CHRIST'S INDIAN PAINTBRUSH (*CASTILLEJA CHRISTII*) MONITORING ON THE SAWTOOTH NATIONAL FOREST: TRANSECT ESTABLISHMENT AND BASELINE DATA

by

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INTRODUCTION

Christ's Indian paintbrush (*Castilleja christii*) is Idaho's rare plant, consisting of a single population, covering approximately 200 acres on Mount Harrison, the highest peak at the north end of the Albion Mountains, Cassia County. More precisely, the southern limit of the population begins approximately 250 feet north of the lookout and continues north for approximately 0.75 mile. The east-west extent of the population is somewhat over one mile in width. The population is entirely on publicly held land, managed by the Burley Ranger District of the Sawtooth National Forest. See Moseley (1993a) for more information on the distribution, abundance, and conservation status of Christ's Indian paintbrush.

Due to its extreme rarity and the numerous disturbances that take place on the summit plateau of Mount Harrison, a Conservation Agreement was signed between the Sawtooth NF and the U.S. Fish and Wildlife Service that enumerates conservation actions that will be implemented to protect habitat for Christ's Indian paintbrush (U.S. Fish and Wildlife Service 1995). One of the proposed conservation actions under this agreement (VI.A.14) states that the Forest Service shall:

> Establish a monitoring program in 1995 for Christ's Indian paintbrush. A primary objective of this program should be to monitor impacts to the Christ's Indian paintbrush population associated with recreational uses. As part of the monitoring schedule, conduct inventories of existing habitat to determine if the population is expanding or contracting. Accommodate needed changes if monitoring determines that deleterious impacts are taking place. Monitoring will be conducted on an annual basis for at least the first five years of this agreement.

Another conservation action related to this states (VI.A.15):

> Delimit Christ's Indian paintbrush populations on a large scale map by the three community types present. Monitoring plots should be established in each of these community types. Establish permanent photoplots; photos will be retaken each year and evaluated for apparent changes in density or distribution of *Castilleja christii*.

To fulfill these requirements, the Forest Service retained the services the Idaho Department of Fish and Game's Conservation Data Center (CDC) through a Challenge Cost-share agreement. The specific objectives are as follows:

> 1. Establish permanent monitoring transects in each of the three community types identified by Moseley (1993a). Collect density and frequency data for Christ's Indian paintbrush at these transects, as well as ecological information on its habitat. Establish permanent photo points at each transect.

2. Delineate the three community types on a large-scale aerial photograph. Use density information from #1 to estimate population size of Christ's Indian paintbrush.

CASTILLEJA CHRISTII NATURAL HISTORY AND MORPHOLOGY

Christ's Indian paintbrush is a perennial forb, 5 to 15 inches tall. Several, erect stems emanate from a branched woody caudex at the top of a taproot. The herbage is glabrous to hispid with some hairs gland-tipped near the inflorescence. Leaves are 2-5 inches long, narrowly to broadly lanceolate, with 1 or maybe 2 pairs of lateral lobes, although sometimes all entire. The leafy stem grades into the inflorescence which is glandular, yellow to yellow-orange, with leaf-like bracts that are lanceolate to ovate, with 1 or 2 pairs of narrow lateral lobes. Each flower produces a capsule with numerous, wingless seeds (Holmgren 1984).

Little is known of its life history characteristics. It begins growth soon after (or possibly slightly before) snow-melt. On the summit of Mount Harrison, this occurs some time during July in most years. Flowering takes place possibly two to three weeks after snow melt (late July or early August). The timing of fruit maturation and seed dispersal are unknown.

Christ's Indian paintbrush occurs in three community types (Moseley 1993a):

Snowbed - Occurs in areas of the latest-lying snowbanks. The community is forb-dominated, with *Solidago multiradiata, Aster foliaceus*, and *Agoseris glauca* being the most prominent.

Graminoid - *Festuca idahoensis* and *Agropyron caninum* dominate this community; *Artemisia tridentata* ssp. *vaseyana* is absent.

Artemisia tridentata ssp. *vaseyana/Festuca idahoensis* (Artrv/Feid) habitat type (Hironaka et al. 1983) - Much of the area covered by this community on Mount Harrison is patterned ground with biscuit and swale topography.

Christ's Indian paintbrush occurs almost exclusively on gentle, northerly facing slopes. It only rarely occurs in deep soils on south- and west-facing slopes. Considerable pocket gopher digging takes place in all three communities. Two quartzite units underlie paintbrush habitat. The soils appear to have derived from the underlying bedrock, being relatively deep and gravelly. They tend to be fed by late-lying snow during the early part of the growing season, and probably remain moist well into August most years.

GENERAL METHODS

Transects

During 1-5 August 1995, 20 permanently-marked transects were established in the habitat of Christ's Indian paintbrush. The transects were 20 meters long and the beginning and ending points were marked with rebar. Metal tags were fixed to one or both rebar indicating the transect number. Most transects were placed near the Lookout Road (the all-weather gravel road to the lookout) or the Electronic Site Road (the dirt road heading north from the Lookout Road to the electronic sites north of Lake Cleveland) to facilitate relocation. The reason for this is that as you get farther away from the road, it becomes increasingly difficult to accurately relocate the monuments and the transects. These two roads were chosen because they are probably the most permanent.

The objective was to place plots in each of the three habitats. Because the graminoid and Artrv/Feid habitats cover less area, fewer transects were placed in these than in the snowbed habitat. Transects in the three habitats are as follows:

Graminoid	5 transects
Artrv/Feid	7 transects
Snowbed	8 transects

To locate the transect, I walked into a suitable-appearing stand from the road a random number of paces. I then chose a random azimuth to run the transect, but the transect was always started at the end closest to a suitable monument (explained in the next section). I collected population data for Christ's Indian paintbrush in "stations" or plots along each transect and an ecological plot, and photo points were established (explained in following sections).

Below is a description of each transect. The locations of each transect are mapped in Appendix 1. Please note that all azimuths are taken with 0° declination.

<u>Transect 1</u>

Location:	26.4 m at 156° from Monument 1
Orientation:	216°
Stations:	N side of line
Plot:	95RM009, N side, adjacent to line with corner at beginning stake
Tags:	both ends

<u>Transect 2</u>

Location:	62.5 m at 249° from Monument 1
Orientation:	289°
Stations:	N side of line, right, downhill
Plot:	95RM010, N side, adjacent to line with corner at beginning stake
Tags:	both ends

Transect 3
Location: 51.15 m at 243º to Monument 2
Orientation: 340º
Stations: northerly side of line (right hand)
Plot: 95RM011, northerly side, adjacent to line with corner at beginning stake
Tags: both ends

Transect 4
Location: 70.4 m at 42º to Monument 1, across road from transect
Orientation: 100º
Stations: S side of line (right, uphill)
Plot: 95RM012, S side, adjacent to line with corner at beginning stake
Tags: both ends

Transect 5
Location: 79.8 m at 33º to Monument 1 across road from transect; transect 5 is 15.23 m at 344º from beginning stake of transect 4
Orientation: 59º
Stations: S side of line, uphill side
Plot: 95RM013, S side, adjacent to line with corner at beginning stake
Tags: both ends

Transect 6
Location: 19.35 m at 244º from Monument 3
Orientation: 267º
Stations: N side of line, right, downhill side
Plot: 95RM014, N side, adjacent to line with corner at beginning stake
Tags: both ends

Transect 7
Location: 61.5 m at 256º from Monument 3
Orientation: 200º
Stations: N side of line, right, downhill side
Plot: 95RM015, N side, adjacent to line with corner at beginning stake
Tags: both ends

Transect 8
Location: 15.6 m at 5º from Monument 3
Orientation: 263º
Stations: N side of line, right, downhill side
Plot: 95RM016, N side, adjacent to line with corner at beginning stake
Tags: both ends

Transect 9
Location: 37.85 m at 328º from Monument 3
Orientation: 8º
Stations: E side of line, right, uphill side
Plot: 95RM017, E side, adjacent to line with corner at beginning stake
Tags: both ends

Transect 10
Location: 67.45 m at 101º from Monument 4
Orientation: 83º
Stations: S side of line, right, uphill side
Plot: 95RM018, N side, adjacent to line with corner at beginning stake
Tags: both ends

Transect 11
Location: 83.0 m at 80º from Monument 4
Orientation: 33º
Stations: S side of line, right, uphill side
Plot: 95RM019, adjacent to line with corner at beginning stake
Tags: both ends

Transect 12
Location: 48.95 m at 347º from Monument 4
Orientation: 50º
Stations: S side of line, right, uphill side
Plot: 95RM020, N side, adjacent to line with corner at beginning stake
Tags: both ends

Transect 13
Location: 86.05 m at 25º from Monument 4
Orientation: 129º
Stations: westerly side of line, right, uphill side
Plot: 95RM021, westerly side, adjacent to line with corner at beginning stake
Tags: both ends

Transect 14
Location: 21.2 m at 248º from Monument 5
Orientation: 257º
Stations: N side of line, right, downhill side
Plot: 95RM022, N side, adjacent to line with corner at beginning stake
Tags: both ends

Transect 15
Location: 51.2 m at 224º from Monument 5
Orientation: 297º
Stations: N side of line, right, downhill side
Plot: 95RM023, N side, adjacent to line with corner at beginning stake
Tags: both ends

Transect 16
Location: 28.55 m at 42º from Monument 6 (tape stretched tight to this monument on rock outcrop).
Orientation: 353º
Stations: S side of line, right, downhill side
Plot: 95RM024, S side, adjacent to line with corner at beginning stake
Tags: on beginning stake only

Transect 17
Location: 20.9 m at 311º from Monument 7
Orientation: 285º
Stations: northerly side of line, right, downhill side
Plot: 95RM025, northerly side, adjacent to line with corner at beginning stake
Tags: on beginning stake only

Transect 18
Location: 53.75 m at 253º from Monument 7
Orientation: 265º
Stations: N side of line, right, downhill side
Plot: 95RM026, N side, adjacent to line with corner at beginning stake
Tags: on beginning stake only

Transect 19
Location: 66.8 m at 281º from Monument 2
Orientation: 256º
Stations: N side of line, right side
Plot: 95RM027, N side, adjacent to line with corner at beginning stake
Tags: on beginning stake only

Transect 20
Location: 51.45 m at 88º from Monument 2
Orientation: 102º
Stations: S side of line, right, uphill side
Plot: 95RM028, S side, adjacent to line with corner at beginning stake
Tags: on beginning stake only

Monuments

Very few natural landmarks exist on the top of Mount Harrison, and metal fenceposts, a common method of monumenting permanent plots, are already used to mark the snowmobile trail to the lookout. I used boulders as permanent monuments for relocation of the transects. All boulders chosen as monuments are isolated and prominent, obviously visible from the roads, especially with the aid of the photographs provided in Appendix 5.

Below is a description of the location of each of the seven monuments used to relocate the 20 transects. The locations of each monument and transect are mapped in Appendix 1 and are mapped on the aerial photo of the Mount Harrison area (see Population Estimate Section). Please note that all azimuths are taken with 0° declination and 10 of my paces equals 8.0 - 8.5 m.

Monument 1

Transects:	1, 2, 4, 5
Location:	155 paces along Lookout Road from intersection with Electronic Site Road (paced along outside [west] edge of turn; not in ditch) to point adjacent to monument. Monument is a prominent white, triangular rock 10 paces at 200°.
Marking:	Orange paint mark at tip (highest point).
Photo:	Rock from road.

Monument 2

Transects:	3, 19, 20
Location:	21 paces from middle of intersection of Electronic Site Road and Lookout Road at 245°. Monument is the northeastern of three rocks arranged in a triangle.
Marking:	Orange paint mark at tip (highest point).
Photo:	Rocks from center of intersection.

Monument 3

Transects:	6, 7, 8, 9
Location:	4990 paces along Lookout Road from intersection with Electronic Site Road (paced along outside [west] edge of road through 2 turns; not in ditch) to point adjacent to monument. Monument is a large gray, flat rock 20 paces at 270° from west edge of road.
Marking:	Orange paint mark.
Photo:	(1) Rock from road; rock in center; (2) close-up of rock.

Monument 4

Transects:	10, 11, 12, 13
Location:	370 paces along Lookout Road from intersection with Electronic Site Road (paced along outside [west] edge of turn; not in ditch) to point adjacent to monument. Monument is taller of two rocks turned on edge 48 paces at 68°.
Marking:	Orange paint mark at tip (highest point).
Photo:	(1) Rock from road; rock in center; (2) close-up.

Monument 5

Transects: 14, 15

Location: Along ways, cross-country at 92° from middle of intersection of Lookout Road and Electronic Site Road. Monument is a large, prominent black of white quartzite visible from intersection.

Marking: Orange paint mark at highest point.

Photo: (1) Rock from intersection; rock in center; (2) close-up.

Monument 6

Transects: 16

Location: Monument is a prominent rock at the end of northeast-southwest trending, low, rocky ridge, northeast of Harrison triangulation station, east of Electronic Site Road near intersection with road that takes off to the west (runs to north of triangulation station ridge).

Marking: Orange paint mark at tip (highest point).

Photo: (1) from road, perpendicular to ridge, (2) parallel to ridge from the northeast (near transect); monument is prominent point in middle of photo.

Monument 7

Transects: 17, 18

Location: 300 paces along Lookout Road from intersection with Electronic Site Road (paced along outside [west] edge of turn; not in ditch) to point adjacent to monument. Monument is flat, white rock parallel to ground surface in Feid stand.

Marking: Orange paint mark at tip (highest point).

Photo: (1) Rock from road; rock in center; (2) close-up.

Population Sampling

The 20 meter-long transect was divided into 20 one-meter-square "stations" or plots, forming what is actually a continuous one-meter-wide belt transect. In each station, I recorded: (1) the number of Christ's Indian paintbrush plants, and (2) the number of stems (sterile and reproductive were combined) for each plant. I used the number of stems as a surrogate for above ground production and, to a lesser degree, fecundity. I didn't count flowers in the plots because of the enormous amount of time needed and because of the varying phenological stages of plants in the three habitats; not all inflorescences appeared to be fully elongated. A blank copy of the form used to record Christ's Indian paintbrush population data is provided in Appendix 2.

Ecological Sampling

At each transect, ecological data was collected for Christ's Indian paintbrush habitat using the methods of Bourgeron et al. (1992). This method is used by all ecologists of the Natural Heritage and Conservation Data Center network in the western United States and is adapted

from the ECODATA methodology employed by the Northern Region of the Forest Service. A 10 x 10 m macroplot was established, with one corner of the plot the same point as the beginning of the transect (see Transects section for a description of the location of each plot in relation to the transect). Two forms were used to collect data from the plots (Appendix 2): (1) Form II, Community Survey Form - identification, location, environmental features and general site description; and (2) Form III, Ocular Plant Species Data - estimated percent cover for every plants species in the macroplot using the midpoint of 12 cover classes, as follows:

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

The plots are numbered consecutively using the following coding convention: first two numbers = year; next two letters = abbreviation of recording ecologists name; last three numbers = the number of the plot established by that recording ecologist during the year. So, the plots for the 20 Christ's Indian paintbrush transects run from *95RM009* to *95RM028*. These plots were the 9th through 28th plots that I established during work in 1995.

Photo Points

Two photos were taken at each transect. One photo was taken down the belt from just behind the beginning stake. Another photo was taken of the ecological plot. Color slides of these photos are reproduced in Appendix 6.

Population Estimate

The Sawtooth NF obtained a large-scale aerial photograph with the distribution of Christ's Indian paintbrush squarely in the center. The photo measures 30" x 30" and is at a scale of approximately 14 inches = 1 mile. The photo was taken on 8-18-93 and is identified as USDA-F 16 614140 892-30.

Using the map of the distribution of Christ's Indian paintbrush that I developed on the topographic map in 1993 (Moseley 1993a), I delineated the paintbrush distribution on the photo (actually a mylar overlay), then stratified the distribution area into the three community types. This allowed me to do two things: (1) measure the actual amount of habitat in the three community types; and (2) estimate the population size of Christ's Indian paintbrush using the density data from the transects. Unfortunately, I did not get the photo unit after field work was complete, so the delineation relied on field notes and memory to "ground truth" the photo interpretation.

BASELINE DATA

Population Data

Table 1 shows the population density and stem counts for Christ's Indian paintbrush in the 20 transects. I counted 1750 plants in the 400 stations that comprised the 20 transects, for an overall density of 4.4 Christ's Indian paintbrush plants/m^2. There was an average of 5.0 stems per plant in the 20 transects. There was considerable variability, however, with density ranging from 8 plants/m^2 to 222 plants/m^2. Much of this variability can be explained by the differences in density between the three community types (Table 2). This corroborates, in part, my observations in 1993 (Moseley 1993a), where I ocularly estimated that the graminoid community had the highest density of Christ's Indian paintbrush. I also stated (Moseley 1993a) that the density of paintbrush is inversely related to the density of *Artemisia tridentata* ssp. *vaseyana* (sagebrush). It generally occurs in openings in the sagebrush and in the nearly shrubless swales between the biscuits in this patterned ground. This is expressed as the lowest density of the three communities (Table 2), although it is better expressed in the original plot data forms, where the discontinuous distribution of the paintbrush in the transects (Appendix 3) is related to the high cover of sagebrush (Appendix 4).

Table 1 Population data for Christ's Indian paintbrush in 20 permanently marked transects on Mount Harrison, recorded in August 1995

Transect	Total Plants	Plant Density (m^2)	Total Stems	Average Stems/ Plant	Community Type
1	122	6.1	629	5.2	graminoid
2	21	1.1	115	5.5	Artrv/Feid
3	26	1.3	151	5.8	Artrv/Feid
4	64	3.2	261	4.1	snowbed
5	36	1.8	145	4.0	snowbed
6	174	8.7	935	5.3	graminoid
7	143	7.2	922	6.4	snowbed
8	12	0.6	54	4.5	Artrv/Feid
9	49	2.5	167	3.4	Artrv/Feid

Table 1 (cont.)

Transect	Total Plants	Plant Density (m^2)	Total Stems	Average Stems/ Plant	Community Type
10	10	0.5	30	3.0	Artrv/Feid
11	8	0.4	52	6.5	Artrv/Feid
12	46	2.3	223	4.8	snowbed
13	178	9.2	1063	6.0	graminoid
14	148	7.4	800	5.4	snowbed
15	222	11.1	1046	4.7	snowbed
16	38	1.9	262	69	snowbed
17	78	3.9	360	4.6	graminoid
18	192	9.6	922	4.8	graminoid
19	12	0.6	56	4.7	Artrv/Feid
20	171	8.6	773	4.5	snowbed
Total	1750	---	8966	---	
Average	87.9 (70.9)*	4.4 (3.6)	448.3 (375.7)	5.0 (1.0)	
Range	8-222	0.6-11.1	30-1063	3.0-6.9	

* Number in parentheses denotes $\pm$ 1 standard deviation.

Table 2 Population data for Christ's Indian paintbrush in 20 transects on Mount Harrison in relation to community type

Community Type	Number of Stations	Total Plants	Plant Density (m^2)	Total Stems	Average Stems/ Plant
Artrv/Feid	140	138	1.0	625	4.5
Graminoid	100	744	7.4	3909	5.3
Snowbed	160	868	5.4	4432	5.1

The original data forms are contained in Appendix 4; this data is also contained in a Lotus 1-2-3 data base file at the CDC office in Boise. All original forms, maps and other information related to this monitoring project are in the *Plant and Community Monitoring File* at the CDC office.

Ecological Data

Table 3 presents the vegetation data for the three community types. Although it was not explored during this study, the distribution of these three types is probably driven by differential snow deposition resulting from topographic features. The snowbed community clearly has the greatest deposition, but I'm unsure of the other two; the graminoid community may receive more than the Artrv/Feid. Artrv/Feid is the only community with a significant shrub cover, largely sagebrush. Artrv/Feid is floristicly similar to the graminoid community; however, both share grass high cover, especially *Festuca idahoensis* (Idaho fescue) and *Agropyron caninum* (bearded wheatgrass). Most associated species in the graminoid community have low cover, the exceptions being *Solidago multiradiata* (northern groundsel) and *Aster foliaceus* (leafy aster). These two species are absent from the Artrv/Feid community but are the community dominants in the snowbed community, possibly indicating that the graminoid community occupies an intermediate position along the snow deposition gradient.

Table 3 Plant cover and constancy (in parentheses) for species in the ecological plots associated Christ's Indian paintbrush monitoring transects. Plant cover values are explained in the text. Constancy values are as follows: 1=5-15%, 2=15-25%, 3=25-35%, 4=35-45%, 5=45-55%, 6=55-65%, 7=65-75%, 8=75-85%, 9=85-95%, 10=95-100%

	Artrv/Feid n = 7	Graminoid n =5	Snowbed n = 8
SHRUBS			
Artemisia tridentata ssp. *vaseyana*	60 (10)	3 (4)	
Chrysothamnus viscidiflorus	3 (3)		
Symphoricarpos oreophilus	3 (3)		
GRAMINOIDS			
Agropyron caninum	10 (6)	30 (6)	3 (4)
Carex xerantica	1 (1)	1 (2)	
Carex sp.	1 (1)	1 (2)	
Festuca idahoensis	50 (10)	70 (8)	1 (1)
Poa secunda	3 (90)	1 (2)	1 (3)
Trisetum spicatum	1 (4)	1 (8)	3 (10)
FORBS			
Achillea millefolium	3 (10)	3 (10)	10 (10)
Agoseris glauca	1 (1)	1 (2)	10 (6)
Antennaria anaphaloides	3 (10)	3 (4)	
Antennaria microphylla		1 (60)	
Arabis sp.	1 (9)	1 (8)	1 (1)
Arenaria capillaris	1 (10)	1 (8)	
Aster foliaceus		10 (4)	40 (10)
Castilleja christii	1 (10)	3 (10)	3 (10)
Cymopterus davisii	3 (9)	3 (6)	3 (9)
Eriogonum umbellatum	1 (3)		
Eriophyllum lanatum	3 (9)	3 (6)	10 (3)
Frasera speciosa	1 (4)		
Lewisia pygmaea	1 (4)	1 (8)	1 (10)
Ligusticum tenuifolium		1 (2)	
Linum perenne	1 (1)		
Lupinus argenteus	10 (10)	3 (6)	3 (6)
Microsteris gracilis			1 (1)
Pedicularis contorta	3 (10)	3 (10)	3 (3)
Penstemon rydbergii		1 (2)	10 (3)

Table 3 (cont.)

	Artrv/Feid n = 7	Graminoid n =5	Snowbed n = 8
Phlox multiflora	1 (3)		
Polygonum bistortoides	1 (3)	3 (8)	3 (3)
Potentilla gracilis		1 (2)	
Rumex paucifolius		1 (2)	3 (6)
Sedum lanceolatum	1 (3)	1 (2)	1 (1)
Senecio integerrimus	1 (4)	1 (4)	
Sibbaldia procumbens			1 (1)
Silene scouleri	1 (4)		
Spraguea umbellata			1 (4)
Solidago multiradiata	3 (7)	10 (10)	20 (10)
Stellaria jamesiana	1 (4)	1 (2)	1 (3)
Taraxacum officinale	1 (4)	1 (2)	1 (1)
Thlaspi montanum	1 (9)	1 (6)	
Valeriana sitchense	3 (4)		

The graminoid community has the highest density of Christ's Indian paintbrush, while the Artrv/Feid type has the lowest. These two communities are obviously related with the major difference being that the graminoid community lacks significant shrub cover. We currently do not know if shrub encroachment is taking place in the graminoid community or if high snow deposition precludes the establishment and growth of sagebrush. Using these vegetation data as the baseline, future monitoring should provide an answer to this question.

Two other rare species occurred in the plots, *Cymopterus davisii* (Davis' wavewing) and *Carex xerantica* (dryland sedge). Davis' wavewing is endemic to the Albion Mountains, where Moseley (1993a) reviewed its abundance, distribution, and conservation status. Dryland sedge is a disjunct species in Idaho, being more common on the Great Plains and in the southern Rocky Mountains. Its status in Idaho was recently reviewed by Moseley (1993b).

Population Estimate

Table 4 presents the estimates of the aerial extent of each community type within the distribution perimeter of Christ's Indian paintbrush and, inferred from the density data of the permanent transects, an estimated number of individuals. This population estimate assumes that the average density of Christ's Indian paintbrush in each community type is uniform throughout its distribution. In reality this is not the case, and the population estimate is probably high, possibly by an order of magnitude.

Table 4 Estimate of individuals of Christ's Indian paintbrush based on density data from the permanent transects in the three community types. See text for cautionary note

	Acres/Hectares	Percent Area	Plant Density (plants/m^2)	Population Estimate
Artrv/Feid	40/16.2	20	1.0	162,000
Graminoid	36/14.6	18	7.4	1,080,400
Snowbed	124/50.2	62	5.4	2,710,800
Total	200/81.0	100	----	3,953,200

RECOMMENDATIONS

1. *Population Monitoring* - Remeasure population data annually for at least the first five years, as specified in the Conservation Agreement. This will assure that some annual variability in the population is accounted for in any management recommendations generated from this monitoring program.

2. *Habitat Monitoring* - The methods employed for vegetation monitoring will detect habitat change at a lower resolution than those employed for population monitoring. Therefore, I recommend remeasuring the ecological plots every five years.

3. *Photo Points* - I recommend retaking photos every five years instead of annually, as recommended in the Conservation Agreement. Every effort should be made to take the photos at the same phenological stage as that of 1-5 August 1995.

4. *Photo Interpretation* - As mentioned in the General Methods section, the aerial photo interpretation needs to be ground truthed. This should be done along with the 1996 population monitoring. If it turns out to be different from that done in the office, population estimates should be recalculated. Also, mapping should be done at a finer resolution than that done in 1993, so that accurate density estimates can be used to calculate population totals. I have little confidence in the accuracy of population totals in Table 4.

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Appendix 1

Location of permanent transects and monuments for
Castilleja christii monitoring on Mount Harrison
(portion of the Mount Harrison USGS quad, greatly magnified)

Appendix 2

Blank monitoring forms: *Castilleja christii* population data sheet;
community survey and ocular plant species data sheets for ecological plots

Appendix 3

Copies of field sheets with 1995 *Castilleja christii* population data

Appendix 4

Copies of field sheets for the 1995 ecological plots

Appendix 5

Photographs of monuments (color slides)

Appendix 6

Permanent photo points of transects and ecological plots (color slides)