-	1	-	-	1	-	-	50
22	-	-	0	-	-	1	-	-	50
Mountain sagebrush community									
2	60	60	60	50	30	30	40	20	20
3	40	40	40	60	40	50	40	20	20
8	50	40	40	60	50	50	20	20	20
9	80	70	70	70	50	50	20	20	20
10	80	60	50	60	50	30	20	20	20
11	70	50	50	60	50	20	20	20	20
19	50	50	50	40	30	50	40	20	20

Table 5. Cover class value changes in plant community plots between 2000 and 2002. Cover values are explained in the text.

Transect	Species	2000 cover class value	2002 cover class value
1	*Festuca idahoensis*	20	40
3	*Festuca idahoensis*	30	50
7	*Aster foliaceus*	10	not recorded
7	*Penstemon rydbergii*	20	1
7	*Solidago multiradiata*	20	40
11	*Festuca idahoensis*	40	20
12	*Aster foliaceus*	40	20
14	*Aster foliaceus*	3	not recorded
20	*Achillea millefolium*	3	20
20	*Aster foliaceus*	20	3

Disturbance factor monitoring

Pocket gopher activity was the most common ground disturbance recorded at each of the 22 monitoring transects in 2002. Fifty percent of all transect microplots (n = 440) had evidence of gopher-related ground disturbance. The majority (54%) were scored as "old" (not current season) activity. Gopher activity was common in all three community types, but a little less so in the sagebrush type. Disturbances in the unknown/other category were also relatively common. Fifteen percent of all microplots, and all but three transects, had disturbances scored in this category. These disturbances were related to unknown or native ungulate prints, or to frost heaving action. Most pocket gopher and unknown category disturbances affected <10% of the microplot surface area (cover class 1 or 2). No transects had prints that could be positively attributed to cattle. One, or more cow pies were recorded along eight transects. Most, if not all were old droppings, but this information was not consistently recorded on the data sheets. None of the transect microplots had evidence of motor vehicle-related disturbance. Two weed species were encountered at <10% cover along several transects. *Bromus inermis* was tallied at three, and *Taraxacum officinale* (common dandelion) at two transects. Disturbance factor monitoring information for each transect is summarized in Table 6. Copies of the disturbance factor field data sheets are in Appendix 7.

Table 6. Summary of 2002 disturbance factor monitoring results by transect.

Transect	**Motor vehicles (# of microplots)**	**Cattle (# of microplots)**		**Weeds (# of microplots)**	**Gopher (# of microplots)**	**Unknown/other (# of microplots)**
		# prints	**# pies**			
Graminoid community						
1	0	0	1	8 – *B. inermis*	4	5
6	0	0	0		13	6
13	0	0	1		5	5
17	0	0	3	2 – *B. inermis*	14	5
18	0	0	0		12	5
Snowbed community						
4	0	0	0		14	4
5	0	0	0		7	7
7	0	0	0		10	6
12	0	0	0		12	1
14	0	0	0		18	1
15	0	0	1		13	1
16	0	0	1		11	2
20	0	0	0		12	11
21	0	0	0	2 – *B. inermis*	2	0
22	0	0	0		11	3
Mountain sagebrush community						
2	0	0	0		8	3
3	0	0	0		8	0
8	0	0	1	1 – *T.officinale*	8	1
9	0	0	2	1–*T.officinale*	7	2
10	0	0	0		13	1
11	0	0	0		10	4
19	0	0	0		9	0

Electronic line habitat recovery monitoring

The Electronic Line Habitat Recovery transect was established in 1996, and 2002 marked the fourth year it was sampled. Copies of the 2002 electronic line recovery transect field data sheets are in Appendix 8. The four year dataset of vascular plant composition and associated cover class values for each transect microplot station is in Appendix 9.

- The total number of vascular plant species recorded along the transect in 2002 was 36, compared to 28 in 2000, 29 in 1997, and 19 in 1996. Nine species were recorded along the transect for the first time in 2002, including the forbs *Aster foliaceus*, *Collomia linearis* (narrow-leaf collomia), *Microseris troximoides* (false agoseris), *Oxytropis* spp. (locoweed), *Polygonum bistortoides* (American bistort), *Sibbaldia procumbens* (sibbaldia), *Silene scouleri* (Scouler's catchfly), and the grasses *Poa secunda* (Sandberg's bluegrass), and *Sitanion hystrix* (squirreltail). All of these new species occurred in trace amounts in only one or a few microplots, but nonetheless, show that recolonization of the disturbed trench line pathway is still ongoing.

- In addition to a greater number of species in 2002, there was also an increase in the number of species with cover class values of 10 or greater at least once along the transect. The majority of species occurred at only trace amounts in 1996 and 1997, but for 2000 and 2002, the majority were represented by higher cover class values one or more times along the transect.

- In 2000, *Lupinus argenteus* (silvery lupine) showed the largest increase in cover of any species along the transect. In contrast, it was one of the few species to decrease in cover (by two or more cover classes) at multiple microplots in 2002. The species with the most substantial increase in cover in 2002 was *Ligusticum grayi* (Gray's lovage). It increased at two microplots and was recorded for the first time at three other transect stations. Other forbs that showed a measurable increase in cover at one or more microplots compared to 2000 were *Agoseris glauca* (pale agoseris), *Erigeron peregrinus* (subalpine daisy), *Eriophyllum lanatum* (wooly eriophyllum), *Penstemon rydbergii*, (Rydberg's penstemon), and *Solidago multiradiata* (northern goldenrod). *Achillea millefolium* was the only species to occur in all 13 transect microplots in 2002. All of these species are common associates of *Castilleja christii* elsewhere on Mount Harrison.

- Of the 36 species recorded along the transect in 2002, 23 were perennial forbs, 7 were annual forbs, and 6 were perennial grasses. One of the grasses, *Bromus inermis*, one of the perennial forbs, *Taraxacum officinale*, and one of the annual forbs *Spergularia rubra* (red sandspurry), are non-native species. *Bromus inermis* was recorded in three microplots, including one for the first time in 2002. Its cover class value increased measurably at one of the other microplots. Both *Spergularia rubra* and *Taraxacum officinale* occurred in only one microplot along the transect.

- *Castilleja christii* was recorded in 3 of the 13 transect microplots in 2000. This represented the first year it was sampled along the transect and demonstrated its ability to colonize an area mechanically disturbed in the past. In 2002, *Castilleja christii* was absent from one of these microplots, but recorded in two new ones for the first time. It now occurs in a total of four (30%) of the microplots.

- *Cymopterus davisii* (Davis' wavewing) is another Forest Service Sensitive plant species that occurs at Mount Harrison. It was tallied in four microplots in 2002, compared to three in 2000, and two microplots in both 1996 and 1997.

- Although he did not provide cover class values, Moseley (1997) noted that bare soil accounted for most of the cover in all microplots the year baseline data were collected in 1996. In 1997, he noted there was substantially more plant cover compared to 1996, but that bare ground cover remained high (Moseley 1998). Bare ground continued to have a cover class value of 50 or higher in most transect microplots in 2000 and 2002. However, ground cover information has not been collected in a consistent manner over the years, making it difficult to compare cover values with confidence. For example, bare soil and rock were recorded separately in 2000, but lumped together as "bare ground" in 2002. Nonetheless, bare ground continues to dominate the ground cover at nearly every microplot even though increased vegetation canopy cover makes it less noticeable.

DISCUSSION

Population monitoring

Five years of population monitoring reveals that the annual abundance of *Castilleja christii* is dynamic, and large fluctuations in plant density do occur. No clear upward or downward trend in plant abundance has occurred since monitoring was initiated. Annual reproductive output, as measured by the number of reproductive stems/plant, can also fluctuate greatly. However the degree of annual variability appears to be greater for reproductive stem production compared to plant density. Even though the 2002 total for *Castilleja christii* abundance was the lowest recorded in five monitoring years, it was still only 27% less than the highest count in 1997, and 2% less than the 1995 baseline. In contrast, the 2002 stem count was 91% less than the highest tally in 1997.

The 2002 results suggest a differential response in plant abundance by community type. Transects in the snowbed community had more consistent and pronounced decreases in *Castilleja christii* abundance compared to the graminoid and mountain sagebrush types. Many of the transects in these latter two community types showed an increase in plant abundance compared to one or more previous monitoring years. A differential plant community response did not occur for stem production. Reproductive stem output was consistently lower in all three community types.

In 2000, I speculated the decline in 2000 versus 1997 reproductive stems density was more likely due to environmental factors, than to biological, habitat, or management problems (Mancuso 2001). The lack of obvious disturbances, pathogens/disease, or largescale herbivory make me suspect environmental factors also played the leading role in the low *Castilleja christii* populations numbers recorded in 2002. The past couple of years have been some of the driest years in Cassia County during the past half century (Western Regional Climate Center 2003). Burley, located about 14 miles northwest of Mount Harrison, received approximately 55% of "average" precipitation in 2002. Precipitation was well below-average (approximately 70%) during the two preceding years as well. In contrast, precipitation records were substantially above average in Burley between 1995 and 1997, when earlier population sampling was conducted. Mount Harrison is much higher and receives more precipitation than Burley, but relative precipitation patterns are likely similar between the two areas. Another factor that may

have contributed to reduced reproductive stem output in 2002 was a late frost. I noticed a number of plants where stem production was initiated, but never progressed, due perhaps to what appeared to be frost damage.

An effect of dry conditions may be reduced reproductive output for *Castilleja christii*. This effect may have been exacerbated in 2002 by three consecutive years of dry conditions. Reproductive output for *Castilleja christii* should increase from 2002 levels during a year with more precipitation if this premise is valid. I feel it is premature to equate the decline in stem production with a long-term downward trend in *Castilleja christii* reproductive output. The short-term trend clearly points to reduced annual fruit production, however. If future monitoring during a wetter cycle continues to show stem counts similar or lower than 2000 and 2002, then a more confident case can be made concerning a longer-term declining trend.

Fluctuations in annual plant density results may be indicating *Castilleja christii* is capable of remaining dormant underground for one or more seasons during periods of unfavorable environmental conditions. Speculations like this point to the paucity of life history information known about *Castilleja christii*. The current monitoring program is not designed to acquire demographic or other life history attribute information. Obtaining this kind of information would require a more research-oriented and intensive monitoring protocol.

Habitat monitoring

Castilleja christii occurs in three subalpine plant community types: graminoid, snowbed, and *Artemisia tridentata* ssp. *vaseyana/Festuca idahoensis* (Moseley 1993).

1) The graminoid community type is characterized by multiple species and high cover of graminoids, dominated by *Festuca idahoensis* in most cases; a diverse suite of forbs, such as *Solidago multiradiata*, *Achillea millefolium*, and *Pedicularis contorta* (white coiled-beak lousewort); and only a few scattered, or no mountain sagebrush shrubs.
2) The snowbed community type is dominated by a diverse suite of forbs, with one or more species such as *Aster foliaceus*, *Penstemon rydbergii*, and *Solidago multiradiata* exhibiting high cover. Other characteristics include low graminoid cover, with *Trisetum spicatum* (spike trisetum) having high constancy; and no more than a trace of sagebrush cover.
3) The *Artemisia tridentata* ssp. *vaseyana/Festuca idahoensis* community type is clearly dominated by these two species, with a diverse set of associated forbs usually occurring at low cover. *Agropyron trachycaulum* (bearded wheatgrass) and *Poa secunda* are two other grass species that can also occur at more than trace cover in this community type.

Monitoring has shown that plant community attributes are not static either. Most annual variability is related to fluctuating amounts of several common forb or grass species. Fluctuations are more pronounced for a few common forbs in the snowbed community type, and for *Festuca idahoensis* in the graminoid and mountain sagebrush community types. I suspect these fluctuations more likely reflect “natural” variations in annual productivity and/or plant competition, or other community processes, rather than habitat condition problems. Although annual variations occur, overall habitat condition as measured by plant composition and associated cover values has changed little, if any, since the monitoring program began. Increases in the number of non-native weed species, and/or increases in their cover would be indicative of declining habitat quality at the *Castilleja christii* population. Decreases in plant

diversity and increased cover by native species tolerant of disturbance would also be indicative of declining habitat conditions.

Results suggest that several forb species pose identification challenges when flowering material is lacking. Forbs such as *Agoseris glauca, Aster foliaceus, Aster integrifolius, Erigeron peregrinus, Penstemon rydbergii*, and *Solidago multiradiata* are often represented mostly, or only, by vegetative basal leave clusters. It is not hard to confuse one with another, especially when intermixed on the ground. I suspect this may explain some of the apparent increases and decreases noted for some forb species at one or more transects in 2002. In addition, discrepancies in the recording of some species present in only trace amounts (e.g., represented by only one or a few individuals) are inevitable because of being easily overlooked, especially if not in flower, or confusion with a similar-looking, more common species. Overlooking these trace species a given year has little or no consequence when interpreting overall habitat conditions. The only exception would be for invasive weed species, which should be detected as early as possible for management purposes.

Disturbance factor monitoring

Monitoring results indicate pocket gopher activity is the primary "natural" ground disturbance in *Castilleja christii* habitat. This disturbance appears to be a regular part of the non-forested subalpine ecosystem at Mount Harrison. Its effect, if any, on the abundance or ecology of *Castilleja christii* is unknown at this time. Other disturbances such as motor vehicle tracks and cattle trampling were minimal in 2002. I assume native ungulates were responsible for the occasional grazing of *Castilleja christii* stems. *Bromus inermis* is the most serious invasive species currently inhabiting *Castilleja christii* habitat. Disturbance factor information for 2002 represents a "baseline" to compare future results. This information probably has more direct management applicability than other portions of the protocol. Management decisions and actions have the potential to curb or exacerbate certain disturbances that may be adversely affecting *Castilleja christii* or its habitat.

Electronic line habitat recovery monitoring

Recovery of the vegetation along the trench line is progressing. Year 2002 was the first time since the trench line was dug in 1996, that it was difficult to visually discern the pathway in many sections. Forb species have been responsible for most of the re-vegetation. Only a few species are common along most of the transect length, including, *Achillea millefolium, Eriophyllum lanatum, Lupinus argenteus,* and *Solidago multiradiata*. Several others contribute substantial cover along shorter portions of the transect, including, *Artemisia ludoviciana* (Louisiana wormwood), *Erigeron peregrinus. Ligusticum grayi,* and *Penstemon rydbergii*. Grass species are relatively uncommon and contribute minimal cover, except for *Bromus inermis* in a few scattered places. A small section of the trench line cut through a patch of mountain sagebrush. To date, no shrub regeneration has been observed within the microplot nearest the sagebrush patch. Both *Castilleja christii* and *Cymopterus davisii* have colonized the trench line path, which indicates they can recover from at least localized, severe ground disturbance activity.

RECOMMENDATIONS

1) Periodic monitoring should continue at the *Castilleja christii* population. I recommend a minimum of every three to five years, but it should be a joint decision between the Sawtooth NF

and the USFWS. Monitoring should also be conducted in years following a largescale disturbance, such as wildfire, if it occurs.

2) I concur with Moseley's (1996) original recommendation that sampling plant community attributes and taking transect photographs every five years is sufficient. However, I recommend the disturbance factor protocol instituted in 2002, be included each monitoring year. I recommend this protocol be slightly revised to better capture motor vehicle and livestock disturbances in the transect area. In some cases, the incidence of these disturbances may be too low to be adequately sampled using the current protocol. For example, nearly every transect plant community macroplot had one or more old cow pies in 2002, but this disturbance was recorded at fewer than half of the transects. Motor vehicle and cattle evidence that occurs in the macroplot, but not along the transect line can also be recorded.

3) For electronic line recovery monitoring, I recommend a comparative transect in undisturbed habitat alongside the trench line transect be established to provide a baseline for comparing revegetation results. This will provide information regarding a desired revegetation goal. Electronic line revegetation can be considered complete when it is comparable to this reference transect.

4) GPS coordinates have been obtained for all the transect location monuments. Coordinates should also be obtained for all of the transect marker rebar stakes to help document their location. All transect rebar marker stakes were in place in 2002, but it is probably just a matter of time before one or more of these stakes disappear. Having GPS coordinates will help re-establish a "lost" transect with more confidence.

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Appendix 1

2002 photo point photographs.

Appendix 2

General information, maps, and GPS coordinates for the two new monitoring transects established in 2002.

Information for the two new monitoring transects and one new reference monument established in 2002.

All azimuths taken with 0^0 declination. The start and end points of both transects were marked using red-painted "pig-tail" rebar stakes hammered to within roughly 2" of the ground.

Transect 21

GPS: 0279878 E 4688148 N (UTM 12T, Map datum NAD 27 Central)

Location: From Monument 8 to the transect marker stake = 61 m at 52^0. See information below for location of Monument 8.

Additional location information: The transect is accessed by driving to the hang glider jump-off point located west of the Harrison triangulation point (9106).

Transect azimuth: 70^0

Microplot stations: Sampled on the north (downhill) side of the transect tape

Plant community plot: Sampled on north side of transect tape

Tags: None

Transect 22

GPS: 0280508 E 4688202 N (UTM 12T, Map datum NAD 27 Central)

Location: From Monument 6 to the transect marker stake = 42.8 m at 315^0. Note that these measurements were made from the top (high point) of the rock outcrop marking Monument 6. See Moseley (1996) and Mancuso (2001) for the location of Monument 6.

Additional location information: The transect is located close to, and runs parallel to a dirt road. From the transect marker stake to a triangular-shaped rock lining the east edge of the dirt road is 7 m at 280^0. A one meter long section of broken subalpine fir branch is lying on the ground approximately two meters from the transect start stake.

Transect azimuth: 11^0

Microplot stations: Sampled on the east (right) side of the transect tape

Plant community plot: Sampled on east side of transect tape

Tags: None

Monument 8

This Monument was selected in 2002 to reference the location of transect 21.

GPS: 0279820 E 4688121 N (UTM 12T, Map datum NAD 27 Central)

Location: Monument 8 is the rock cairn at the hang glider jump-off point. It is located at the end of a rocky spur that leads to the jump-off area. The cairn has a metal pole sticking out of it. The pole has some flagging attached to indicate wind direction.

Appendix 3

Copies of *Castilleja christii* population monitoring field data sheets.

Appendix 4

1995 to 2002 dataset for *Castilleja christii* population monitoring transects.

Appendix 5

Composition and cover class data for habitat monitoring macroplots by plant community type.

Appendix 6

Copies of the 2002 plant community field data sheets for *Castilleja christii* monitoring transect macroplots.

Appendix 7

Copies of the 2002 disturbance factor field data sheets for *Castilleja christii* monitoring transects.

Appendix 8

Copies of the 2002 Electronic Line Habitat Recovery transect field data sheets.

Appendix 9

Electronic Line Habitat Recovery transect vegetation data, 1996 – 2002.

Electronic Line Habitat Recovery transect vascular plant cover class data, by species and year. Cover classes are explained in the report text.

		Transect microplot (meter mark along transect)												
Species	**Year**	**25**	**50**	**75**	**100**	**125**	**150**	**175**	**200**	**225**	**250**	**275**	**300**	**325**
Abies lasiocarpa	1996													
	1997													1
	2000													
	2002													
Achillea millefolium	1996					1	10	1		3	3		1	1
	1997	1	1	1	1	10	1	1	1	1	3	1	1	1
	2000	20	10	1	3	3	1	3	1	1	10	1	1	3
	2002	10	20	3	10	1	3	3	1	3	3	1	1	10
Agoseris glauca	1996				1	1		1		1	1	1	1	
	1997			1			1	1		1	1			
	2000				3			1		10	10			
	2002				20		1			1	3	1		1
Agropyron trachycaulum	1996													
	1997								1					
	2000													
	2002		3						1	1				
Agrostis variabilis	1996													
	1997		1									1		
	2000		1	1								1	1	
	2002												1	
Allium brandegei	1996													
	1997			1										
	2000	1		1										
	2002	1		1										
Artemisia ludoviciana	1996	1												
	1997	1		1		10	1	1	1					
	2000						20	10	20		1			
	2002					1	20	10	20					
Aster foliaceus	1996													
	1997													
	2000													
	2002		3											
Aster integrifolius	1996													
	1997			1										
	2000				1									10
	2002								1					
Bromus inermis	1996					1				10				
	1997					30								
	2000					50				3				
	2002		10			50				20				
Castilleja christii	1996													
	1997													
	2000		3				1				1			
	2002		1				3	3		1				

Species	Year	25	50	75	100	125	150	175	200	225	250	275	300	325
Chenopodium fremontii	1996					1				1				
	1997					1				1				
	2000													
	2002									1				
Collomia linearis	1996													
	1997													
	2000													
	2002	1						1		1				
Cymopterus davisii	1996						1		1					
	1997						1		1					
	2000		1				3		1					
	2002	3	1				1		3					
Epilobium alpinum	1996													
	1997			1										
	2000			1	1					1			1	
	2002		1	1										
Erigeron peregrinus	1996			3	1	1	1	1	1	1		1	3	3
	1997				1	3			1			1	1	1
	2000					3			1		10	20	3	20
	2002				1	1				1	10	20	20	40
Eriophyllum lanatum	1996				1		1			1	1			
	1997	1			1		1	1		1	1			
	2000	3		1	1		3	1	3	1	1			
	2002	10	1	1	10	1	1	3	1	3				
Galium boreale	1996					1								
	1997													
	2000													
	2002													
Gayophytum racemosum	1996													
	1997								1				1	
	2000													
	2002									1			1	
Lewisia pygmaea	1996											1	1	
	1997											1	1	
	2000		1	1			1					1	1	1
	2002		1	1				1					1	1
Ligusticum grayi	1996		1			1	1		1				1	3
	1997	1					1		1				1	1
	2000			10	1		1		3				3	3
	2002		3	30	1		1	3	3			1	3	20
Lupinus argenteus	1996			1			1			1		1		
	1997						1	1	1	1	1	1	1	1
	2000	10		1	1	3	10	10	10	20	10	40	3	10
	2002	10		3	10	1	10	1	10	3	1	3	1	
Microseris troximoides	1996													
	1997													
	2000													
	2002			1										

Species	Year	25	50	75	100	125	150	175	200	225	250	275	300	325
Microsteris gracilis	1996							1		1				
	1997				1	1	1	1		1	1			
	2000		1		1			1		1				
	2002													
Oxytropis sp.	1996													
	1997													
	2000													
	2002													1
Penstemon rydbergii	1996					1				1	20	1		1
	1997						1			1	30			
	2000								1	10	3			
	2002							3		20	10			1
Poa pratensis	1996													
	1997													
	2000					1								
	2002													
Poa secunda	1996													
	1997													
	2000													
	2002					1								
Poa ? sp.	1996													
	1997		1											
	2000													
	2002													
Polemonium pulcherrimum	1996													
	1997													
	2000													1
	2002													
Polygonum bistortoides	1996													
	1997													
	2000													
	2002		1											
Polygonum douglasii	1996	1		1	1	1	1	1	1	1		1		1
	1997	3	3	1	40	10	20	60	1	1	1	1	1	1
	2000	1	1	1	1		1	1	1	1	1		1	
	2002		1	1				1		1			1	
Polygonum kelloggii	1996													
	1997		1	1										
	2000													
	2002													
Rumex paucifolius	1996													
	1997											1		
	2000													1
	2002													
Sedum lanceolatum	1996									1				
	1997													
	2000													
	2002													

Species	Year	25	50	75	100	125	150	175	200	225	250	275	300	325
Sibbaldia procumbens	1996													
	1997													
	2000													
	2002		3										1	
Silene scouleri	1996													
	1997													
	2000													
	2002				1									
Sitanion hystrix	1996													
	1997													
	2000													
	2002									1				
Solidago multiradiata	1996				1			1		1	10			
	1997							3	1	1	10			1
	2000		1		1	3	10	10	3	10	10	10		3
	2002		10	1	3	3	10	3	20	10	10	10		
Spergularia rubra	1996													
	1997	1	1	1	1		1	3		1				1
	2000		1	1						1		1		3
	2002												1	
Spraguea umbellata	1996				1		1				1			
	1997		1		1		1	1			1	1		1
	2000				1		1	1	1		1	1		1
	2002				1						1		1	1
Stellaria jamesiana	1996				1	1	1			1				
	1997				1	1			1	1				1
	2000				1	1	1	1	1	1				
	2002				1	1	1	1	1	1				
Taraxacum officinale	1996													
	1997													
	2000	1	10						1					
	2002		20											
Thlaspi montanum	1996									1				
	1997													
	2000					1	1			1				
	2002	1				1			1	1				
Trisetum spicatum	1996													
	1997										1	1		
	2000										1	1		
	2002		1					1			1	1		
Bare Ground	1996[1]													
	1997	90	90	90	80	20	80	70	90	80	50	90	98	98
	2000	80	40	60	80	30	40	70	40	70	50	70	80	50
	2002[2]	80	60	80	80	40	70	90	80	50	70	80	90	30
Rock/Gravel	1996[1]													
	1997[2]													
	2000		40	30	10	1	50	20	50	3	3	3	20	3
	2002													

Species	Year	25	50	75	100	125	150	175	200	225	250	275	300	325
Litter	1996[3]													
	1997					20								
	2000					50								
	2002													

[1]not recorded in 1996

[2] lumped with and considered “bare ground” in 1997 and in 2002

[3] not recorded in 1996 and 2002