For SA, WLN

DEMOGRAPHIC MONITORING OF

PENSTEMON LEMHIENSIS

DILLON RESOURCE AREA

BUREAU OF LAND MANAGEMENT

1992 Progress Report

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Agreement No. E950-A1-0006
Task No. 8

February 1993

This report is to be cited as follows: Heidel, B. L. and J. S. Shelly. 1993. Demographic monitoring of Penstemon lemhiensis in the Dillon Resource Area, Montana; 1992 Progress Report. Montana Natural Heritage Program. Helena, MT. 18 pp.

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I. INTRODUCTION

Penstemon lemhiensis (Keck) Keck and Cronquist (Lemhi beardtongue) is a showy perennial in the Figwort Family (Scrophulariaceae). It is a regional endemic in three counties of southwestern Montana (Beaverhead, Ravalli and Silver Bow) and one county of eastern Idaho. It is a Category 2 species candidate for listing as a threatened or endangered species by the U.S. Fish and Wildlife Service (USDI 1990). It is currently ranked as G3/S2 (globally vulnerable, state imperiled) by the Montana Natural Heritage Program (Lesica and Shelly 1991), considered sensitive by Region 1 of the U.S. Forest Service (USDA 1988) and considered sensitive in the draft list by the Bureau of Land Management State Office (USDI 1993).

Penstemon lemhiensis occupies grassland habitat of variable elevation, which is subject to alteration by grazing, mining activity and weed control by herbicide spraying (Schassberger 1990, Shelly 1990). Its populations include a relatively few number of large populations in undisturbed habitat, and relatively many small populations in habitats of manmade disturbance such as roadsides. We suspect that the large populations in natural settings are more stable than the small populations through time, and that the latter are more prone to local extirpation.

Population counts have been made at large population sites since 1986, including the BLM Badger Pass exclosure site, documenting marked increases and decreases in population size (Achuff and Shelly 1991). There is a need to monitor the populations to differentiate natural fluctuations from overall trend and identify critical life history stages so that an assessment of long term viability can be made.

The purpose of this project is to study Penstemon lemhiensis life history; monitoring growth, fecundity, recruitment, and mortality to determine overall trend in two populations of Penstemon lehmiensis at two sites representing relatively natural and unnatural settings. This information is needed to interpret data on the location and size of Penstemon lemhiensis populations, it augments monitoring studies in natural settings elsewhere in both states, and it provides a sensitive species management baseline for BLM.

Penstemon lemhiensis is being monitored on Beaverhead National Forest in Montana, and BLM land in both Montana and Idaho. Populations on the Beaverhead National Forest have been monitored since 1989 (Achuff and Shelly 1991, Shelly 1990, 1993) and are all located within ten miles of the Badger Pass BLM site. In 1990, plants within a recently-constructed BLM monitoring exclosure near Badger Pass Microwave Tower were marked and described, encompassing most or all of a population in an intact

setting. In 1991, three demographic monitoring belt transects were established in the BLM exclosure by the method described in Lesica (1987), and an additional belt transect was established near Horse Prairie, in a roadside right-of-way setting also on BLM land. Data from the Badger Pass exclosure belt transects are tallied as a single data set, making up the same approximate sample size as the single Horse Prairie belt transect though covering a larger sample area.

This report summarizes results from the third year of revisiting marked plants in the Badger Pass exclosure, and the second year of reading the transects in both the exclosure and the Horse Prairie area. The transect readings provide important data not available in the marked plant study. Detailed transect readings are needed for a minimum of four years to make trend assessments.

II. STUDY SITES

The study sites and sampling locations are described in detail in previous monitoring establishment and progress reports (Achuff 1990, 1991). Notes and revisions on site transect and permanently-marked plant layouts are incorporated on a corrected table in Appendix B. This is to replace all previous site tables.

It was learned that road maintenance operations along FS Road 7340.1 had scraped out the right-of-way segment where the Horse Prairie transect is located in the late 1980s (Svoboda pers. comm.).

Study site experimental considerations are treated in the discussion section.

III. MONITORING METHODS

Methods for recording data from marked plants and reading the transects are provided in Achuff (1991). In order to examine differences in population structure, Penstemon lemhiensis individuals were placed into one of three size categories:

1 Seedling category = "S". It is represented by small rosettes with cotyledons evident or rosette diameter <15 mm. This was initially though to approximate the juvenile life history stage. However, several of the plants in the "S" class were reappearing plants, and do not correspond with a first year age class. In 1992, very small rosette buds that were part of largest plants were also noted for the first time and placed in the "S" class.

2 Nonflowering category = "R". It is represented by one or more rosettes, noting the number of rosettes. The number of rosettes generally reflects vigor. The rosette category does not represent an age class because plants were found to change back and forth between nonflowering and flowering categories.

3 Flowering category, having infloresences and with or without fruits, in addition to rosettes. Reproductive parameters tallied for each plant reflect reproductive outlay.

I = Inflorescences, i.e., total flowering stems. The low incidence of bolting was noted separately. The low incidence of leaf mining activity, more often on cauline leaves rather than rosette leaves, was noted.

B = Browsed infloresences, a subset of infloresence tally.

F = Fruits which are fertile.
Note: There was obvious moisture condensaton noted inside a small number of fruit capsules, appearing to have fungal decay, but these were included in with the Fruit total.

P = Predated fruits, a subset of fruits tally.

A = Separate tally of aborted fruits having no fruit formation apparent

In addition, plants which were dead were noted by "D". Plants which could not be relocated in subsequent years despite careful search were noted as "-" and presumed dead.

Few plants in the "S" class have been found to date, and the "S" class plants are merged in with the numbers of "R" plants in the tally of plant in vegetative (nonfruiting) vs. reproductive condition. The tally of individuals in these categories is taken to represent all individuals within a given area because there is no evidence of species dormancy over a growing season.

The number of viable seeds produced by a plant is the best indication of its reproductive outlay, but is impractical to monitor compared to counting fruits. To get an estimate of the relation between seed numbers and fruit numbers, tallies of viable seeds per fruit capsule were made in previous years. Capsules were collected in the past and examined for the number of viable-appearing seeds (Achuff and Shelly 1991, Shelly 1990), but there were so few capsules in 1992 that none were collected this year. Seed viability studies have not been conducted.

Information on the vigor and reproductive outlay of each plant was collected in tabulating rosette, infloresence and fruit information. A plant with five rosettes, two inflorescences, 12 fruits, and 25 aborted flowers was recorded as $R_5I_2F_{12}A_{25}$.

Tabulations and demography calculations are reported on an annual basis, and analyses will be run at the culmination of intensive monitoring to characterize rates of change and overall trends. Measurement calculations are summarized below:

Recruitment = % of new plants observed in year t to the number surviving from year t-1 to year t

Mortality = % of plants dying between year t-1 and t to the number surviving in the same period

Fecundity = number of fertile fruits per plant (not including aborted)

Average fruit production = number of fruits / number of fruiting plants

Browsing loss = 100 - (actual fruit production / potential fruit product: the number of fruiting plants x mean number of fruits per unbrowsed plant)

Abortion loss = 100 - (actual fruit production / potential fruit production: the number of maturing fruits on unbrowsed plants / number of maturing + aborted fruits on unbrowsed plants)

IV. RESULTS AND DISCUSSION

Recruitment, mortality, fecundity, browse loss and abortion loss values are presented below for the two sample sites:

PENSTEMON LEMHIENSIS MONITORING - Life History Highlights*

	BADGER PASS		HORSE PRAIRIE	
	1991	1992	1991	1992
Recruitment (%)	-	20	-	39
Mortality (%)	-	6	-	44
Browse Loss (%)	16	69	39	**
Abortion Loss (%)	72	82	28	**

* See Table 1, which follow report text, for more details
** All flowering plants at Horse Prairie were browsed in 1992, and all of the flowers which were produced had aborted

Penstemon lemhiensis population structure in the two belt transects for 1991 and 1992 is depicted in Figures 1 and 2, based on the field data recorded in Appendix 1. These indicate that the population size and structure is relatively unchanging over the two-year monitoring period. There are small declines in flowering at both sites.

Data on marked plants in the Badger Pass exclosure for 1990, 1991, and 1992 are presented in Appendix 1. The marked plant study is redundant with the belt transect study to some degree; 59% (N=of the plants in the belt transects are in the marked plant study. It is recommended that this marked plant monitoring data set be maintained because it includes one additional year of data, provides an opportunity to compare methods, and involves relatively little additional time.

The Badger Pass sample area has a greater component of flowering plants by a factor of four compared to Horse Prairie sample area, while it has only 25% as high a density as plants in the Horse Prairie area. The Horse Prairie transect lies entirely within a dry narrow right-of-way ditch scraped of all topsoil, apart from adjoining native community cover. It is hypothesized that the Horse Prairie flowering plants are survivors from the 1980s right-of-way scraping, and that all nonflowering plants represent more recent recruitment. This may reflect the disturbance origin of population establishment, with higher density and recruitment on the bare roadside surface.

The Horse Prairie transect is subject to the road maintenance activities of the U.S. Forest Service along FS Road 7340.1. Dialogue has been initiated with U.S. Forest Service on avoiding the monitoring site during at least the duration of the project. The value of the Horse Prairie transect may be enhanced by comparing subpopulation structure on the right-of-way and the adjoining intact upland. Expansion of the study design to include the adjoining upland will be considered in 1993.

The presence of species such as Penstemon lemhiensis in a road ditch does not make the species "weedy" or "adventive" just because it does not compete well with other plants or depends on some natural disturbance regime simulated by man-made disturbance. Its habitat is locally distinguished by low vegetation density (Ramstetter 1983). Neither does it make the ditch site a conservation priority. The small part of the population on intact uplands on its own represents a "D-ranked" element occurrence, and its extension into an unnatural setting by definition ranks no higher than "D-rank". Nevertheless the Horse Prairie site is being tracked as it may indirectly fit into species conservation by comparison.

Preliminary review of the data indicates that recruitment exceeds mortality in the Badger Pass site, signifying a stable or

expanding short-term trend. The relatively high recruitment rates at the Horse Prairie site are more than exceeded by the higher mortality rates.

The Badger Pass monitoring site lies completely within an exclosure, and may help in formulating hypotheses about the impact of grazing and browsing, but it was not set up as a controlled management response study. The exclosure restricts access by livestock, but not to wildlife. There are no clear patterns of difference between the browse levels between the Badger Pass exclosure site and the Horse Prairie site. The heaviest levels of browsing on Penstemon lemhiensis to date took place within the exclosure in 1992.

Related monitoring projects for Penstemon lemhiensis are underway on the Beaverhead National Forest and public lands in Idaho. It is recommended that monitoring data between studies be compiled at the culmination of demographic monitoring, and an updated statewide or rangewide status report be prepared.

It has been suggested in earlier studies and reports that Penstemon lemhiensis population numbers may be limited by availability of bare ground surface for recruitment (Ramstetter 1983, Shelly 1987, Schassberger 1990, Shelly 1990), and that oscillations in population numbers may make the many small-sized populations of Penstemon lemhiensis particularly vulnerable to extinction (Shelly 1990).

Therefore it is recommended that site groundcover data and nearby meteorological data be collected for all Penstemon lemhiensis monitoring sites. Monitoring of Penstemon lemhiensis on BLM lands will be pursued accordingly in 1993.

In summary, the present data provide baseline for extended monitoring. They are not in and of themselves sufficient to draw species biology conclusions, but by observing the individual plants and the changes in population structure over several years they will provide a valid basis for assessing the demographic characteristics and viability of Penstemon lemhiensis at the two monitoring sites.

V. LITERATURE CITED

Achuff, P. L. 1992. Demographic monitoring of Penstemon lemhiensis in the Dillon Resource Area, Montana; 1991 Progress Report. Montana Natural Heritage Program, Helena, MT.

Achuff, P.L. and J.S. Shelly. 1991. Demographic monitoring of Penstemon lemhiensis, Beaverhead National Forest; 1990 progress report. Montana Natural Heritage Program, Helena. 34 pp.

Lesica, P. 1987. A technique for monitoring nonrhizomatous, perennial plant species in permanent belt transects. Natural Areas Journal 7(2):65-68.

Massey, J.R. and P.D. Whitson. 1980. Species biology, the key to plant preservation. Rhodora 82: 97-103.

Ramstetter, J. 1983. An ecolgoical study of the regional endemic Penstemon lemhiensis (Keck) Keck & Cronq. (Scrophulariaceae). M.A. Thesis. University of Montana, Missoula, MT. 116 pp.

Schassberger, L. 1990. Report on the conservation status of Penstemon lemhiensis, a candidate threatened species, Montana. Montana Natural Heritage Program, Helena, MT.

Shelly, J. S. 1987. Status review of Penstemon lemhiensis, Beaverhead and Bitterroot National Forests, Montana. Montana Natural Heritage Program, Helena, MT.

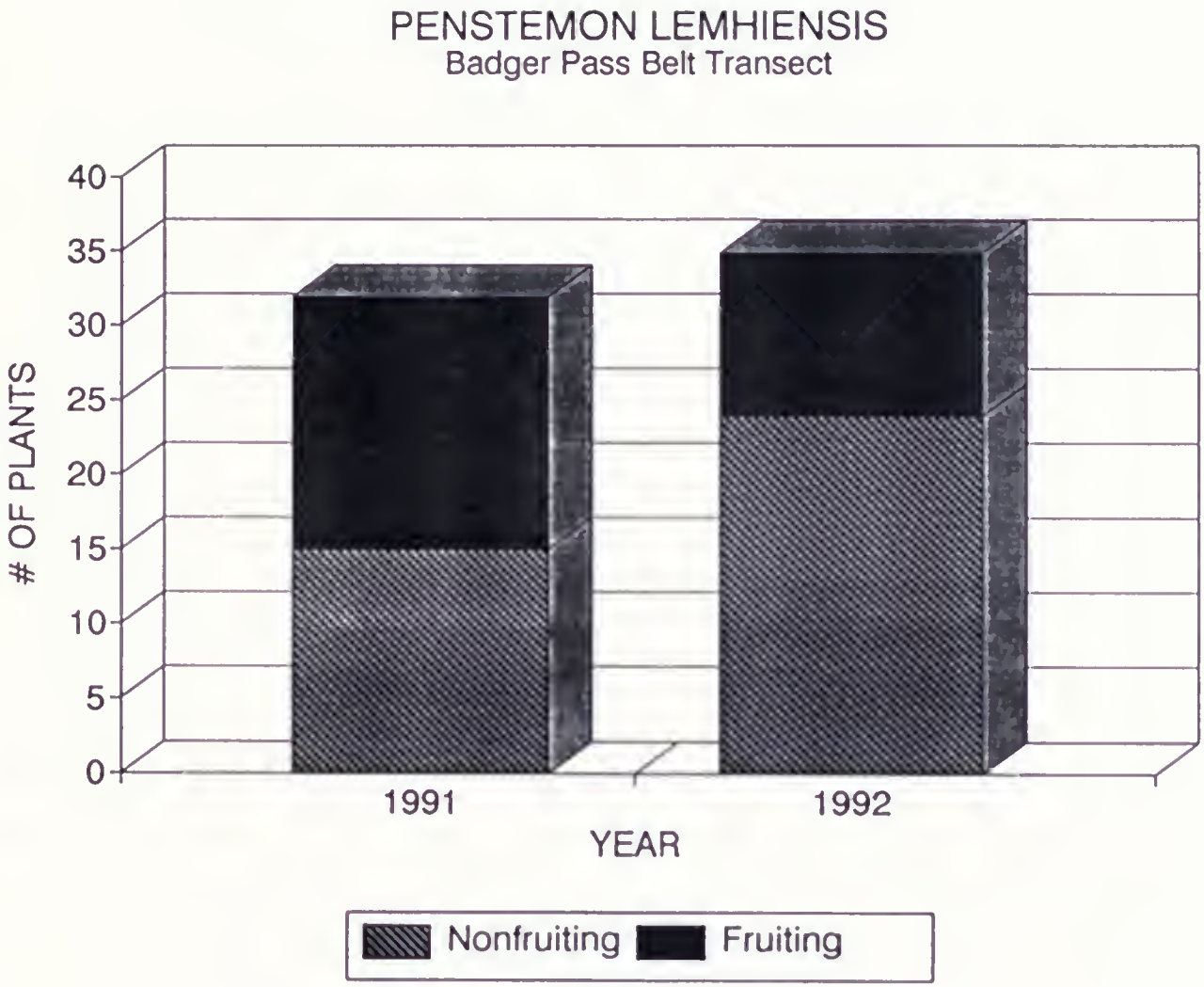
Shelly, J.S. 1990. Status review and establishment of demographic monitoring studies: Penstemon lemhiensis. Montana Natural Heritage Program report to Beaverhead and Bitterroot national forests, Montana. 61 pp.

Shelly, J.S. 1993. Demographic monitoring of Penstemon lemhiensis on Beaverhead National Forest; 1992 Progress Report. In progress.

U.S. Department of Agriculture - Forest Service. 1988. Sensitive Plant Field Guide for Montana.

U.S. Department of the Interior - Fish and Wildlife Service. 1990. Endangered and threatened wildlife and plants; review of taxa for listing as endangered and threatened species; notice of review. Federal Register 50 CFR Part 17: 6184-6229.

U.S. Department of Interior - Bureau of Land Management. 1993. Draft Special Status Plant Policy and List. Billings, MT.


PENSTEMON LEMHIENSIS
Badger Pass Belt Transect
OF PLANTS
40
35
30
25
20
15
10
5
0
1991
1992
YEAR
Nonfruiting
Fruiting

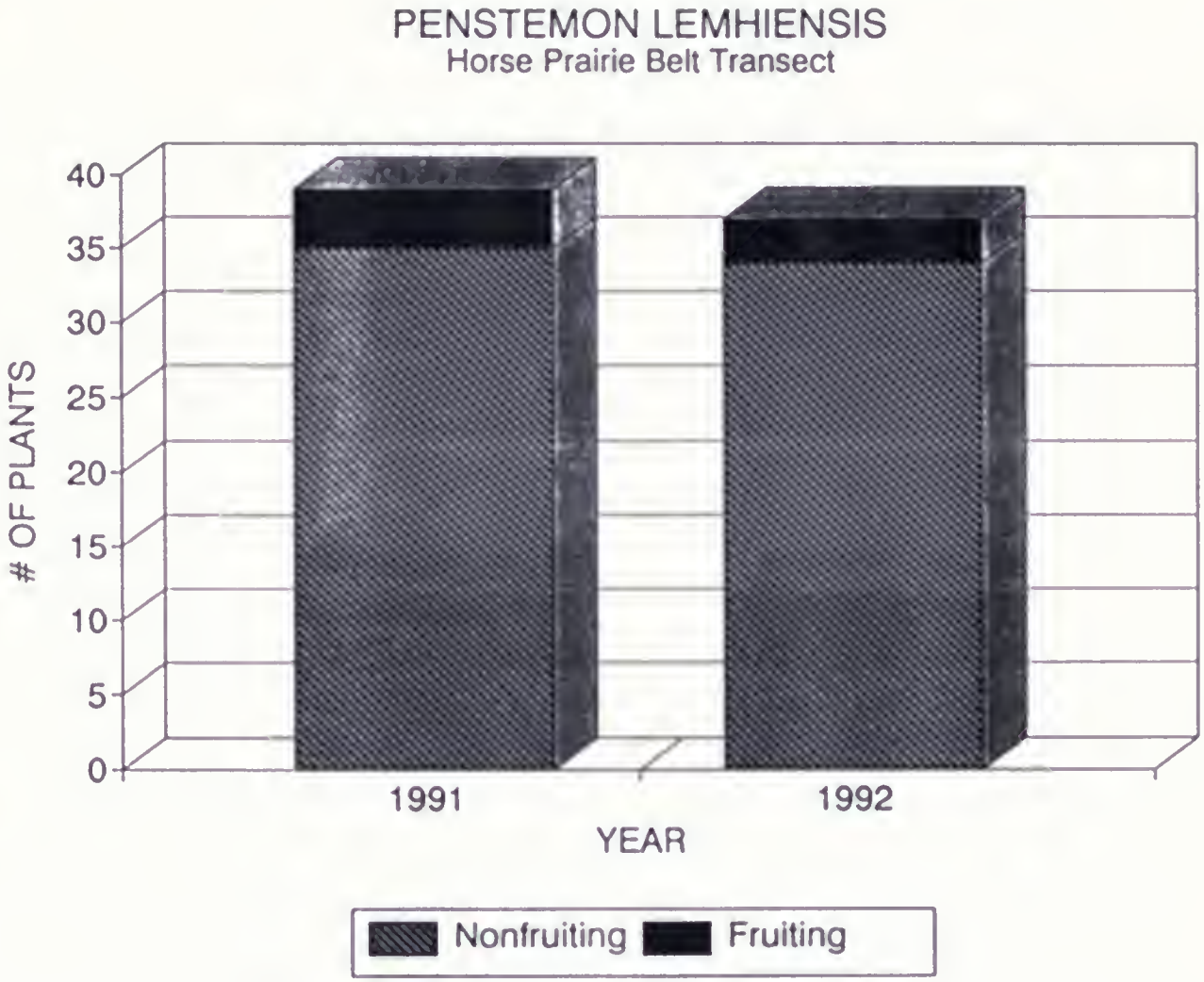

PENSTEMON LEMHIENSIS
Horse Prairie Belt Transect
OF PLANTS
40
35
30
25
20
15
10
5
0
1991
1992
YEAR
Nonfruiting
Fruiting

Table 1. Population data for Penstemon lemhiensis in long-term monitoring, Dillon Resource Area of Butte District, BLM, 1990-1992

	BADGER PASS RP1+2+3			BADGER PASS Transect 1+2+3 (area= 20m)		HORSE PRAIRIE Transect 1 (area=5m)	
	1990	1991	1992	1991	1992	1991	1992
Total # of plants	34	39*	39	31**	34	39	37
# Fruiting plants	18	17	17	16**	11	4	3
% Fruiting	53	44	44	52	32	10	8
Plant density/m	-	-	-	1.6	1.7	7.8	7.4
# Viable fruits	190	230	189	134	17	363	0
# Aborted fruits	401	723	294	353	75	144	6
% Aborted fruit loss	68	76	61	72	82	28	?***
% Browse loss	19	46	21	16	69	39	?***
% Mature fruits	32	24	39	27	18	16	0
# Stems/fr plant	1.3	1.7	1.8	1.5	1.7	3.0	4.0
Fecundity (fr/pl)	13	25	16	10	5	150	?***
Mortality # ****	-	1	1	-	2	-	14
Mortality	-	3	3	-	6	-	44
Recruitment #	-	-	-	-	6	-	12
Recruitment	-	-	-	-	20	-	39
Recruitment/mortality #s	-	-	-	-	3	-	0.85

* Seven individuals were added to the marked plant sample set in 1991.

** A plant mapped as two individuals in 1991 was remapped as one individual in 1992; the 1991 number was decreased accordingly.

*** All fruiting plants at Horse Praire were browsed in 1992; only aborted fruits were produced.

**** Plant #8 among the permanently marked plants was recorded as dead in 1991 and alive in 1992; it was excluded from mortality figures. This is the only reported incidence of dormancy, and may reflect a misinterpretation or a new plant establishing in the same place as the old one.

APPENDIX 1: DEMOGRAPHIC MONITORING DATA

These data show the performance of individual *Penstemon lemhiensis* plants in permanent monitoring plots in 1991 and, for some plants, in 1990. The following codes are used:

A = aborted flowers (no fruit formation apparent)

B = browsed flowering stem

D = dead

F = fruits

I = inflorescences (flowering stems)

P = predated

R = rosettes (basal tufts of leaves on mature plants)

S = seedling (cotyledons evident or rosette <15 mm in diameter)

The codes form a formula describing the state of the plant. For example, a plant with five rosettes, two inflorescences, 12 fruits, and 25 aborted flowers was recorded as $R_5I_2F_{12}A_{25}$.

BADGER PASS MICROWAVE EXCLOSURE MARKED PLANTS - RP1

Plant	1990	1991	1992
1	R4	D	D
2	R1	R1	R1
3	R4I1F14A17	R3I1F6A6	R2I1F5A6
4	R3	R4	R3
5	R12I1F24A10	R11I3F13A16P1	R17I2F19A9
6	R2	R1B1	R2

BADGER PASS MICROWAVE EXCLOSURE MARKED PLANTS - RP2

Plant	1990	1991	1992
7	R4I1F15A19	R5I3F31A75	R8
8	R1	D	R1
9	R6I4F4A109+	R7	R2
10	R8	R7I2F12A64	R4I3F30A36B1
11	R6	R4	R3S1
12	R5	R4I1F5A34	R4I1F18A23
13	R2I1F7A17	R4	R3
14	R1	R3	R1

14A	--	R1	R2

BADGER PASS MICROWAVE EXCLOSURE MARKED PLANTS - RP2 (cont.)

Plant	1990	1991	1992
15	R4B1F1	R3I3F23A84	R5I1F12A14
16	R5	R4	R5I3F14A22B2P7
17	R2I1F13A19	R5I1F11A41	R4I3F7A18B1
18	R4I1F12A21	R13I4F48A151	R18I5F61A76
19*	R4B1	R15	D
22	R8I1F6A10B1	R8I2F1A4B2	R5I3B3
23	R5I1F1A3B1	R5I3F17A45	R3
24	R7I2F23A31B1	R12I1F2A3B1	R7
26	R1	R3	R1
27	R6	R8I1B1	R7
29	R1	R4I1F6A27	R4
30	--	R7I1F15A38	R7S1
31	R5	R3I2F8A61	R3I2F5A16
32	R3I1F11A24	R3	R7I2F6A16

* Gaps in the sequence of plant numbers represent plants tagged in 1990 for which no signs of the plants or metal markers could be found in 1991.

BADGER PASS MICROWAVE EXCLOSURE MARKED PLANTS - RP3

Plant	1990	1991	1992
33	R4	R1	R1I1A1
34	R3B1	R1	R4
35	R14I2F36A35	R4I2B2	R4I1F2A8B1
36	R3I1F8A27	R3	R2
37	R3I1F8A32	R3	R3
38	R2I1F8A27	R3	R2
39	R2	R1	R1
40	--	R2I1F4A17	R1I1F2A13
41	--	R1I1F6A16	R2
42	--	R4I1F8A14	R4I1B1
43	--	R3	R3I3F8A36
44	--	R13I1F14A27	R19I1B1

BADGER PASS MICROWAVE TRANSECT 1

The number in parentheses is the tag number for numbered plants that occur within a transect.

Plot	Plant	1991	1992
1		-	-

BADGER PASS MICROWAVE TRANSECT 1 (cont.)

Plot	Plant	1991	1992
2	a	R2	R2
	b (37)	R3	R3
	c (38)	R3	R2
3-8		-	-
9	a (35)	R4I2B2	R4I1F2A8B1
	b (34)	R1	R1
	c (33)	R1	R1I1A1
10		-	-
11	a (36)	R3	R2
	b (39)	R1	R1
	c (40)	R2I1F4A17	R1I1F2A13

BADGER PASS MICROWAVE TRANSECT 2

The number in parentheses is the tag number for numbered plants that occur within a transect.

Plot	Plant	1991	1992
1	a	R3I3F14A35	R2S4I1F0A4B1
2-3		-	-
4	a	R4I3F14A44	R11I2F0B2
	b	R4I1F4A12	(part of above)
	c	R2	-
	d	R5I2F15A42	R6I4F4A13B2
5	a	R1	C1
	b	R1I1F5A23	-
	c	R1	R3
	d	R5I1F8A23	R3
	e	-	R2I1F1B1
6-8		-	-
9	a (41)	R1I1F6A16	R2
	b (42)	R4I1F8A14	R4I1B1
	c (43)	R3	R3I3F8A36
	d	-	R4
	e	-	R4
10	a (44)	R13I1F14A27	R19I1B1

BADGER PASS MICROWAVE TRANSECT 3

The number in parentheses is the tag number for numbered plants that occur within a transect.

Plot	Plant	1991	1992
1		-	-
2	a (30)	R7I1F15A38	R7S1
	b (29)	R4I1F6A27	R4
3	a	R1	R1
	b (24)	R12I1F2A3B1	R7
	c (27)	R8I1B1	R7
	d (23)	R5I3F17A45	R3
	e (22)	R8I2F1A4B2	R5I3B3
	f	-	R1
	g	-	R1
	h	-	R1
4	a	R1	D
	b (26)	R3	R1
	c	R1	R2
5		-	-

HORSE PRAIRIE MONITORING TRANSECT

Plot	Plant	1991	1992
1	a	R2	R2
	b	R1	R1
	c	R1	R1
	d	R2	-
	e	R2	-
	f	R2	-
	g	R2	R2S1
	h	R1	-
	i	R2	-
	j	R1	R3
	k	R1	R1S1
	l	-	R2S1
	m	-	R1
	n	-	R4
	o	-	R2
	p	-	R3
	q	-	R3

HORSE PRAIRIE MONITORING TRANSECT (cont.)

2	a	R1	R1
	b	R2	R3
	c	R14	R16I4F0B4
	d	R1	R1
	e	R1	R1S1
	f	R2	R1
	g	R2	-
	h	R3	S1
	i	S	-
	j	-	R1
	k	-	R1
3	a	R8I2B2	R2
	b	R1	-
	c	R12I5F63A55B2	D
	d	R10I4F208A65P1	D
	e	R2	-
	f	R1	R3
	g	R1	R1I1A4B1
	h	R3	R2
	i	R2	-
	j	R5	-
	k	R1	R5
	l	R1	R1
	m	R1	R4
	n	R1	R2
	o	R3	R5
	p	R2	R3
	q	-	R1
	r	-	R1
	s	-	R3
	t	-	R4
4	a	R11I1F92A24	R14I7A2B7
	b	R1	R2
	c	S	-
5		-	

MARKED PLANT AND TRANSECT LOCATIONS

Exclosure at Badger Pass microwave site.

Group 1. (RP1): RP1 (Reference Point 1) is the fence post in the northernmost corner of the exclosure (Fig. 1). The plants are located as follows:

Heading	Distance	From	To
231°	0.50 m	RP1	plant 1
126°	3.75 m	plant 1	plant 2
110°	3.60 m	plant 2	plant 3
140°	1.75 m	plant 3	plant 4
222°	4.95 m	plant 4	plant 5
112°	4.30 m	plant 5	plant 6

Group 2 (RP2): RP2 (Reference Point 2) is a corner post at a jog in the fence in the central northwest part of the exclosure (Fig. 1). **An individual plant, #14A, was inserted into the sequence in 1991, located <10 cm from #14, at ca. 45 degrees. Gaps in the tag number sequence represent plants which could not be relocated in 1991 and which are omitted from consideration in 1991.** The plants are located as follows:

Heading	Distance	From	To
112°	4.75 m	RP2	plant 7
157°	23.15 m	plant 7	plant 8
261°	13.10 m	plant 8	plant 9
260°	10.40 m	plant 9	plant 10
301°	0.50 m	plant 10	plant 11
195°	0.40 m	plant 11	plant 12
318°	0.40 m	plant 12	plant 13
83°	0.10 m	plant 13	plant 14
27°	0.50 m	plant 14	plant 15
222°	1.20 m	plant 15	plant 16
90°	0.25 m	plant 16	plant 17
132°	1.15 m	plant 17	plant 18
132°	0.50 m	plant 18	plant 19
253°	7.35 m	plant 19	plant 22
nd	0.30 m	plant 22	plant 23
nd	0.15 m	plant 23	plant 24
nd	0.40 m	plant 24	plant 26
nd	0.40 m	plant 26	plant 27
nd	0.70 m	plant 27	plant 29
148°	0.82 m	plant 29	plant 30
165°	17.70 m	plant 8	plant 31
70°	9.00 m	plant 31	plant 32

Group 3 (RP3): RP3 (Reference Point 3) is the fence post in the corner of the exclosure closest to the microwave tower (Fig. 1). The plants are located as follows:

Heading	Distance	From	To
356°	12.40 m	RP3	plant 33
55°	0.15 m	plant 33	plant 34
157°	0.40 m	plant 34	plant 35
174°	7.20 m	plant 35	plant 36
228°	0.60 m	plant 36	plant 37
nd	0.20 m	plant 37	plant 38
nd	0.45 m	plant 38	plant 39
40°	0.65 m	plant 39	plant 40
190°	1.25 m	rebar	plant 41
190°	1.35 m	rebar	plant 42
190°	1.45 m	rebar	plant 43
180°	1.00 m	plant 43	plant 44

B. BADGER PASS MICROWAVE EXCLOSURE MONITORING TRANSECTS

1. **Transect 1:** The starting pin for transect 1 is located 3.58 m from RP3 on an azimuth of 10°. The transect runs for 10 m at 10° with the 1 m^2 plots lying along the west side of the baseline. An additional 1 m^2 plot lies on the east side of the baseline between meters 1 and 2.

2. **Transect 2:** The starting pin for transect 2 is 13.8 m at 160° from the omnidata pod cover (Fig. 1) and is at the south end of the transect. The transect runs at 340° for 5 m. The 1 m^2 plots are along the east side of the baseline. **Individual plant #44 falls outside of plot #10 in the continuous belt along the transect. It lies perpendicular to the transect rather than parallel to it. The area around it is tentatively renamed as plot #10.**

3. **Transect 3:** The starting pin for transect 3 is 2.8 m north of RP4, a painted fence post along the southwestern perimeter fence (Fig. 1) and is at the south end of the transect. The transect runs for 5 m at 350° along the edge of the trees parallel to the fence **and plots 1-5 are on the east side of the line, with the tape as the bottom edge of the square.**

C. HORSE PRAIRIE MONITORING TRANSECT

The Horse Prairie transect is located at the site of the Montana Natural Heritage Program element occurrence 027 for Penstemon lemhiensis. The site is about ½ mile southeast of the Horse Prairie Guard Station. The transect is located on the north side of the road **about halfway between the third water bar and the cattle guard while going up the hill (not between the second and third water bars)**. The transect runs parallel to the road in a generally westerly direction and is 5 m long. The 1 m^2 plots are north (upslope) of the base line. **The transect is read from west to east.**