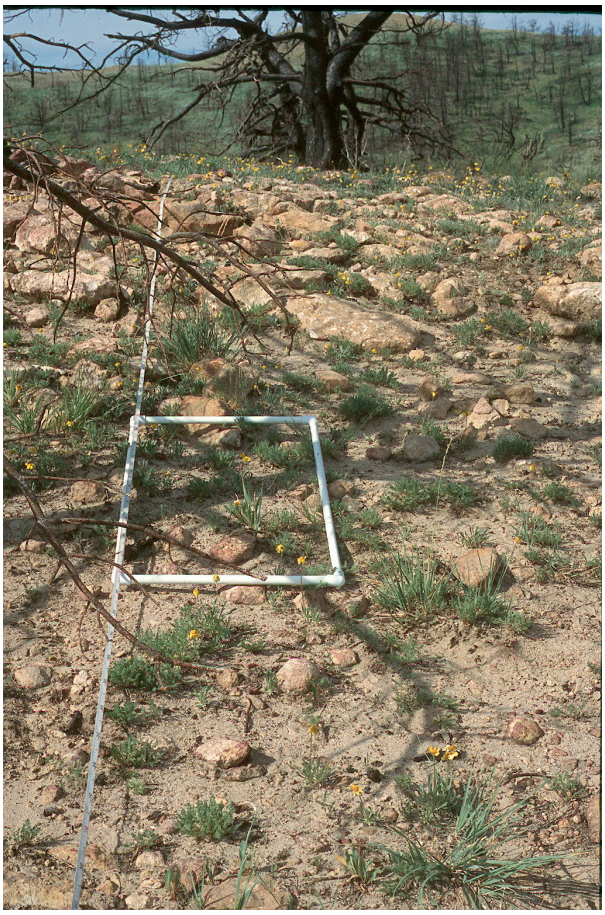
Demographic monitoring of Evert's waferparsnip (*Cymopteris evertii*) following the 2000 Enos Fire



By:

Bonnie Heidel
Wyoming Natural Diversity Database
University of Wyoming
P.O. Box 3381
Laramie, WY 82071

Prepared for:
Bureau of Land Management
Worland Field Office and Wyoming State Office

November 2002

Agreement #KAA010012
Task Order No. TO-011

Abstract

Evert's waferparsnip (*Cymopteris evertii*) is a regional endemic of northwestern Wyoming and northeastern Utah that is currently known from 18 extant occurrences in Wyoming and at least 2 more in northeastern Utah. It was surveyed in 1988 and 1998 to produce conservative Wyoming species number estimates of over 30,000 individuals in over 300 acres of habitat. Most populations were characterized as relative secure due to their location in rugged, relatively inaccessible habitats.

One of the populations thought to be relatively secure is on a ridge above Enos Creek in the Owl Creek Mountains. It was also one of three populations where permanent demographic monitoring had been established in belt transects in 1998. The population and its ridgetop habitat burned in the 2000 Enos Fire. Monitoring of this population was replicated in 2002 to evaluate species' response to wildfire.

The 2002 monitoring results document a net decline of less than 10%. Mortality levels approached or exceeded 50% among well-established plants. But the decline is compensated at least in part by high recruitment levels, and the numbers of small plant numbers two years after fire was over twice as high as previously recorded in all 1998 monitoring results.

This monitoring study provides preliminary evidence that the long-lived Evert's waferparsnip (*Cymopteris evertii*) survives and propagates after fire. Survival and recruitment levels approached or exceeded mortality levels in the short term after intense crown-fire. If flowering levels are enhanced over the long-term by nutrient influx and reduced competition, there may be a positive long-term population trend in the monitored subpopulation.

A provisional checklist of monitoring design considerations and species response criteria are provided to apply these results to BLM sensitive species policy for Evert's waferparsnip (*Cymopteris evertii*) in particular, and as a springboard for evaluating sensitive species responses to fire in general.

Cover: Evert's wafer-parsnip (*Cymopteris evertii*) persists in a 30 meter permanent belt transect after the 2002 Enos Creek Fire (view looking south).

Table of Contents

Introduction 1
Methods 2
Study Site 3
Results 6
Discussion 9

Figure 1. Illustration of *Cymopteris evertii*
Figure 2. Overview of monitoring site on ridge north of Enos Creek, 4 July 1998
Figure 3. Overview of monitoring site on ridge north of Enos Creek, 28 June 2002
Figure 4. South end of transect, 1998
Figure 5. North end of transect, 1998
Figure 6. South end of transect, 2002
Figure 7. North end of transect, 2002
Figure 8. Number of *Cymopteris evertii* individuals by size class in 1998
Figure 9. Number of *Cymopteris evertii* individuals by size class in 2002
Figure 10. *Cymopteris evertii* distribution along transect in 1998
Figure 11. *Cymopteris evertii* distribution along transect in 2002
Figure 12. Small *Cymopteris evertii* plants
Figure 13. Charred rootcrown of dead *Cymopteris evertii* plant
Figure 14. Vigorous, flowering medium-size *Cymopteris evertii* plants along belt transect
Figure 15. South-facing slope directly below belt transect, overlooking Enos Creek

Table 1. Number of *Cymopteris evertii* individuals by size class in 1998
Table 2. Number of *Cymopteris evertii* individuals by size class in 2002
Table 3. Density of *Cymopteris evertii* in 1998 and 2002
Table 4. Vegetation composition in 1998 and 2002
Table 5. Conditions of the 2000 Enos Fire

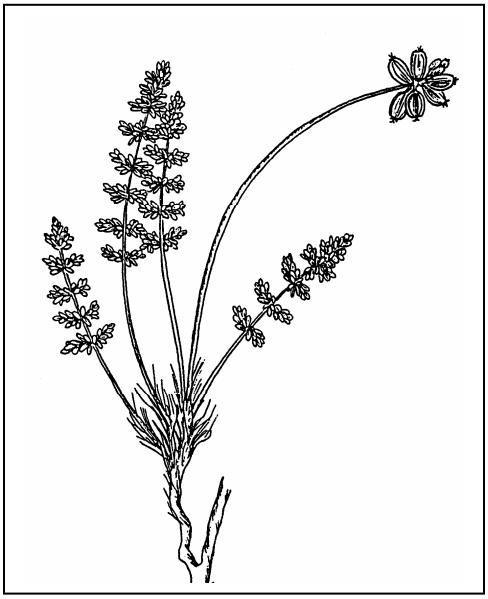
Appendix A. Transect #3 Census Data
Appendix B. Transect #3 Raw Data
Appendix C. Updated Element Occurrence Record

Acknowledgements

This project reflects the breadth and depth of the prior *Cymopteris evertii* status survey conducted by Laura Welp Fertig and Walter Fertig (WYNDD), and would not have been possible without their original work. The support and interest of Karen Hepp and Jeff Carroll in coordination with Walter Fertig made the original work and current work all possible. Review and comments provided by Scott Laursen and Gary Beauvais (WYNDD) are gratefully acknowledged.

Introduction

Figure 1. Illustration of *Cymopteris evertii*, by Walter Fertig



The goals of the USDI Bureau of Land Management (BLM) Wyoming policy for sensitive species are to:

- Maintain vulnerable species and habitat components in functional BLM ecosystems
- Ensure sensitive species are considered in land management decisions
- Prevent a need for species listing under the Endangered Species Act
- Prioritize needed conservation work with an emphasis on habitat

Evert's wafer-parsnip (*Cymopteris evertii*) is a Wyoming BLM sensitive species (USDI BLM 2000) and a regional endemic of northwestern Wyoming and northeastern Utah. It is a Wyoming plant species of special concern global and state ranks of G2G3/S2S3 indicating it is on the border between recognition as imperiled and vulnerable (Fertig and Heidel 2002). Systematic surveys of it were conducted in 1988 (Marriott 1988), in 1992 (Fertig 1992) and in 1998 (Fertig et al. 1999) to determine that it is currently known from 18 occurrences in Wyoming, in two counties (Dorn 2001), plus at least two more occurrences in northeastern Utah. Most populations were characterized as relatively secure due to their location in rugged, relatively inaccessible habitats.

As part of the 1998 surveys, baseline demographic monitoring plots were set up as belt transects in three major populations to monitor density, size distribution, and reproductive potential over time. The results of such monitoring help determine whether BLM sensitive species goals are being met, provide species life history data, and contribute to our understanding of the species status and conservation needs.

One of the populations considered relatively secure was documented on a ridge above Enos Creek in the Owl Creek Mountains (element occurrence #024.) It was one of three populations where permanent demographic monitoring were established in a belt transect in 1998 (Transect #3; Fertig et al. 1999.) This population was chosen because it was higher in the foothills so it provided a contrast with the lower elevation population sites. It also had more reproducing plants than the other two population sites (Fertig et al. 1999.)

Two years later, this population and its ridgetop habitat burned in the 2000 Enos Fire. Monitoring of this population was replicated in 2002 to evaluate species' response to the wildfire, a very specific research task that potentially has bearing on species status and conservation needs. The objectives of this project were to remeasure, describe, and photograph the species and its habitat after fire, document any weeds present, and survey the Enos Fire for additional or new populations.

Methods

The permanent belt transect monitoring site was relocated with the directions and documentation presented by previous researchers (Fertig et al. 1999) and copied below:

County: Hot Springs.
Occurrence: The element occurrence number is #024, rather than #022 as originally reported with the 1998 monitoring results.
Legal Description: T46N R100W S28 SW4 of NE4 of NE4.
Orientation: 29º NNE.
USGS Quad: Adam Weiss Peak.
Directions: Drive west on BLM road 1303 along Enos Creek to two-track on north side of road (see map (T46N R100W S27). Follow two-track up to ridgetop and turn west (Slide 15). Follow faint two-track along ridge ca. 0.5 mile. Path will pass through a stand of trees and then open out to a dip in the ridge. There is a large dead tree near fence where the ridge begins to rise again (Slide 16). Walk to the west side of this tree. The end of the belt tranect is 7 paces away at 328º near a fence post. From the endpoint, walk 30 meters at 219º to the origin. Both the origin and the end point are marked by orange-tipped re-bar and a small pile of stones (Fertig et al. 1999).

A 30 x 0.5 meter permanent belt transect was established by Laura Welp on 4 July 1998 following the general protocol of Lesica (1987). It marked by permanent rebar at both ends. *Cymopterus evertii* is so small that the 1 x 1 square meter plots used by Lesica were considered impractical, so they were modified to 0.5 x 1 meter plots, with the long side parallel to the tape (see the cover photograph). The record of the original monitoring work reported that the belt transect was read from the origin to the endpoint in 1 meter increments on the left side of the tape. The origin for this transect was reported to be the north end near the fenceline and the end point was reported to be the south end (see directions, above). However, all circumstantial evidence indicates that the transect was originally read in the opposite direction, from the south "endpoint" to the north "origin", on the righthand (western) side of the tape. This interpretation is based on the pattern of species distribution along the transect. It is not evenly distributed along the belt transect but was highly skewed toward the north end of the line in 1998 and in 2002. Judging by this pattern as a long-lived perennial, it appears that the belt transect at this site was read in reverse.

Photographs from the 1998 work were on file that showed the general setting, and the view of the belt transect from opposite ends. The general setting and pair of transect photos were replicated for direct comparison between 1998 pre-burn conditions and 2002 post-burn conditions, as well as for future reference (Figures 2 - 7). In the 2002 revisit, all of the features could be relocated, though the ridge top stand of trees was killed by crown fire, and the large dead tree near the northern end of the transect had toppled.

In each ½ m plot, data were collected on percent vegetative cover and number of individual plants in each of three age/size classes: Small (1-3 cm. in diameter); Medium (3.1-10 cm. diameter); and Large (>10 cm in diameter). Diameters were measured across the top of the largest part of the canopy. Size apparently does not always correspond to reproductive capacity in this species, since some plants in the Small range bore evidence of past fruiting/flowering. Therefore, categories could not be based on life stage, although it is assumed that the smaller

plants are younger. The number of Reproductive plants was recorded, along with the number of fruiting heads on each plant. Dead plants of any size class were noted.

Clusters of individuals were recorded as one plant on the data sheets, since individual plants could not be distinguished without digging up the cluster. The diameter of each cluster was recorded on the data sheet approximately where it occurred spatially in the plot, marked in a small box with tick marks at 20 cm intervals. In addition, the number of fruiting heads on reproductive individuals was recorded as a subscript under the diameter and the two numbers were circled.

It was originally suspected that shading might influence *Cymopterus evertii* populations in some way, so a coarse categorization of the amount of shade falling on each plot during the midpoint of the day was estimated by judging how much overstory canopy was directly above the plot. S = plot is shaded during midpoint of day; P = plot is partially shaded during midpoint of day; U = plot unshaded during midpoint of day. The percent vegetative cover and the level of shade were recorded in a box within each plot. All trees in the vicinity were killed by the 2000 Enos Fire, so there were no shaded plots in 2002. If standing dead trees cast more than 5% of the plot in midday shadow, it was recorded as partially shaded; DP = partially shaded by dead standing trees.

The monitoring transect was reread on 28 June 2002 following the original methods. In addition, the percentage or rock cover and percentage of slope was also noted in each frame. To address the survey needs, the whole local subpopulation was censused to tally all plants in and around the belt transect. The lack of litter and standing dead vegetation facilitated census. To evaluate weed invasion in the immediate vicinity, a checklist of associated species was prepared over the subpopulation area. This also offers a preliminary comparison between previous descriptions of common species and species composition in 2002.

Demographic monitoring data were analyzed in 1998 to determine the tally and density of plants by size class. Data analysis was repeated and graphed in 2002, and expanded to determine the level of mortality among established plants (over 3.1 cm diameter), and examine the spatial pattern of mortality along the 30 m transect.

Attempts were made to use the 1998 data and 2002 data for comparing the fate of individual plants over time, the most revealing level of demographic analysis. This did not prove to be possible because plants were originally mapped with +/- 20 cm precision, they were not monitored for consecutive years, and the only prospective “survivors” in the transect were in clusters where there were almost always more than 1 plant per 20 cm. In the future, this precision is possible if the plants are mapped in greater detail, e.g., on graph paper for each plot, and if monitoring is conducted in consecutive years.

Study site

The monitoring plot is established in the largest of four *Cymopteris evertii* subpopulations of element occurrence #024 on the ridge system north of Enos Creek (7080 ft. elevation). The montane setting for this subpopulation is on the top and crest of the rocky sandstone ridge comprised of coarse sandy red soil derived from the Aycross Formation. The slope ranges from

0-5% (mean: 1%) and the proportion of bare rock ground cover in each plot ranges from 1%-60% (mean: 22%). The ridge slope is steep and drops abruptly below the 30 m transect at both ends, steeper on the south end. The 30 m^2 transect cuts across the full width of the ridge in a N-S direction. The vegetation was originally characterized as open *Pinus flexilis* / *Artemisia tridentata* var. *vaseyana* savanna with *Juniperus scopulorum*. All individuals of these woody species were killed by the 2000 Enos Fire in the immediate vicinity of the plot (Figures 2 and 3).

Figure 2. Overview of monitoring site on ridge north of Enos Creek, 4 July 1998.
The transect runs from the middle of the lefthand photo margin behind trees to a point behind the trees that are in back of the standing dead tree.

Figure 3. Overview of monitoring site on ridge north of Enos Creek, 28 June 2002
(Note the bend in the fenceline and the toppled tree below that corresponds with the standing dead tree in the 1998 photo above.)

Figure 4. South end of transect, 1998

Figure 5. North end of transect, 1998

Figure 6. South end of transect, 2002

Figure 7. North end of transect, 2002

Results

Demographic results:
There was a 9.7% net reduction in the total number of *Cymopteris evertii* plants in the permanent belt transect between 1998-2002, a downward trend from 165 to 143 (Tables 1 and 2). This is a modest change in total numbers compared to the dramatic change within population size classes between 1998-2002 (Figures 8 and 9). There was a tenfold drop in the number of large plants (>10 cm diameter), from 51 individuals to 4 individuals. This was countered at least in part by a greater than threefold increase in the number of small plants (0-3 cm diameter), from 23 to 76 individuals (Tables 1 and 2, Figures 10 and 11).

Figure 8. Number of *Cymopteris evertii* individuals by size class in 1998

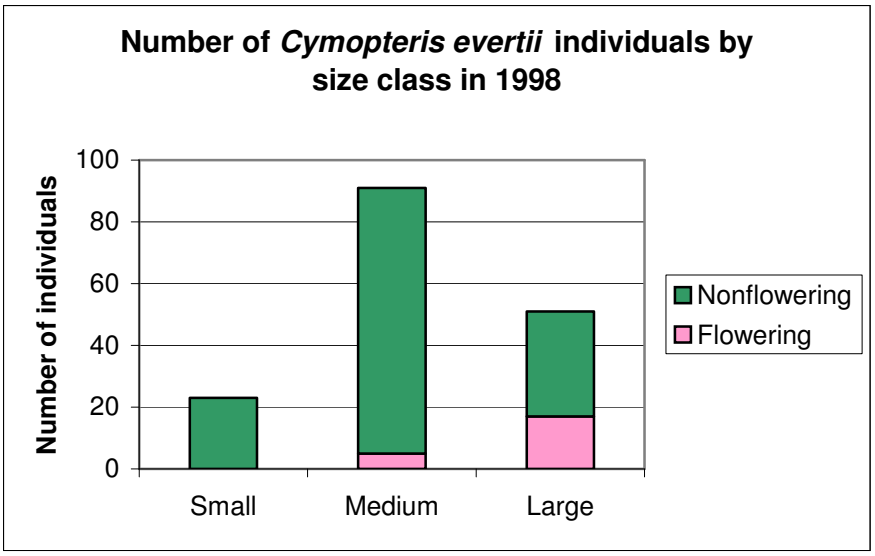


Table 1. Number of *Cymopteris evertii* individuals by size class in 1998

	Sm	Med	Lg	Total
Flwr	0	5	17	22
Nonflwr	23	86	34	143
Total	23	91	51	165

Figure 9. Number of *Cymopteris evertii* individuals by size class in 2002

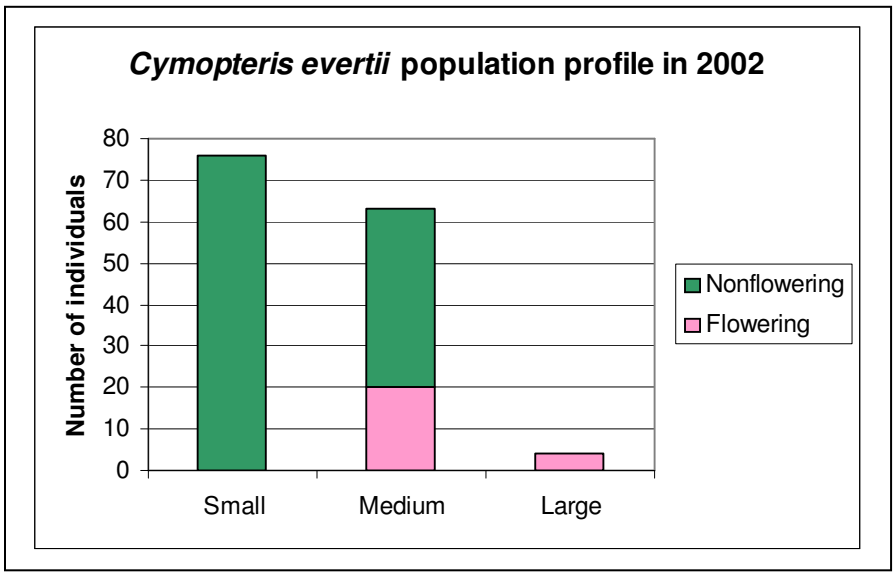


Table 2. Number of *Cymopteris evertii* individuals by size class in 2002

	Sm	Med	Lg	Total
Flwr	0	20	4	24
Nonflwr	76	43	0	119
Total	76	63	4	143

This same pattern is evident in comparing density values tabulated for 1998 and 2002 (Table 3).

Table 3. Density of *Cymopteris evertii* in 1998 and 2002

Parameter	**1998**	**2002**
Total density/m^2	11.2	9.5
Density of Small/m^2	1.5	5.1
Density of Medium m^2	6.1	4.3
Density of Large/m^2	3.6	0.3
Density of Reproductive/m^2	1.3	1.5
Reproductive plants by class size (Small, Medium, Large)	0 Sm; 5 Med; 17 Lg.	0 Sm; 20 Med; 4 Lg
# plants in **S**haded, **P**artially shaded, and **U**nshaded plots	S27; P112; U36	S0; P83 ;U60

The total number of flowering plants appears to be very similar in 1998 and 2002, as did the number of flowering stalks (1998 total: 64; 2002 total: 67). Though there were similar reproductive levels, there is no data on seed set. Many of the flowering stalks in 2002 appeared to have nothing but aborted flowers.

Survey results:
Total population numbers for element occurrence # 024 were censused at 564 in 1998, including 360 plants in the ridge top subpopulation where the permanent belt transect is placed. Casual observation in 2002 indicated that the subpopulation was much larger than 360 plants. Census was taken in and around the belt transect, which covered less than 1 acre. A total of 1046 individual plants were counted, and estimates were rounded up to 1100-1200 for the subpopulation. If the other three subpopulations still have the same numbers in 2002 as they did in 1998 (214 individuals, total), then the entire population is likely to have numbers of at least 1300-1400.

Did the population numbers double due to fire? Possible explanations for this difference between estimated 1998-2002 numbers include difficulty in 1998 discerning *Cymopteris evertii* plants among litter and vegetation cover, or real increases in subpopulation numbers. Since the population numbers declined within similar habitat and fire conditions in the immediately adjoining area of the belt transect, it is unlikely that species numbers were showing opposite response patterns in the same locale and more likely that 1998 population estimates were low in tallying individuals outside the sampling area. The number of plants within the belt transect (145) represents almost 15% of the local subpopulation (1046). The species' habitat at this local is not in a linear band, and it seems more likely that the belt transect as a ½ m strip of species habitat would encompass a small fraction of total subpopulation numbers as opposed to over 50% (164 of 360 individuals in 1998).

Weed results:
Lists were compiled of the species known to be present at the Enos Creek monitored subpopulation in 1998 and 2002 (Table 4). Exotic species and noxious weeds in particular were sought across the ridgetop area. No noxious weeds are present and only trace amounts of two

exotic species were found, including *Taraxacum officinale* and *Tragopogon dubius*. Notes on the distribution of woody species in 1998 are based on dead plant remnants in 2002. The southern rim of the ridge had the highest concentration of weedy or adventive species, and some showy species displays of native species like *Gaillardia aristata*. It appeared that many of the species were survivors rather than newly-established, and some may have seen major decline in numbers. For example, *Elymus spicatus* was present in only a couple bunches whereas it may have been common prior to the fire. This site-specific list of associated species includes all of the species characterized as frequently occurring with *Cypmopteris evertii*, as presented in Fertig et al. (1999), with the exception of: *Armisia frigida, Cymopterus longiglobus, C. terebinthinus, Elymus elymoides*, and *Phlox muscoides*. Some of these may be more characteristic of its low elevation habitats rather than missing in the wake of fire.

Table 4. Vegetation composition in 1998 and 2002 at the Enos Creek monitored subpopulation

Species[1]	**1998**	**2002**
Achillea millefolium		X
Allium geyeri		X
Antennaria rosea		X
Artemisia tridentata var *vaseyana*	Throughout	Killed; no regen.
Astragalus miser var *decumbens*		X
Cerastium arvense		X
Elymus lanceolatus		X
Elymus spicatus	X	X
Eremogone nuttallii	X	X
Erigeron compositus	X	X
Juniperus scopulorum	At ridge edges	Killed; no regen.
Koeleria macrantha	X	X
Lepidium spp.		X
Leucopoa kingii	X	X
Linum lewisii		X
Lupinus argenteus		X
Monolepis nuttalliana		X
Musineon spp.		X
Penstemon laricifolius		X
Pinus flexilis	Open scattered canopy	Killed; no regen.
Poa secunda		X
Potentilla ovina		X
Sedum lanceolatum	X	X
Stipa nelsonii		X
*Taraxacum officinale**		X
Tetraneuris acaulis var *acaulis*		X
*Tragopogon dubius**		X
Vicia americana		X

[1] Exotic species are marked by an asterisk

Discussion

Mortality and recruitment are responsible for the change in the numbers of plant populations over time. The 1998 monitoring results suggested that reproduction may be sporadic and that plants are long-lived once established (Fertig et al. 1999). The 2000 Enos Fire appears to represent a major episode of plant death and recruitment corresponding with an intense crown fire.

All of the individuals that are medium- or large-size (3.1 cm diameter or greater) appear to be well-established and have well-developed root crowns. If such root crowns require more than two full growing seasons to develop, then plants with root crowns in 2002 are all survivors of the 2000 Enos Fire. A comparison of numbers for medium- and large-size individuals in 2002 compared to 1998 reflects fire mortality in large part, and there was a loss of 48.6% of well-established plants (69 survivors among 142 original plants). The persistence of dead, intact root crowns suggests that the species cannot resprout from the subterranean root but only resprouts from apical meristem at the root crown (Figure 13).

Small plants may be either new plants or established plants in which parts of their root crown was killed. In a few cases, plants that were clearly seedlings were evident in 2002 (Figure 12). Since this monitoring took place two years after the burn, post-fire recruitment and mortality could not consistently be discerned based on the sum totals. The 2002 monitoring results had over twice the density of small plants compared to 1998 monitoring results, reflecting a resilience of established plants or a flurry of germination and establishment.

A monitoring baseline of pre-burn trends is not available for interpreting 2002 results, but long-term monitoring of other umbels growing from a woody root crown (Heidel 2001) indicates that:

1) Established plants can live for some number of decades,
2) Almost all changes in size class over time are increases in size, and
3) Established plants are generally less likely to die from year-to-year under normal conditions than small-size plants.

This provides the basis for preliminary interpretations and hypotheses above.

Another mortality pattern became obvious as monitoring started in 2002. The southern 1/3 of the belt transect had no plants, i.e. complete mortality. Species numbers were concentrated at the north end in both 1998 and 2002. There was no survivorship or recruitment of new plants at the southern end (see Figures 10 and 11).

To evaluate that pattern, the distribution of plants per plot was graphed from the 1998 and 2002 date (Figures 10 and 11). In addition, fire pattern and intensity observations were recorded from the area. The scars on the trees and patterns of the burn across the landscape suggest that the fire reached the ridge from the south-facing slopes below. The high mortality at the south end may reflect intense fire temperature patterns at that end. Immediately north of the belt transect, a fence line runs perpendicular. A few of its wooden fence poles closest to the belt transect had been replaced since the fire, presumably because of fire damage. An aluminum can along the fence line had melted in spots, also indicating extremely high fire temperatures at the north end of the belt transect. Despite the stony ridge top surface, there were no surviving woody plants or standing dead herbaceous material persisting.

Figure 10. *Cymopteris evertii* distribution along transect in 1998

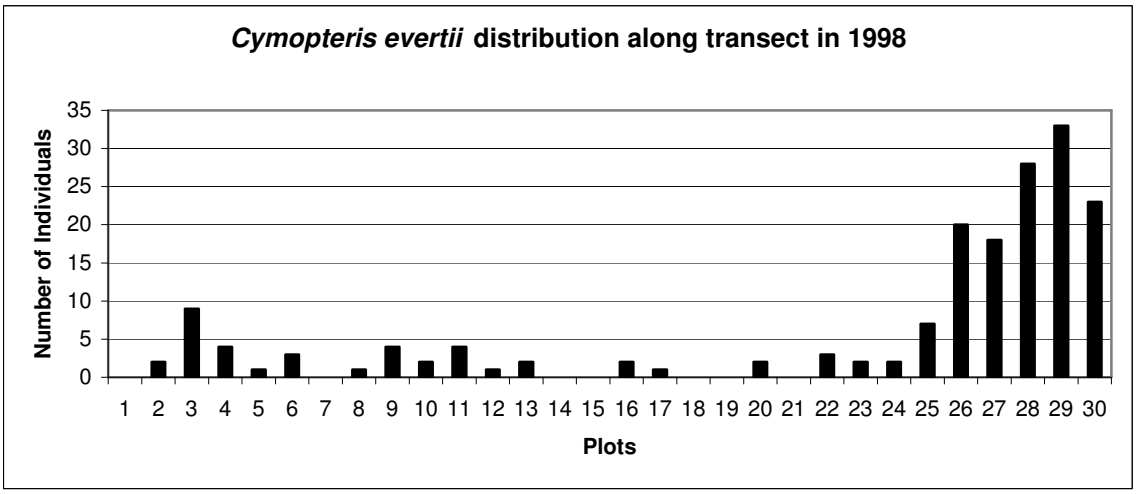
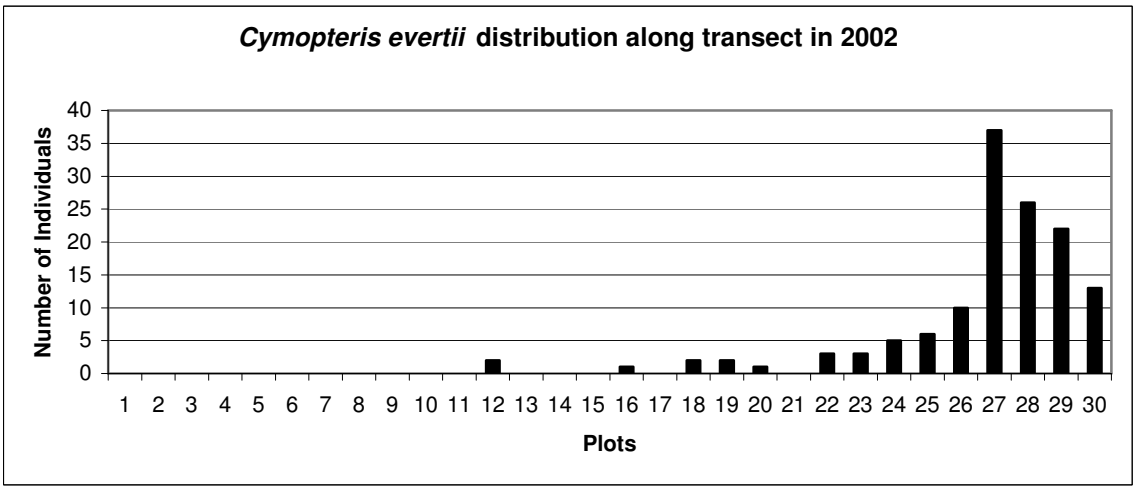


Figure 11. *Cymopteris evertii* distribution along transect in 2002



The left side of the graphs (above) correspond with the southern end of the belt transect, where plant mortality was highest and recruitment was absent. Even though the transect was only 30 m long, there is evidence of a gradation in response, possibly refelct fire intensity.

The high-intensity, stand-replacing conditions of the 2000 Enos Fire are aberrant for this landscape. Nevertheless, *Cymopteris evertii* had significant survivorship (ca. 50%) and major recruitment. The immediate short-term decline due to mortality may or may not be compensated by continued recruitment and elevated flowering.

Every plant species' response to fire is conditioned by the timing of a burn (i.e., the timing in relation to the life cycles of the species), the area of the burn, the frequency of burn, and the intensity of burn (Hessl and Spackman 1995). A profile of the burn conditions as best we know them is summarized in Table 5.

Table 5. Conditions of the 2000 Enos Fire

Fire parameters	**2000 Enos Fire**
Timing of fire	?
Stage of plant life cycle at time of fire	?
Area of burn	Extensive (Figure 15)
Historical fire frequency and regime	Semi-frequent, low intensity
Intensity of burn	Intense, particularly at south end

Every plant species' response to fire is also conditions by its botanical and ecological characteristics. A framework for comparing species' in their "pre-adaptation" of "resilience" to fire is provided in the Fire Effects Information Database (http://www.fs.fed.us/database/feis/plants). The characteristics fall under the headings of:

- General botanical characteristics
- Raunkiaer life form
- Regeneration processes
- Site characteristics
- Successional status
- Seasonal development

In addition, it is ideal to have baseline demographic monitoring to determine the key life history stages that condition population viability and then separately evaluate species' response to fire with a focus on the particular stage(s) (e.g., Heidel and Shelly 2001). While this is not available for *Cymopteris evertii*, many other key attributes are known or inferred, as highlighted below:

Table 6. Fire adaptation and resilience of *Cymopteris evertii* and its habitat

Species and species' habitat parameters	***Cymopteris evertii***
Life form and life cycle	Herbaceous perennial
Position of perennating bud	Root crown immediately at or below surface
Flammability	Unknown; has high concentration of volatile oils
Persistence of seeds in the soil	Presumed to be a seed bank
Colonizing ability	No long-distance seed dispersal vectors are known
Vegetation cover	Low; sometimes forming inclusions in open woody communities
Litter accumulation	Low and concentrated around tufted or mat-forming plants

Fire adaptation/vulnerability attributes could readily be compiled for all BLM sensitive species, and a matrix of considerations developed for evaluating species' response to wildfire or proposed prescribed burn.

In any case, effective use of demographic baseline monitoring requires annual data collection. This monitoring study would have much more value if it were conducted in 2001, the year after fire. As it is, the "small" plants (0-3 cm diameter) that were recorded in 2002 can be either

established plants that were killed back in part of their root crown by the fire, new plants that established in 2001, or new plants that established in 2002. All three cases appear to be present,

Figure 12. Small *Cymopteris evertii* plants, including one seedling (lower right)

Figure 13. Charred rootcrown of dead *Cymopteris evertii* plant
(to the right of grass shoots)

Figure 14. Vigorous, flowering medium-size *Cymopteris evertii* plants along belt transect

Figure 15. South-facing slope directly below belt transect, overlooking Enos Creek tributary and Creek

as determined in excavating around the base of plants. Figure 12 shows three plants that represent all three conditions. The plants killed by intense fire are much more readily discerned in the year after fire rather than subsequent years. Figure 13 shows the vestiges of *Cymopteris evertii* rootcrown, apparently killed by fire. Effective use of demographic baseline data also requires precise mapping (no greater error than +/- 5 cm) if clumped individuals are to be followed through the monitoring period (Figure 14).

As a result of the 1998 monitoring work, two microhabitat variables were identified as influencing local distribution of plants, including shade (overstory canopy) and vegetation cover (understory canopy) (Fertig et al. 1999). It was subjectively observed in all populations that plants were more abundant in areas with less vegetative cover. Vegetation cover declined threefold in 1998-2002. The estimated vegetation cover in each plot ranged from 0%-60% in 1998 (mean: 33.5%) and from 0%-23% in 2002 (mean: 9.1%). Another, less consistent observation in 1998 was that plants (especially the smaller, younger individuals) were more abundant under trees than out in the open. Larger plants would be found both under shade and in less shaded areas. This was often true for low elevation populations on the periphery of the range; however, in other areas at higher elevations in the mountains, population density was more correlated with low vegetation cover than amount of shade. This may indicate that the higher elevation sites are more mesic, and plants can tolerate more sun than those in the lower, more xeric sites. Reduction in vegetation cover by fire may ultimately favor *Cymopteris evertii*.

What is recommended for the future of this monitoring project? It was originally recommended that these plots should be re-measured annually or biennially until a trend is established, at which time monitoring could be less frequent. It has served an immediate purpose in spite of the infrequent monitoring. It can serve an expanded purpose to evaluate flowering and recruitment after fire. In addition, baseline documentation of species life history may be pursued outside of burned habitat. It would be ideal to rigorously monitor all three transects of the species in order to provide more context for 2002 results and build species life history information.

Revisions to study design may be warranted if monitoring is pursued. Sample size adequacy needs review, particularly in the two lower elevation sites. More detailed mapping of individual plants and an annual monitoring cycle would enhance data value. Information on reproductive success, distinguishing fertile from aborted fruits, may also warrant consideration.

It is also appropriate to look back at the original *Cymopteris evertii* status report (Fertig et al.1999). Due to the species' local abundance and low threats in the Absaroka Range, *Cymopterus evertii* was dropped as a candidate for federal listing under the Endangered Species Act in 1990. Fertig (1992) and Fertig et al. (1998) recommended against BLM Sensitive status, although periodic monitoring of populations on BLM lands was recommended. The surveys suggested that populations continue to be stable and that sensitive designation was not necessary. Due to the plants limited range, however, monitoring was recommended so that possible future downward trends can be detected early and appropriate management responses can be formulated. Foothills populations may be more susceptible to drought than the montane populations. A re-reading of the two foothills belt transects and expanded survey for *Cymopteris evertii* across burned habitat may be warranted as part of the species status review.

Finally, this study provides an opportunity to revisit the monitoring design and framework for addressing sensitive species response to fire in general. It is recommended that a literature

review and fire adaptation profile be developed for all BLM sensitive plant species. It may also be helpful to have a contingency table developed as part of general sensitive species policy for evaluating each species' responses to wildfire or to proposed prescribed burn treatment as a standard to guide policy. It was fortuitous that a permanent monitoring baseline had been established before wildfire, a rare exception among sensitive plant populations that burn. This study offers a springboard for addressing the more far-reaching questions for *Cymopteris evertii* and Wyoming BLM sensitive species collectively.

Literature cited

Dorn, R.D. 2001. Vascular Plants of Wyoming, third edition. Mountain West Publishing, Cheyenne, WY.

Elzinga, C. L., D. W. Salzer, and J. W. Willoughby. 1998. Measuring and monitoring Plant Populations. BLM Tech. Ref. 1730-1, BLM/RS/ST-98/005. Denver, CO.

Fertig, W. 1992. Sensitive plant species surveys and revised species checklist, Grass Creek Resource Area, BLM. Report prepared for the Bureau of Land Management by the Wyoming Natural Diversity Database, Laramie.

Fertig, W., L. Welp and S. Markow. 1999. Status report on Evert's waferparship (*Cymopteris evertii*) in Northwestern Wyoming. Unpublished report to the Bureau of Land Management. Wyoming Natural Diversity Database, Laramie.

Fertig, W. and B. Heidel. 2002. Wyoming plant species of special concern. Unpublished reference list. Wyoming Natural Diversity Database, Laramie.

Hartman, R and R. Kirkpatrick. 1986. A new species of *Cymopterus* (Umbelliferae) from Northwestern Wyoming. Brittonia 38(4): 420-426.

Heidel, B. 2001. Monitoring *Shoshonea pulvinata* in the Pryor and Beartooth Mountains, Carbon County, Montana. Unpublished report for the Bureau of Land Management. Montana Natural Heritage Program, Helena.

Heidel, B. and J. S. Shelly. 2001. The effects of fire on Lemhi penstemon (*Penstemon lemhiensis*) – final monitoring report 1995-2000. Unpublished report to the Bureau of Land Management and Beaverhead-Deerlodge National Forest. Montana Natural Heritage Program, Helena.

Hessl, A. and S. Spackman. Effects of fire on Threatened and Endangered plants: an annotated bibliography. USDI Geological Service Information and Technology Report 2. Washington, D.C.

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

Marriott, H. 1988. Sensitive Plant Species Surveys, Shoshone National Forest. Wyoming Natural Diversity Database, Laramie, WY.

Appendix A. Transect # 3 Census Data

Date: 4 July 1998
Surveyor: Laura Welp
Length: 30 meters

Plot #	Total # plants	# Small (1-3 cm dia.)	# Medium (3.1-10 cm dia.)	# Large (> 10.1 cm dia.)	# Reprod./ (cm. dia-# frting heads)	Cm. dia / # fruiting heads of reprod. plants	# Dead	%Veg Cov	Shaded? *
1	0	0	0	0	0		0	0	S
2	2	0	0	2	1	12/4	0	25	S
3	9	0	4	5	1	20/11	0	25	S
4	4	0	0	4	1	93/6	0	50	S
5	1	0	0	1	1	13/1	0	60	P
6	3	0	1	2	0	0	0	60	P
7	0	0	0	0	0	0	0	15	S
8	1	1	0	0	0	0	0	<1	S
9	4	1	1	2	0	0	0	30	S
10	4	0	1	2	2	15/2; 12/5	0	20	S
11	3	0	1	2	0	0	0	65	S
12	1	0	0	1	1	16/1	0	30	P
13	2	0	1	1	1	13/1	0	25	P
14	0	0	0	0	0	0	0	15	U
15	0	0	0	0	0	0	0	35	U
16	0	0	0	0	0	0	0	20	U
17	1	0	1	0	0	0	0	35	U
18	0	0	0	0	0	0	0	25	U
19	0	0	0	0	0	0	0	20	U
20	2	0	1	1	1	11/2	0	55	U
21	0	0	0	0	0	0	0	70	U
22	3	0	2	1	1	15/1	0	75	U
23	2	0	1	0	1	10/3	0	75	U
24	2	0	2	0	0	0	0	40	P
25	7	0	1	6	3	11/4;11/1; 15/1	0	20	U
26	21	4	11	6	3	5/2; 20/7; 21/3	0	45	U
27	19	4	11	4	0	0	0	30	P
28	31	7	20	4	2	9/1; 22/5	0	45	P
29	31	8	22	1	2	10/1; 8/1	0	25	P
30	22	4	12	6	1	13/1	0	30	P
TOT	**175**	**27**	**86**	**61**	**19**		**0**	**x = 28%**	

Total # of plants per 0.5 meter: 5.8
Small (1-3 cm dia) per 0.5 meter: 0.96
Medium (3.1-10 cm dia) per 0.5 meter: 2.8
Large (10.1-24 cm dia) per 0.5 meter: 2.0
Reproductive plants per 0.5 meter: 0.63
Reproductive plants by size class: 0 Small, 5 Medium, 17 Large
* Y = plot is shaded during midpoint of day; P = plot is partially shaded during midpoint of day; U= plot unshaded during midpoint of day.

Total # of plants per square meter: 11.6

Small (1-3 cm dia) per square meter: 1.92
Medium (3.1-10 cm dia) per square meter: 5.6
Large (10.1-24 cm dia) per square meter: 4.0
Reproductive plants per square meter: 1.26

Comments:
The results of the 0.5 x 1 meter plots were multiplied by 2 to report results by square meter.

* S = plot is shaded during midpoint of day; P = plot is partially shaded during midpoint of day; U = plot unshaded during midpoint of day.

S = 27 plants in 9 plots; P = 112 plants in 9 plots; U = 36 plants in 12 plots

Transect # 3 Census Data

Date: 28 June 2002
Surveyor: Bonnie Heidel
Length: 30 meters

Plot #	Total # plants	# Small (1-3 cm dia.)	# Medium (3.1-10 cm dia.)	# Large (> 10.1 cm dia.)	# Reprod./ (cm. dia-# frting heads)	Cm. dia / # fruiting heads of reprod. plants	# Dead	%Veg Cov	Shaded? *
1	0	0	0	0	0	0		0	P
2	0	0	0	0	0	0		0	P
3	0	0	0	0	0	0		0	P
4	0	0	0	0	0	0		2	P
5	0	0	0	0	0	0		12	P
6	0	0	0	0	0	0		7	P
7	0	0	0	0	0	0		1	P
8	0	0	0	0	0	0		1	P
9	0	0	0	0	0	0		2	P
10	0	0	0	0	0	0		0	P
11	0	0	0	0	0	0		2	P
12	2	0	1	1	2	12/4, 6/1		20	P
13	0	0	0	0	0	0		15	U
14	0	0	0	0	0	0		10	U
15	0	0	0	0	0	0		10	U
16	1	1	0	0	0	0		12	U
17	0	0	0	0	0	0		18	U
18	2	0	2	0	1	7/3		12	U
19	2	0	1	1	2	5/1, 19/12		12	U
20	1	0	1	0	1	8/8		20	U
21	0	0	0	0	0	0		15	U
22	3	0	2	1	3	11/6, 10/10, 9/8		12	U
23	3	0	3	0	0	0		12	U
24	15	10	5	0	4	6/2, 7/3, 5/1		10	P
25	6	1	5	0	0	0		7	P
26	10	7	3	0	3	10/4, 5/2, 9/3		10	P
27	37	17	14	1	5	11/11, 7/5, 9/3, 10/2, 6/2		23	U
28	26	15	11	0	2	10/3, 5/1		18	P
29	22	17	5	0	1	9/1		3	P
30	13	8	5	0	0	0		15	P
TOT	**143**	**76**	**63**	**4**	**24**				

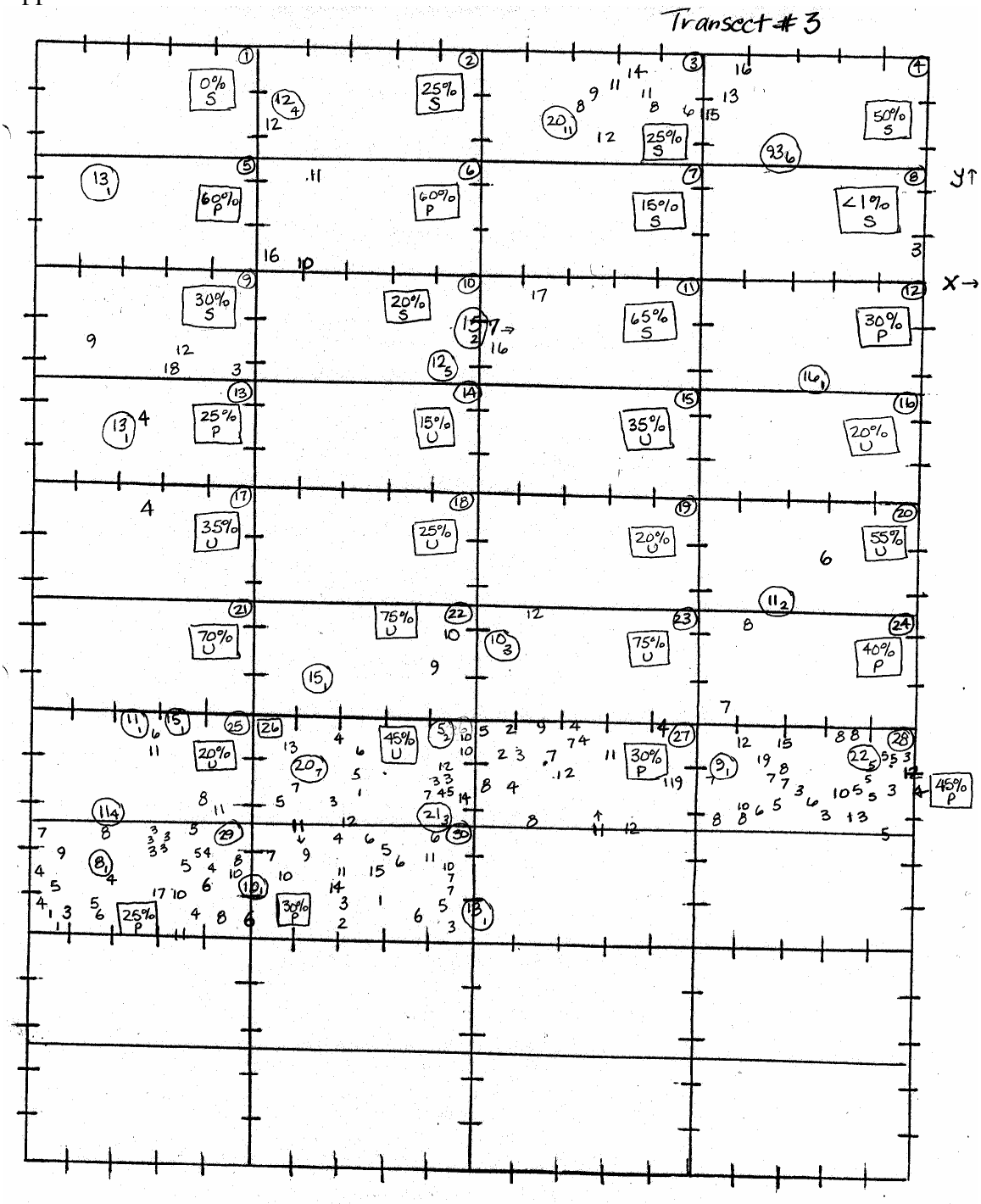
Total # of plants per 0.5 meter: 4.8
Small (1-3 cm dia) per 0.5 meter: 2.5
Medium (3.1-10 cm dia) per 0.5 meter: 2.2
Large (10.1-24 cm dia) per 0.5 meter: .13
Reproductive plants per 0.5 meter: 0.8
Reproductive plants by size class: 0 Small, 19 Medium, 4 Large
* Y = plot is shaded during midpoint of day; DP = plot is partially shaded during midpoint of day by standing dead trees; U= plot unshaded during midpoint of day.

Total # of plants per square meter: 9.5
Small (1-3 cm dia) per square meter: 5.1
Medium (3.1-10 cm dia) per square meter: 4.3
Large (10.1-24 cm dia) per square meter: 0.3
Reproductive plants per square meter: 1.5

Comments:
The results of the 0.5 x 1 meter plots were multiplied by 2 to report results by square meter.

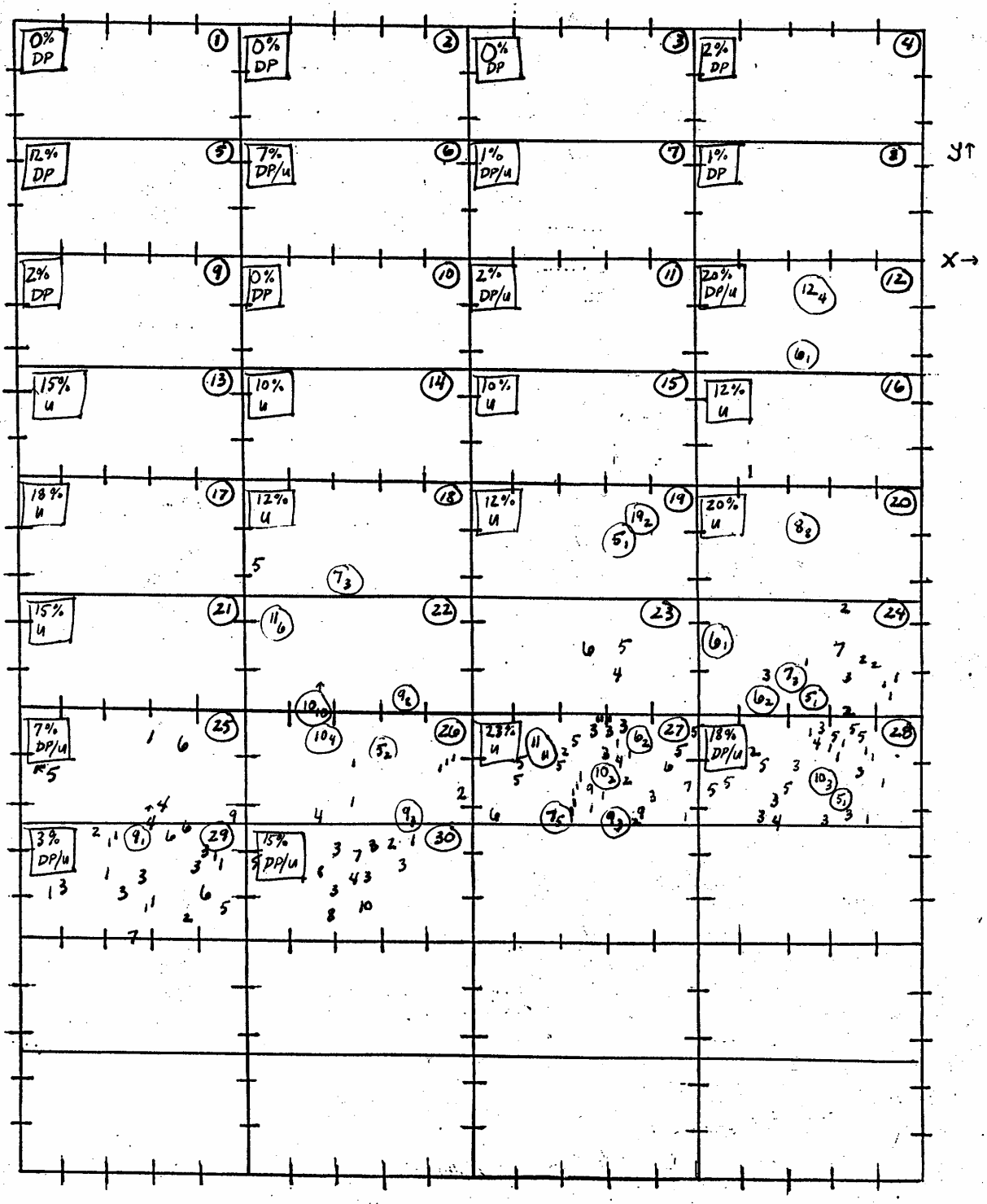
* S = plot is shaded during midpoint of day; P = plot is partially shaded during midpoint of day; U = plot unshaded during midpoint of day.

Appendix B. Transect # 3 – Raw data from 1998



Target Species: Cymoptenus evertii
Surveyor: Laura Welp
Date: 7/4/98
Legal Desc.: T46N R100W S28 SW4 of NE4 of NE4
Quad: Adam Weiss Peak
Orientation: 29° NNE
Notes:

Appendix B. Transect #3 Raw Data from 2002



Target Species: *Cymopteris evertii*
Surveyor: B. Heidel
Legal Desc.: T4S N R100W Sec 28
Orientation: 29° NNE
Notes: Study site burned in 2000 Enos Fire

Date: 28 June 2002
Quad: Adam Weiss Peak

Appendix C. Updated Element Occurrence Record

WYOMING NATURAL DIVERSITY DATABASE
-Element Occurrence Record-

CYMOPTERUS EVERTII Number: 024

Common Name: EVERT'S WAFERPARSNIP PDAPI0U140
Data Sensitive?: N Identification verified: Y
TNC Global Rank: G2G3 WYNDD State Rank: S2S3
Federal Status: WY Distribution Note: REGIONAL ENDEMIC
Management Status: WY BLM SSL

County: Hot Springs
USGS Quad Name: ADAM WEISS PEAK

Latitude: 435551N Longitude: 1085129W
South Lat: 435515N East Long: 1085100W
North Lat: 435553N West Long: 1085129W
Map Accuracy: Precise; location is within a 75 foot radius of point on USGS topo map.

Town/Range:	Section:	T/R/S Comments:
046N100W	27-28	SEC 27 SW4SW4; SEC 28 NE4NE4

Location: Southeastern Absaroka Range, ridge north of Enos Creek, ca 1.3 air miles east of Bill Dickie Draw and ca 3-4 air miles north of Twin Buttes, ca 35 air miles west of Thermopolis.

Last Observed: 2002-06-28 First Observed: 1992-07-24
Occurrence Rank: AB
Rank Comments: Population moderately large, habitat in good condition, additional habitat in vicinity.

Data: 2002-06-28: Demographic monitoring showed net reduction in numbers within the belt transect but many new and resprouted plants. In the entire subpopulation, 1046 plants were counted and 1100 estimated, a net increase from the earlier estimate of 360. If other subpopulations show no net change, then total population numbers are 1300-1350. 30% in fruit and 70% vegetative under drought conditions.
Occurrence consists of 4 small subpopulations in area 0.25 x 0.8 mile area. 1998-07-02: Three small subpopulations observed in Sec 28 by Laura Welp. 200 plants observed in one colony ca 25 x 15 meters (20% in fruit, 80% vegetative). Second colony with ca 360 plants (30% fruiting, 70% vegetative) in a 30 x 50 meter area. Third colony of 4 vegetative plants in 1 x 1 meter area. Occurs with SEDUM LANCEOLATUM, ERIGERON COMPOSITUS, ARENARIA, ASTRAGALUS MISER, KOLERIA MACRANTHA, and ELYMUS SPICATUS. Plants typically clumped in all 3

subpopulations.
1992-07-24: Sec 27 SW4 colony: Observed in fruit by R. Dorn.
Habitat: Crest and steeper slopes of rocky sandstone ridge in coarse sandy red soil [Aycross Formation] in open PINUS FLEXILIS/ARTEMISIA TRIDENTATA VAR VASEYANA savanna with JUNIPERUS SCOPULORUM. Limited to small patches within limber pine/sagebrush matrix.

Elevation: 6800-7100 feet Size: 5 acres

Comments: This occurrence is in the vicinity of EO # 022, but is separated by Enos Creek. A demographic monitoring transect was set up in 1998. This site burned in 2000. The transect was re-read in 2002.

Managed Area:
BLM WORLAND FIELD OFFICE

Ownership:

Mgmt Comments:

Specimens: Welp, L. (7863). 1998. RM.
Dorn, R. (5100). 1992. RM.

Sources: Welp, Laura. Previous Assistant Botanist and Special Projects Manager. Wyoming Natural Diversity Database, University of Wyoming, PO Box 3381, Laramie, WY, 82071. (307) 766-3022.
Fertig, W., L. Welp, and S. Markow. 1999. Status report on Evert's waferparsnip (CYMOPTERUS EVERTII) in northwestern Wyoming. Report prepared for the Bureau of Land Management Wyoming State Office by the Wyoming Natural Diversity Database, Laramie, Wyoming.

Heidel, B. 2002. Demographic monitoring of Evert's waferparsnip (Cymopteris evertii) after the 2000 Enos Fire. Unpublished report to the Bureau of Land Management. Wyoming Natural Diversity Database, Laramie.

Author: B. Heidel Edition Date: 02-10-14