OREGON DEPARTMENT OF AGRICULTURE

NATIVE PLANT CONSERVATION PROGRAM

Population assessments and site observations for *Thelypodium eucosmum* in east-central Oregon

2009 Field Season

Prepared by
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Population assessments and site observations for *Thelypodium eucosmum* in east-central Oregon: 2009 Field Season[1]

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Thelypodium eucosmum (arrow-leaved thelypody—Figure 1), is a biennial or short-lived perennial species in the mustard family (Brassicaceae), inhabiting mesic microsites at lower to intermediate elevations in juniper-sagebrush habitat. The species is listed as *threatened* by the State of Oregon (see OAR 603-070), and is managed as *sensitive* by the Bureau of Land Management (BLM).

Figure 1. The target species, *Thelypodium eucosmum.* (Photo: M. Carr)

This attractive wildflower has been reported from approximately 60 sites to date (give or take, depending on how one defines a population), with most plants typically found in steep, seasonally moist basalt drainages, near the edges of trickling ephemeral streams, or in vernally moist (often "chalky" appearing) alkaline flats and hillside seeps, commonly in close association with juniper trees that may shade the sites. Restricted to higher valleys, plateaus, and lower montane areas in Grant and Wheeler counties, the majority of extant occurrences for this regionally endemic species occur on land managed by the BLM.

[1] Completed under BLM Grant No. **L09PX00804**, in collaboration with Jo Anne Armson (Prineville BLM)

Populations have been reported to range from only a few to over 5,000 individuals, with considerable variation in population size and distribution between years (BLM records).

Thelypodium eucosmum is impacted by grazing, although the affinity of the species for steep drainages (Figure 2) that are often more or less inaccessible to cattle is believed to

Figure 2. Typical rocky, basalt habitat with seeps or seasonal moisture that characterizes most *Thelypodium eucosmum* sites on the Prineville District. Plants here would be expected in the small meadow above the rocky bluff at the upper left, or in the riparian brush below. (Photo: R. Meinke)

provide it with some measure of protection. And although the on-going succession of grassland-juniper savannah to more overstoried juniper woodlands (promoted by fire suppression and grazing—see Figure 3) may also be a risk factor, the more pressing concern comes from exotic weeds, which are believed to have a significant effect on recruitment and seed bank maintenance in thelypody populations.

Germination protocols for *T. eucosmum* were previously determined at Lewis and Clark College and the Berry Botanic Garden, and seed of the species is housed in the Garden's cryogenic storage facility in Portland. Other than that, little research on or evaluation of the species had been completed prior to 2009. In particular, the overall conservation status of *T. eucosmum* had not been recently considered, and little up-to-date information on population size, viability (based on the number of reproductive individuals), reproductive output, and

threats was available. Such data are essential for maintaining sufficient conservation programs for rare species, particularly those occurring primarily on public lands, such as this one. A current conservation assessment is also necessary for (1) reviewing the placement of *T. eucosmum* on the state list of threatened and endangered plants (required every 5 years by ORS 564), (2) creating management priorities for BLM, and (3) determining whether or not the species would qualify for listing under the federal Endangered Species Act.

Figure 3. Over-shaded habitat, with *Thelypodium eucosmum* plants scattered on the grassy bank under the junipers. Fewer seedlings were noted in shaded sites during surveys. (Photo: R. Currin)

2009 Project Goals

Field work in 2009 was scheduled for the spring and early summer (planned for the month of June), to visit and census selected *T. eucosmum* populations on lands managed by the BLM's Prineville District in Grant and Wheeler counties. To assist with the preparations, BLM provided maps, UTM data for selected populations, and previous site survey forms where available (see below). Approximate locations for *T. eucosmum* populations that were known to BLM and the Oregon Biodiversity Information Center (OBIC) in 2009 are plotted in Figure 4 (based on the GPS data provided by BLM and OBIC). Sites were located in Wheeler and western Grant counties, with two outliers in Grant County just south of John Day.

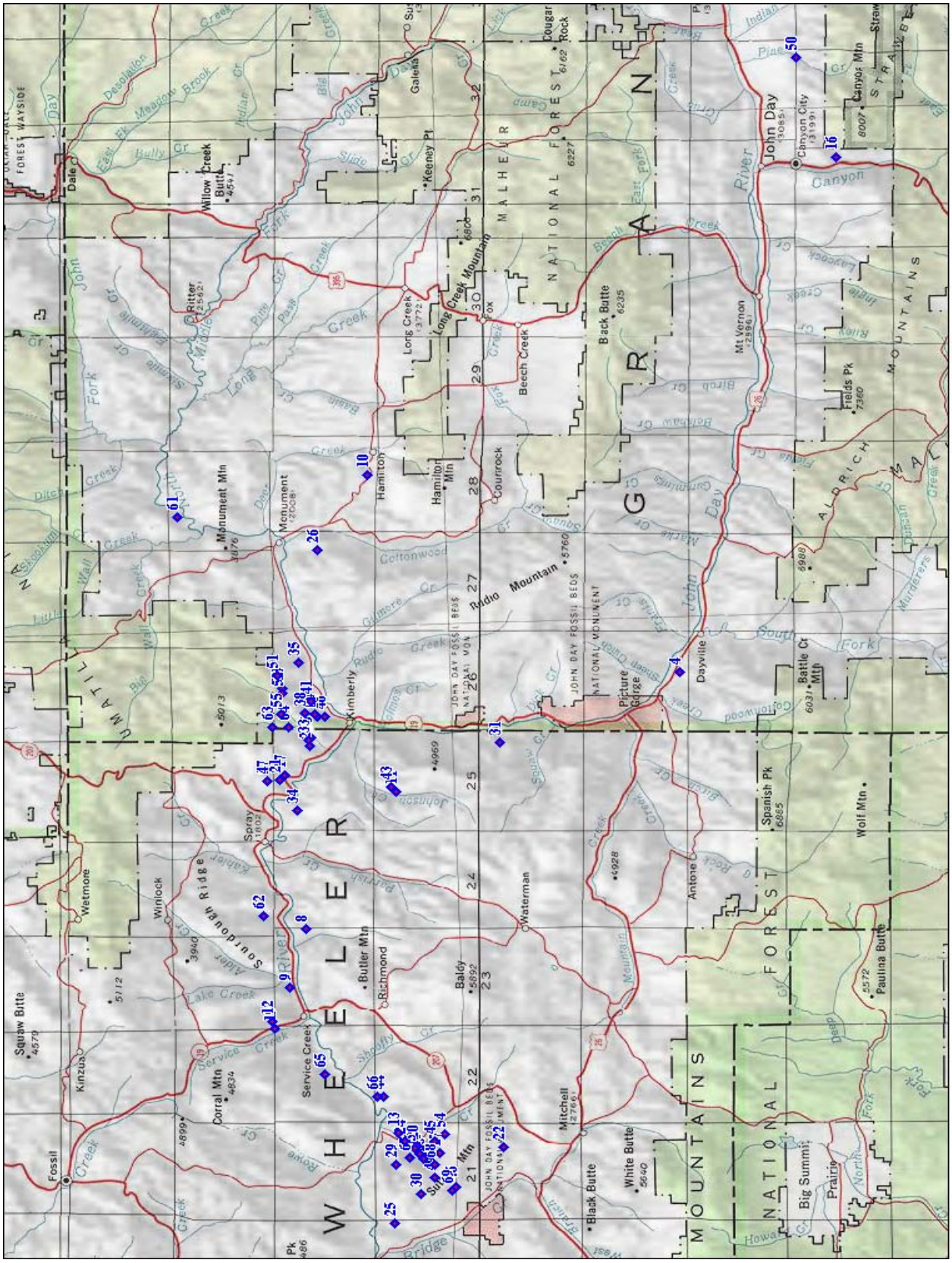

Figure 4. Map of the overall *Thelypodium eucosmum* survey area in Wheeler and Grant counties. Numbers represent element occurrences (EOs) from approximated GPS points (data from Appendix 1).

The populations of *T. eucosmum* depicted in Figure 4 are described in Appendix 1 (attached at the end of the report), which lists a total of 63 sites for *T. eucosmum*. The information it includes is based on *element occurrence* (or **EO**) information on file with the Oregon Biodiversity Information Center (OBIC) at Portland State University, as well as notes and UTM coordinates provided by the BLM. The OBIC data includes information gleaned from BLM or other agency reports, as well as university theses, research papers, herbarium collection data, and reported observations originating from a wide range of sources. For this project we are using the element concurrence (**EO**) number assigned by OBIC to each *T. eucosmum* population as our site reference numbers.

Of the various materials made available to us by BLM and OBIC, the data we compiled in Appendix 1, when cross-referenced with previous site reports (including old BLM Plant Taxon Field Data Reports and OBIC Rare Plant Field Survey Forms), were the most help in reviewing and selecting areas for inventory during this project. The 63 **EOs** were evaluated prior to the start of field work in 2009, and to be considered for field work, sites had to occur on land managed by the BLM, have a high likelihood of being accessible and relocatable within a reasonable amount of time, and not (in our opinion) be a duplicate of another **EO.**

The baseline goal for the 2009 field season (which had been intended to be the first year of a minimum two-year project[2]) was to visit at least 50% of the available **EOs** meeting the above criteria, to the extent feasible. Once on site, we planned to:

- Census or estimate population size (focusing on reproductive individuals) at each sampled location, with visits timed to coincide with flowering and fruiting;
- Assess seed production for the same populations (Table 2 provides details on the methods we used to estimate seeds produced by a population);
- Evaluate the reproductive health of the species, by considering (in addition to seed output) pollinator abundance and diversity, probable breeding system (assessed by looking at floral phenology), floral predation levels, and apparent seed viability;
- Record any apparent threats; and
- Provide a summary report on the survey efforts, and recommend management strategies for conservation of the species on BLM lands.

[2] The second year of *Thelypodium* surveys was ultimately not funded in 2010, due to BLM budgeting priorities, so this document represents the final report for this project.

Results

Site selection and census. Eleven of the 63 reported EOs (or populations) in Appendix 1 were excluded from the project during our pre-field work evaluation. In these cases, the EOs either appeared to represent duplicate records, consisted of populations not occurring on BLM land, or represented sites with directions that we felt were too vague or imprecise to allow us to relocate the populations within a reasonable amount of time (see Appendix 1). Out of the 52 remaining EOs, we eliminated one more that was reported to be reachable only by boat, and would have been impractical to include.

This left 51 theoretically surveyable populations of *T. eucosmum* occurring on Prineville District BLM lands. As previously stated, the project goal was to survey half of these in 2009, and we managed to visit 25 (between June 2nd through June 26th). Some of the sites ended up requiring extensive on-the-ground work, and others less so (when it was obvious few or no thelypody plants were present).

Of the 51 EOs we considered "survey-eligible," a number still presented challenges in terms of accessibility. Some required getting permission from landowners to cross private property or open gates, and our efforts to do this were not always successful (typically we could not reach the right person, and we didn't have the opportunity to make repeated attempts to contact them). Other sites simply occurred too far within rugged roadless areas to be easily reached in the time we had available in 2009. And then some populations we just expected would take extra time to track down, due to less than specific or conflicting directions (not all BLM and OBIC GPS data for the EOs matched up, for example). Many of these were sites that (according to OBIC data) had not been seen for 15 to 20 years or more, and for which the GPS data was not particularly useful (note that although Appendix 1 includes OBIC-generated GPS data for most EOs, for certain older records this data has obviously been "estimated," with the lat/long coordinates evidently back-calculated from old map-based information or sketchy written directions). We felt these sites certainly had the potential to be found and surveyed at some point, but we elected to postpone trying to sample them until 2010.

So since the project had been designed to run for a minimum of two years (with work beyond the initial year dependent on the outcome of 2010 federal budgets), we decided to focus on the most readily accessible sites during the 2009 field work. The rationale was that the planning and set-up work being completed in 2009 would not need to be redone the

following year. With that already completed, we could then better focus our efforts on locating the more problematic *T. eucosmum* sites in 2010, after a year of planning and initial field work was under our belts.

As an overview, Table 1 provides the 2009 project status for the 63 EOs listed in Appendix 1 (indicating which sites were excluded, which were selected for survey work, and which were then pushed back for potential survey in 2010).

Table 1. Status summary for *Thelypodium eucosmum* populations (listed in Appendix 1) relative to the 2009 field season.

Population Status	***Element Occurrence (EO) Number***
Excluded: Historic site, impossible to relocate	1, 2, 6
Excluded: Duplicate site (EO believed to be the same as another EO—see Appendix 1 for details)	5, 11
Excluded: EO not on public land managed by BLM	15, 59, 60 (EO 6 also)
Excluded: EO not considered reliably relocatable	14, 27, 56
Excluded: Boat needed to access site	70
Included: Sites that were surveyed in 2009	4, 9, 10, 12-13, 16-26, 33, 40-41, 47, 50, 57, 62, 65, 69
Postponed: Sites with surveys planned for 2010	8, 28-31, 34-36, 38-39,43-46, 49, 51-55, 61, 63-64, 66-68

To summarize, a total of 63 *Thelypodium eucosmum* sites (including 3 historic EOs as well as 60 presumed extant populations) were on record with OBIC in 2009 (Appendix 1). We considered 12 of these reported sites to be unsuitable for survey work for various reasons (see Table 1), and they were subsequently dropped from the current project. Twenty-five sites were ultimately visited or assessed, with all site visits in June of 2009, and these were evaluated as described under Project Goals. Twenty-six sites were not visited, with the assumption they would be scheduled for surveys in 2010. Census results for the 25 EOs surveyed in 2009 are provided in Table 2.

Table 2. Census results, seed production, and threats for 25 *Thelypodium eucosmum* sites on Prineville BLM public lands, visited between June 2nd and June 26th, 2009.

EO Number (also see Appendix 1) ↓	***Estimated population size*** **[After some consideration, we elected not to try and census seedlings or juvenile plants at most of the sites (some exceptions are noted below)—non-reproductive plants were generally difficult to locate in smaller populations, and among the thick cover of exotic grasses at many sites. And then a good portion of the first year plants in 2009 had already dried up (either dead or senesced) by mid-June. Accordingly, most of the counts given below (N) are for flowering plants only.]**	***Seed production by site*** **[We estimated this based on a *mean seeds per fruit* (MS) of 23.93 (SD=6.61; N=50) and a *mean fruits per plant* (MF) of 86.68 (SD=107.33; N=30). Seed and fruit counts were taken from randomly selected plants at a single site (EO 25) with a large population that we felt was representative, considering the overall constraints of the project. An *adjusted mean seeds per fruit* (AS) was then determined by reducing MS by 40%—to 14.36. We used this to calculate our *seeds per plant average,* SP, from (AS)(MF), which ended up being just under 1,245 seeds. This adjustment accounted for estimated levels of seed abortion and pre-dispersal ovule predation we observed in sampled fruits. The numbers below were then derived from (N)(SP).]**	***Apparent threats*** **[The most important *exotics* are mainly annual grass species, although include some forbs as well, depending on the site; *shading* (mostly by junipers) may limit pollinator visits and potentially reduce seed and fruit set, and an increase in junipers may be hydrologically detrimental if water tables are lowered; *grazing* will eliminate or affect THEU plants by direct browsing, promoting the establishment of exotics, damaging seed beds, and destroying pollinator habitat.]**
4	320 (one of few sites with many obvious seedlings in 2009, about 1,200 noted)	398,312	Grazing; heavy exotics)
9	75	93,354	Grazing, exotics
10	0	0	Heavy grazing; exotics
12	0	0	Heavy grazing; exotics
13	130	161,814	Grazing; exotics
16	24	29,873	Grazing; exotics
17	13	16,181	Grazing; exotics; shading
18	0	0	Grazing; exotics
19	0	0	Grazing; exotics; possible shading
20	135	168,038	Grazing; exotics
21	240	298,734	Grazing; exotics
22	0	0	Grazing; heavy exotics

23	0	0	Grazing; exotics
24	105	130,696	Grazing; exotics
25	8,600 (upwards of 4,000 seedlings/non-reproductives still evident on June 4th, but many drying up)	10,704,633	Grazing and trampling (outside electric fence); also scattered exotics
26	400 (with an estimated 20,000 seedlings or larger rosettes in mid-June!)	497,890	Limited grazing (too steep); many native species with relatively fewer exotics
33	45	56,103	Grazing; exotics
40	18	22,405	Grazing; exotics
41	0	0	Grazing; exotics
47	0	0	Grazing; heavy exotics
50	160 (about 300 seedlings counted in a s ingle patch)	199,156	Grazing; some exotics; shading
57	0	0	Grazing; exotics
62	90 (46 seedlings noted below crumbling bank)	112,025	Grazing; exotics
65	0	0	Grazing; exotics
69	9	11,202	Grazing; exotics

Comments on population surveys. Fifteen of the 25 visited EOs (or 60%) were found to support *Thelypodium eucosmum* plants in 2009, with a few of these sites reasonably well-populated (especially EOs 4, 25, and 26). Overall, however, 19 of the EOs had fewer plants in 2009 (often significantly fewer) than had been recorded during the last visits to the sites, suggesting that 76% of the sampled populations had demographically lost ground in recent years (data from Table 2 and cross-checked with Appendix 1). Of the ten sites where no thelypody plants could be detected in 2009 (Table 2), only one of these was also without plants during its most recent earlier survey, a dramatic increase in the number of sites where populations may be extirpated (although this obviously bears following up in future years). Six sites showed net increases over the number of plants reported from the most recent surveys. EO 25 had a significant jump (from 5,000 to 8,600 reproductive plants), though whether this increase is real or represents survey error is unknown. This site had comparatively better habitat than most locations visited, and cattle had been excluded in 2009 (and perhaps other years) by an electrified fence, so a population increase here might not be unexpected.

Every sampled site showed evidence of recent grazing, and in some areas this was very intense. Each of the sites (except parts of EO 25) was also infested with a moderate to heavy

cover of exotic weeds, with annual grasses (largely *Bromus* spp., but additional species as well) being the dominant competitors faced by the thelypody plants and other remaining indigenous forbs (Figure 5). None of this will be news to BLM, as prior conversations with the botany staff have indicated that most, if not all, *T. eucosmum* populations on the Prineville District are known to be exposed to varying levels of grazing. We've simply observed that the on-going pattern of cattle usage and weed infestations in virtually all areas with *T. eucosmum* habitat is still on track. Cattle are known to consume thelypody plants when they run across them, but the indirect effects resulting from habitat modification (i.e., the loss of suitable microsites for germination, establishment, and seed bank maintenance, mainly due to trampling and the introduction of competing weeds) are overall much more critical issues. Not surprisingly, it appears that today the great majority of remaining sites for *T. eucosmum* are located in narrow basalt drainages, along the sides of steep banks and above talus piles, near seasonally wet seeps on isolated hanging bluffs, and other similar areas that tend to be difficult for cattle to negotiate (see Figures 2 and 6).

Figure 5. Typical microsite for *Thelypodium eucosmum* today—a mix of exotic bromes and other weedy grasses, usually with few natives. Note the bumblebee pollinator. (Photo: R. Currin)

Although each of the EOs in Table 2 has *grazing* listed as a threat, the areas where thelypody populations are typically confined are narrow or steep (or both) (Figure 6), and the actual number of cows that make it into a given site each year is probably limited. Often, only part of a site is accessible at all to cattle, and the areas they cannot reach are where thelypody plants tend to persist. Regrettably, the exotic weeds that are the legacy of past and current grazing are not kept at bay by the steep slopes or narrow chutes that stymie livestock. Although a handful of the sites we visited still had a significant native component to the flora, most were inundated by non-native weeds, and all sites had at least some exotic species present.

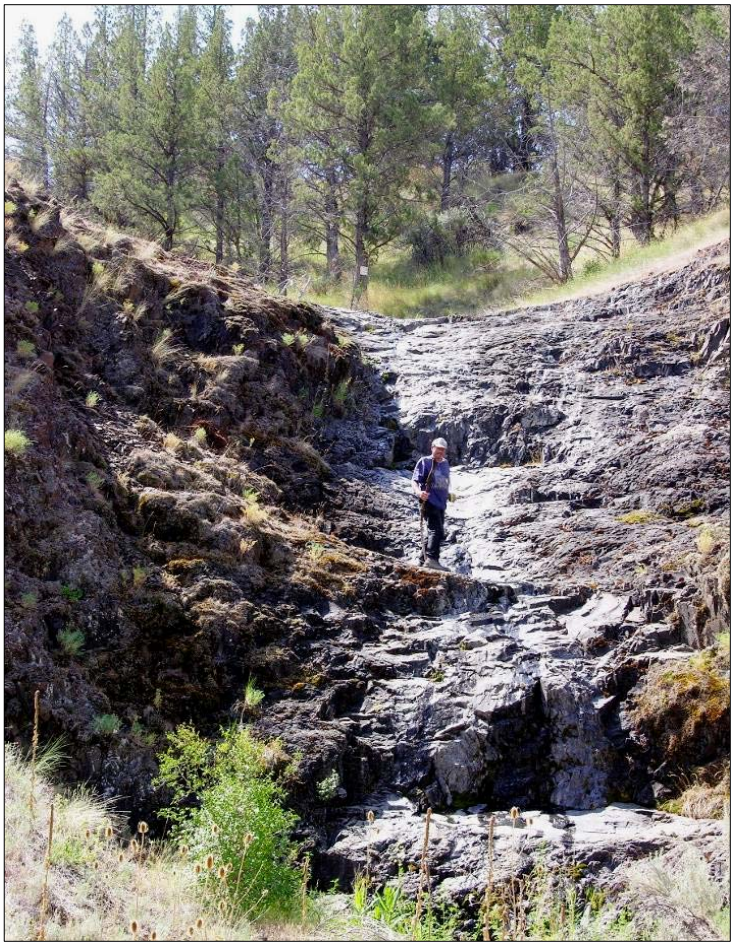

Figure 6. ODA surveyor gamely traversing a hard-to-access seepage site, typical of remaining *Thelypodium eucosmum* habitat on the Prineville District. (Photo: R. Meinke)

A question worth asking is whether or not the distribution of populations, as described above, is representative of what might have existed in east-central Oregon prior to the arrival of settlers and livestock in the 19th century. If it is, then the argument might be made that domestic grazing has not necessarily been a significant influence in the rarity of *T. eucosmum*, that the species was simply historically and naturally rare, and that it continues to occur today in scattered, isolated populations as it always has. And although weeds have admittedly invaded the sites to some degree after cattle arrived, the overall impacts to the species from livestock (in terms of direct grazing, destruction of microsites, etc.) may be overstated.

However, this argument fails to take into account the fact that the highest quality remaining populations (EO 4, and then EO 25, in particular) occur in sites completely unlike

those inhabited by the vast majority of existing thelypody populations. Rather than steep, rocky drainages or brushy seeps high on basalt cliffs and plateaus, these sites are characterized by open, alkaline flats or meadows (within sagebrush-juniper savannah) associated with springs and wetlands. EO 25, by far the most impressive population of *T. eucosmum* we visited, with thousands of flowering plants, was nominally protected by an electric fence in 2009 that enclosed a portion of the site (it was clear that areas outside this perimeter, where grazing was evident, were in much poorer shape in terms of plant survival and reproduction). The point is, if *T. eucosmum* actually prefers the rocky, less accessible sites the vast majority of populations seem restricted to today (like the site in Figure 6), why does it do so spectacularly well here, on barren, chalky flats far from any cliffs or narrow drainages?

Figure 7 (above). Open spring at EO 25 (outside the electric fence), which was heavily impacted by cattle during our 2009 visits—*Thelypodium* plants here were grazed and trampled. Figure 8 (right). Protected habitat within the fenced area at EO 25, where thousands of thelypody plants successfully reproduced in 2009. (Photos: R. Meinke)

The likely explanation is that the species has never favored the type of site where most populations presently occur, and that habitat modifications in the lowland meadows (principally due to grazing) have resulted in the disappearance of the species in other areas similar to EO 25, which would have been historically focused on for development and livestock use due to the availability of spring water. Small, peripheral thelypody populations

probably always existed in the marginal upland sites where we routinely see the species today, but these patches would probably have been incidental to the larger populations spread around the alkaline springs. With the loss of these spring sites came the loss of much of the diversity the species would have once had. Large, centralized populations such as EO 25, with their tremendous seed output, in days past would have served as genetic reservoirs as well as sources for emigration and the founding of new populations. Small, outlier sites for the species would have ebbed and flowed, and likely even vanished at times due to natural perturbations such as drought, with the seeds dispersed by the larger, more stable populations providing opportunities for recurrent re-colonization. Now that most founder populations of *T. eucosmum* appear to have vanished, the potential for the natural recovery of any remaining small populations that wink out (due to grazing or whatever) is minimal at best. The overall result seems to be a geographically and ecologically challenged species that appears to be on a slow, inexorable path to extinction.

Figure 9. A native hairstreak butterfly (top of inflorescence), a common floral visitor and potential pollinator of *Thelypodium eucosmum*. (Photo: R. Meinke)

Reproductive status. At EO 25 and other sites, wherever large patches of *T. eucosmum* were present, numerous native pollinators, mostly bees (*Bombus* spp. primarily—see Figure 5) and butterflies *(Eumaeus* sp.) (Figure 9), were observed working the flowers. The smaller populations, particularly those overtopped by junipers and now often shaded, appeared pollinator-limited (although plants still seemed to produce a fair amount of seed). On sunny days, especially in open sites, bees and butterflies were plentiful on thelypody flowers, which were worked for both

pollen and nectar. The bees appeared to be the more efficient pollinators, although the sheer number of butterflies on larger plants (a dozen or more were often observed at a time on inflorescences) suggests that they may also play a role in pollen transfer.

An evaluation of developing flowers shows that anthers are closed when corollas first open, while stigmas are accessible to pollinators (see Figure 10). Protogyny (the availability and receptivity of a stigma in a flower before its pollen is being shed) has been reported in many species of the Brassicaceae, and it seems likely that *T. eucosmum* is also protogynous. This offers the flower a brief "female phase," when it can only be fertilized by pollen from another flower. In the field, bees were noted landing first on the most recently opened flowers (working their way from the top down on an inflorescence), thereby increasing the chances that

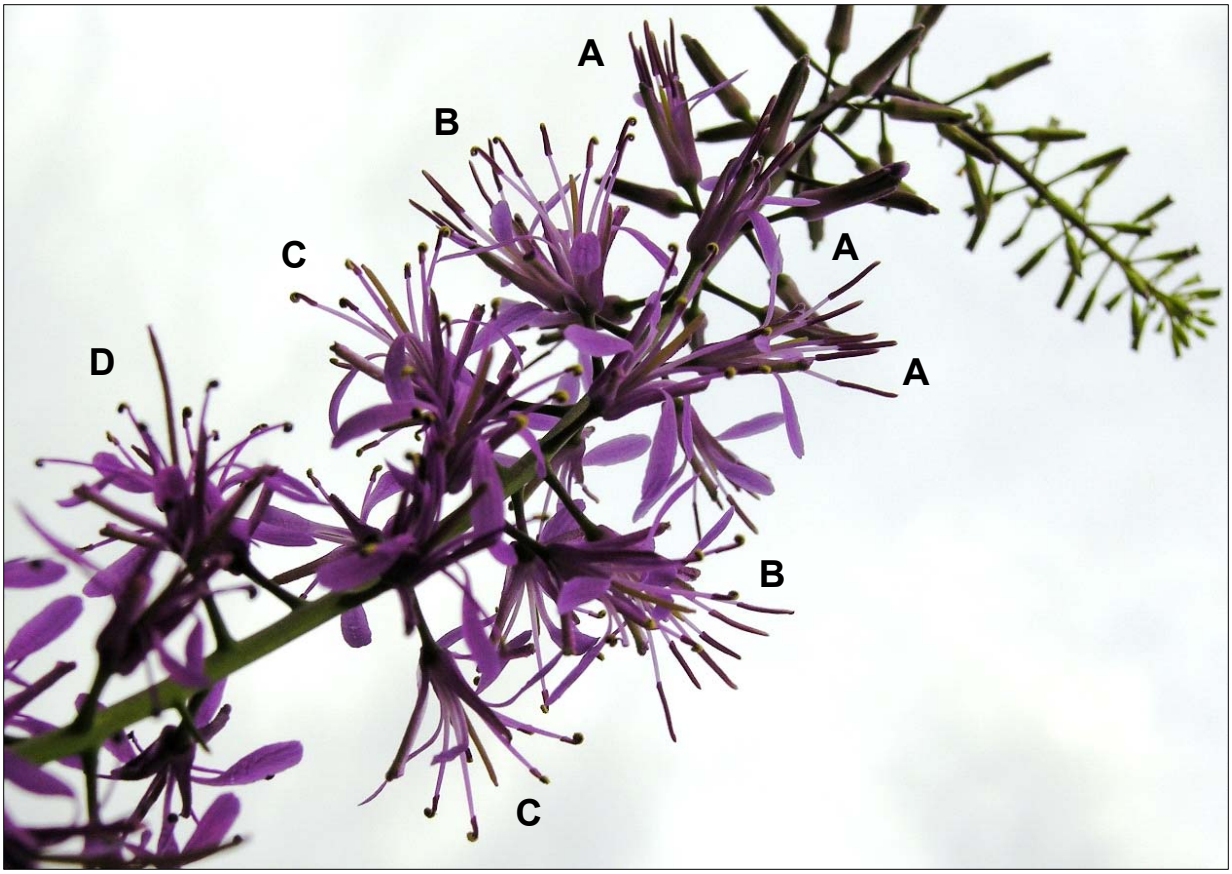

Figure 10. Floral phenology of *Thelypodium eucosmum*. When first open (A), flowers exhibit undehisced anthers, yet have accessible stigmas that are often doused with pollen by insect visitors. After a few hours to a day, anthers begin to open up and coil (B), releasing pollen. Eventually, all the anther sacs on a flower have split open (C), and by this time (~24-48 hours after anthesis) most flowers have been pollinated. Siliques begin developing shortly thereafter (D). When anthers mature in a flower after stigmas have become receptive it is called *protogyny*. Species that exhibit this pattern typically have flowers adapted for outcrossing. (Photo: R. Meinke)

pollen from another genetic individual will effect fertilization (assuming the bee had just arrived carrying pollen from a neighboring thelypody plant). Although we did not specifically test for self-compatibility by bagging or manually self-pollinating flowers, this suggests that even if *T. eucosmum* flowers are self-fertile and can ultimately be self-pollinated as flowers age (either via autogamy or—more-likely—geitonogamy), they stand a reasonable chance of being cross-pollinated first, by virtue of the protogyny combined with pollinator behavior.

Fruit that were collected in the field (which were used in estimating the seed counts reported in Table 2) showed evidence of predation (of both seeds and ovules) by insect larvae, as well as unspecified ovule abortion. We estimated that approximately 40% of the available ovules in the 50 fruit we randomly sampled (in Table 2) were inviable, either from larval damage or simply not surviving to produce a germinable seed (with this presumably due to resource limitation, genetically unsuitable pollen, or simply from remaining unfertilized). Cursory observations of fruits at several sites confirmed a similar pattern of ovule attrition. Despite this loss, the estimated seed production totals in Table 2 show that *T. eucosmum* plants can and do turn out large and presumably viable seed crops (which are known to require exposure to cold fall or winter temperatures to later germinate), portions of which would be expected to persist in an overwintering soil seed bank if habitats were optimal. And on rare occasions, large numbers of thelypody seeds do still germinate (e.g., EO 26 in Table 2), but they are largely germinating into an adverse environment.

The natural seed beds necessary to maintain a perpetuating seed pool and support germinating thelypody seedlings have been under assault by livestock and exotic weeds for decades in eastern Oregon. Shrinking populations equate to shrinking seed banks, and vice versa, resulting in a vicious ecological circle. In time, most thelypody populations across the limited range of the species will probably vanish, as remaining habitat is further degraded and the potential for natural re-colonization of these sites declines.

Conclusions and Recommendations

Without specific conservation action, the vast majority of *Thelypodium eucosmum* populations, a species known only from Oregon, will probably be extinct or no longer self-sustaining within 25 years. The information in Table 2 and Appendix 1 supports this conclusion, in that most of the populations sampled during this survey were shown to have

declined in numbers over the last 10 to 25 years or so, with 9 sites having no plants at all in 2009. Many of the populations that remain are tiny and may require management intervention to persist, especially considering that the pattern of established seed banks that would have once contributed to the natural recovery of such populations has probably been severely disrupted. Small populations also suffer from a lack of genetic diversity leading to inbreeding depression, which is further exacerbated when a species (particularly one prone to outcrossing as this one appears to be) is reduced to a series of fragmented and isolated occurrences. And then the stiff competition the species clearly faces year after year from encroaching annual exotics only adds to an already dismal scenario.

So what are the best options? First and foremost, if BLM wants to give *T. eucosmum* a fighting chance, it should consider permanently setting aside EO 25 as a preserve for the species, and rigorously exclude grazing. The Burns BLM District created an exclosure for the federally listed species *Stephanomeria malheurensis,* and their approach would be a good model for Prineville to follow. Regrettably, *S. malheurensis* is known from only the one site and is already essentially extinct. So why not be more proactive here, when there is still a chance that extinction can be avoided? Without this, livestock use will ultimately sink the thelypody population at EO 25, as it has elsewhere. For whatever reason (perhaps the grazing history of the site has been less intense), a unique and significant thelypody population has managed to persist here. And although there is no way to know if it was actually even larger at one point, the population still has enough plants and (presumably) a large enough seed bank to serve as the best remaining conservation anchor for the species.

A percentage of the wild seed produced at EO 25 could be harvested, and sown elsewhere, or used to start plants in cultivation for the purpose of mass seed production. Although EO 25 may be the key remaining site for the species, any cultivation plan should also include seed from other populations, if possible (perhaps those with 100 or more reproductive plants in a given year—Figure 11), to increase the genetic diversity of the seed produced. Either wild-collected or bulk seed from greenhouse grow-outs could be used to augment declining *T. eucosmum* seed banks at selected populations (which sites to focus on would need to be assessed), while also adding a shot of genetic diversity to boost dwindling gene pools. And if habitat restoration (especially weed control efforts) could be concurrently implemented to improve thelypody recruitment, applying seed for several years may very well help bolster

populations. Direct seed sowing would likely be more effective than transplanting greenhouse-grown plants, an often-cited alternative in re-introduction work. Scattered reproductive individuals still persist at many of these sites, but they are clearly not enough to sustain or improve the populations—adding a further handful of pot-grown plants at this point won't significantly improve the situation.

Grazing and weeds are the main issues facing *Thelypodium eucosmum*. Reduce or eliminate these impacts in just a few areas on the district, and you improve the prospects of the species. And take steps to protect important populations while there is still time. Considering how much BLM range is given over to grazing allotments, permanently setting aside the handful of acres at EO 25, for example, and devoting some resources to habitat restoration for *T. eucosmum* at just a few sites, would be inconsequential to the overall public lands grazing program of the Prineville District. As it stands, the species is currently more than eligible for listing under the federal ESA. Perhaps that might be postponed or even prevented altogether if the district implemented a *Thelypodium* conservation plan focusing on site protection, seed bank augmentation, and selective habitat restoration.

Figure 11. Possible seed donor plants at EO 21, in uncharacteristically good habitat. (Photo: C. Meinke)

Appendix 1

The following pages largely include specific information on 63 *Thelypodium eucosmum* sites provided by the Oregon Biodiversity Information Center (OBIC). The UTM coordinates were provided by BLM. We compiled this into an Excel spreadsheet format for use in the field with our maps. Most of the information included in the spreadsheet represents *unedited content* from an OBIC database download for *T. eucosmum*, and is generally self-explanatory. The download includes considerable data originally submitted to OBIC by Prineville BLM staff and other sources.

EO (or *element occurrence*) numbers refer to the OBIC system of numbering rare plant populations in their database. These numbers are used by BLM as well.

The GPS data provided by OBIC (the lat/longs specifically) were determined to be of varying usefulness, and we ultimately relied more on descriptive directions to relocate sites. Moreover, a number of sites were quite spread out, and we felt that even the UTM coordinates and shape files provided by BLM would likely only get you in the "ball park" in many instances. We would probably rely more on the UTM data for survey work within the roadless areas (which was planned more for 2010). Fortunately, once we had a search image for the habitat types in place, we were able to do a good job of locating sites and determining population numbers in 2009.

Of the 63 sites in the Appendix, 12 were excluded from the project for varying reasons. These are noted in the spreadsheet, with the reason for their exclusion added in the "Directions to the Site" column (see also Table 1 on page 7 for a summary of excluded sites). Excluded sites also are identified in the Appendix by orange cells in the left-hand "EO#" column.

After review, 51 *T. eucosmum* sites were considered "survey-eligible" for this project. Twenty-five EOs were assessed in 2009, and 26 were left for expected survey work in 2010. Sites surveyed in 2009 have yellow cells in the "EO#" column in the Appendix, and sites that were not surveyed have white "EO#" cells. Discussion regarding site survey decisions for 2009 can be found on pages 6 and 7 (together with an overall summary of EO survey status in Table 2).