Townsendia condensata Parry ex Gray var. anomala (Heiser) Dorn (cushion Townsend daisy): A Technical Conservation Assessment

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Species Conservation Project

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Jennifer C. Lyman received her Ph.D. in Plant Ecology and Genetics from the University of California, Riverside. Her thesis focused on an ecological and genetic comparison of the endemic plant *Oxytheca emarginata* (Polygonaceae), restricted to the San Jacinto Mountains of California with a few of its widespread congeners. After completing her doctorate, she became a biology professor at Rocky Mountain College in Billings, MT in 1989. In 1991, Dr. Lyman left teaching to work for BioSystems Analysis, Inc., an environmental consulting firm based in California but with a branch office in Billings, MT. After managing the Billings office for four years, Dr. Lyman returned to teaching at Rocky Mountain College in order to develop an Environmental Sciences program. Dr. Lyman is currently Chair of the Science and Mathematics division at the college. Her research interests include the study of floristics and ecology of plants of the Djungarsky and Altai mountain ranges in Russia and Kazakhstan. She is co-author with Drs. Juri Kotokov and Anna Ivashenko of *The Flora of the Vascular Plants of the West Altai Reserve, Kazakhstan*, published in 2002, as well as a number of articles about new rare plant findings in Kazakhstan.

COVER PHOTO CREDIT

Townsendia condensata var. *anomala* (cushion Townsend daisy). Photograph courtesy of Wyoming Natural Diversity Database files 2005 and J. Whipple.

SUMMARY OF KEY COMPONENTS FOR CONSERVATION OF *TOWNSENDIA CONDENSATA VAR. ANOMALA*

Status

Townsendia condensata var. *anomala*, a variety of cushion Townsend daisy, has been designated a sensitive species in the USDA Forest Service (USFS), Rocky Mountain Region (Region 2). Most known occurrences are on National Forest System land in Region 2. While the taxon has been found on land managed by the Bureau of Land Management (BLM), it is not on the BLM list of sensitive species for Wyoming. Nor is it a candidate for listing as Threatened or Endangered under the federal Endangered Species Act. NatureServe and the Wyoming Natural Diversity Database have assigned this species the rank of G4T2S2, defined as "imperiled because of rarity" on both a global and state basis.

The entire known range of *Townsendia condensata* var. *anomala* is within Region 2, in the Absaroka Mountains in northwestern Wyoming. A total of 31 of 33 documented occurrences are on lands managed by Shoshone National Forest. Of these, 14 are within designated wilderness areas, and three are in areas under consideration for USFS Research Natural Area designation. One of the two occurrences not on USFS land is under private ownership; the other is on land managed by the BLM.

There is some evidence that *Townsendia condensata* var. *anomala* is the sexual progenitor of the apomictic var. *condensata*. It may be appropriate to recognize only the full species, as has been done for other complexes of closely related taxa in *Townsendia*. If separate varieties of *T. condensata* are no longer recognized by the taxonomic community and the USFS, the taxon will no longer be listed as sensitive since the full species *T. condensata* is sufficiently common to not be of conservation concern. At this time however, there is insufficient information available concerning phylogenetic relationships within *T. condensata* to make such decisions.

Townsendia condensata var. *anomala* is restricted to the northern part of the Absaroka Mountains; occurrences are concentrated in the drainage of the North Fork of the Shoshone River, at elevations ranging from 6,000 to 12,000 ft. Most sites are on upland slopes and ridgecrests, or on scree below cliffs. A few occurrences are based in part on collections from gravel bars, but include mainly upland habitat. Soils are poor, many of the sites are exposed and harsh, and vegetative cover is sparse.

Townsendia condensata var. *anomala* grows as scattered patches on suitable sites. Patch size varies as does distance between patches. Estimates of up to 1,000 plants have been reported for "sub-populations," with a range of 200 to 500 plants being more common. Recent surveyors reported much smaller numbers at survey sites. However, there has been no consistency among surveyors in defining sites and populations for this taxon, nor are there reliable repeat observations available for assessing population trends. Thus, there is no information concerning trends in abundance for this taxon. *Townsendia condensata* var. *anomala* is a perennial mat-forming herb that occupies sparsely-vegetated sites, suggesting that it is a poor competitor. It reproduces sexually, and it appears to be an obligate outcrosser.

Primary Threats

There are no known existing threats to the viability of *Townsendia condensata* var. *anomala* across Region 2. Several potential threats have been identified, but none are thought to affect the overall viability of the taxon at this time.

Invasive plant species have been reported at only a few *Townsendia condensata* var. *anomala* sites. Cheatgrass (*Bromus tectorum*) was found near some sites, but it appears to be restricted to slightly more mesic habitat, rather than the exposed sites where *T. condensata* grows. In addition to cheatgrass, Dalmatian toadflax (*Linaria dalmatica*) and spotted knapweed (*Centaurea maculata*) are serious problems in the area, but these species also appear to require more mesic habitat.

Currently, there is no oil and gas development within the known range of *Townsendia condensata* var. *anomala*. However, the Absaroka volcanic rocks overlie at least one structural basin, with oil-bearing sedimentary strata likely. The Absaroka volcanic province is considered to have medium to high potential for oil and gas accumulations in the underlying sedimentary rock. Much of the Absaroka volcanic province lies within wilderness areas, but this does not necessarily restrict development. From the perspective of economic geologists, wilderness areas are off limits only until technology or need dictates otherwise.

Recreation (e.g., trails, trampling) and hydrologic change have been identified as potential threats to parts of several occurrences of *Townsendia condensata* var. *anomala*. However, their overall impact would be insignificant. Utilization by livestock is unlikely due to the location of the populations. Fire would not carry in most occupied habitat due to its very sparse vegetative cover. The genus *Townsendia* is popular with rock gardeners, but over-collection is unlikely due to the difficulty of collecting the plant compared with cultivating it in a greenhouse. It is difficult to speculate on the possible effects of global climate change, cooling, drought, or increased moisture on this taxon.

Primary Conservation Elements, Management Implications and Considerations

Assigning a conservation status to *Townsendia condensata* var. *anomala* is complicated by the existence of conflicting factors. The taxon is common within its range, but its global range is limited. Many populations are small, but it is not clear that this is a risk to the overall viability of the taxon. Large areas of habitat with high potential for occurrences remain unsurveyed. Currently there is little management conflict and little impact from human use in general, but the area has medium to high potential for oil and gas resource development. Invasive plant species are not currently threatening Townsend daisy sites, but they may become problematic in the future.

It is difficult to identify conservation elements for *Townsendia condensata* var. *anomala* as little is known about its biology and ecology. A few elements can be hypothesized based on its apparent habitat requirements and the little information about its life history. It appears to require sparsely-vegetated microsites, but apparently it is not an early seral species. Most sites in which this taxon occurs are not disturbed, and it would be incorrect to conclude that disturbance is needed for habitat maintenance. In fact, upland populations could require many years to re-establish following disturbance given the harsh conditions of those sites. *Townsendia condensata* var. *anomala* appears to be an obligate outcrosser, requiring appropriate pollinators, but pollen vectors are not known for this taxon.

There is much we do not know regarding the biology and ecology of *Townsendia condensata* var. *anomala*. From a management perspective, the biggest gap is the absence of population trend data. If *T. condensata* var. *anomala* continues to be of conservation concern, a low-intensity monitoring program designed to flag unexpected, large changes in abundance or distribution *might* be justified. However as with any monitoring program, need, appropriate design, and cost-effectiveness must be demonstrated.

An important management need is to conduct additional species surveys. Large areas of potential habitat for *Townsendia condensata* var. *anomala* remain unsurveyed on Shoshone National Forest. Most of these areas are difficult to access, and surveys would be time-consuming. A cost-efficient approach would utilize pre-project inventories, thereby putting resources where there might be conflict with human activity.

Additional study of the taxonomic relationships between *Townsendia condensata* var. *anomala* and its close relatives is needed as results may have implications for management. Intrageneric relationships in the genus *Townsendia* are not well understood, and there is disagreement as to what constitutes separate species and subspecific taxa within this genus. Past research has suggested that *T. condensata* var. *condensata* may be an apomictic derivative of var. *anomala*, and there is debate among plant taxonomists as to whether to recognize apomictic derivatives as separate taxa. With more material now available, relationships between the two varieties need to be reassessed, as well as the implications of taxonomic revision for conservation status of *T. condensata* var. *anomala*.

Little is known about other aspects of the biology of *Townsendia condensata* var. *anomala*, for example autecology, demography, and community ecology. However, this information is not currently of high priority for management.

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INTRODUCTION

This assessment is one of many being produced to support the Species Conservation Project for USDA Forest Service (USFS), Rocky Mountain Region (Region 2). *Townsendia condensata* var. *anomala* (a cushion Townsend daisy, also known as the North Fork Easter-daisy) has been included in the project because it has been designated a sensitive species by the Regional Forester (USDA Forest Service 1995, 2003). Within the National Forest System, a sensitive species is a plant or animal whose population viability has been identified as a concern by a Regional Forester due to significant current or predicted downward trends in abundance or habitat capability that would reduce its distribution (USDA Forest Service 1995). A sensitive species may require special management, so knowledge of its biology and ecology is critical.

Goal

Species conservation assessments produced as part of the Species Conservation Project are intended to provide forest managers, research biologists, and the public with thorough discussions of biology, ecology, conservation status, and management of the species of concern, based on available knowledge. Assessments are not intended to make management recommendations, but any recommendations proposed or implemented elsewhere are discussed. Instead, these documents provide the ecological background needed for effective management. Potential environmental changes resulting from management (i.e. management implications) also are discussed.

Scope

This assessment addresses the biology, ecology, conservation, and management of *Townsendia condensata* var. *anomala* throughout its known range, which is entirely within Region 2. Major sources of information for this assessment include refereed literature, non-refereed publications, research reports, data maintained by the Wyoming Natural Diversity Database (WYNDD), field survey forms from recent inventories, herbarium specimens, and personal communications with experts.

Since most of the information about *Townsendia condensata* var. *anomala* resides in unpublished literature and institutional files, it was not possible to rely completely on refereed literature in producing this assessment. There were some exceptions however. Refereed literature was the main source of information for discussions of systematics and reproductive strategy. Even so, much of this information did not apply specifically to *T. condensata* var. *anomala*, and it was necessary to judge and discuss relevance.

Treatment of Uncertainty

Science strives to be a rigorous, systematic approach to obtaining knowledge, in which competing ideas regarding how the world works are measured against observations. However, we cannot avoid uncertainty because our descriptions of the world are always incomplete. Observations, inference, good thinking, and models may guide our understanding, but we must be aware of the associated limitations. Throughout this assessment, availability and strength of evidence are discussed, with alternative explanations included when appropriate.

From a management perspective, the most significant gaps in our knowledge of *Townsendia condensata* var. *anomala* concern abundance and population trends. In addition, we know almost nothing regarding its autecology, demography, or community ecology. However, these topics are not as relevant in assessing conservation status and making management decisions.

In contrast, the impact of land use on the viability of *Townsendia condensata* var. *anomala* is of great concern to managers, but this topic is surrounded by much uncertainty. For many taxa, including *T. condensata* var. *anomala*, there is insufficient information from which to draw conclusions regarding management activities and viability. Extrapolation from other species and from plants in general must be done with extreme care. Therefore, our approach is one of caution when considering extrapolation, generalization, and synthesis (e.g., see discussions of pollination and species viability under Implications and potential conservation elements). This scientific rigor will benefit management in the long term.

Publication of Assessment on the World Wide Web

Assessments produced for the Species Conservation Project are being published on the World Wide Web site (http://www.fs.fed.us/r2/projects/scp/) of the USFS Region 2. Web publication makes these reports available to agency biologists and the public in a timely fashion. It also facilitates revision of the documents, which will be done based on guidelines established by Region 2.

Peer Review

Species Conservation Project assessments have been peer reviewed prior to their publication on the World Wide Web. This assessment was reviewed through a process administered by the Society for Conservation Biology, which employed two recognized experts in this or related taxa. Peer review was designed to improve the quality of communication and to increase the rigor of the assessment.

MANAGEMENT STATUS AND NATURAL HISTORY

Management Status

USFS Region 2 has designated *Townsendia condensata* var. *anomala* as a sensitive species (USDA Forest Service 1995, 2003). The ultimate goal of sensitive species designation and management is to avoid listing it under the Endangered Species Act (ESA). *Townsendia condensata* var. *anomala* is not currently a candidate for listing as Threatened or Endangered under the ESA.

Two occurrences of *Townsendia condensata* var. *anomala* are on lands managed by the BLM (one of these is shared with Shoshone National Forest). These reports are relatively new, based on review of specimens at the Rocky Mountain Herbarium during preparation of this assessment, and on surveys in 2004 and 2005 (Wyoming Natural Diversity Database 2006). *Townsendia condensata* var. *anomala* had not been reported previously from BLM lands, and it is not on the BLM sensitive plants list for Wyoming (USDI Bureau of Land Management 2002).

NatureServe (formerly the heritage division of The Nature Conservancy) and the Wyoming Natural Diversity Database have assigned *Townsendia condensata* var. *anomala* the rank of G4T2S2, defined as "imperiled because of rarity" on a both a global (G) and state (S) basis (Keinath 2003, NatureServe 2004). The global rank includes two parts: G4 is the rank of the full species, and T2, a trinomial rank, is the rank of the variety. In the absence of other factors, a rank of "2" usually is assigned to species represented by six to 20 occurrences. However, small population size is a factor in the conservative ranking of this taxon (Heidel et al. 2002). Complete definitions of heritage ranks are included at the end of the Definitions section of this assessment. Heritage ranks may be used by land management agencies as guidance, but they confer no legal protection.

Existing Regulatory Mechanisms, Management Plans, and Conservation Strategies

The entire known range of *Townsendia condensata* var. *anomala* is within Region 2 (**Figure 1**), in the Absaroka Mountains in northwestern Wyoming (**Figure 2**). Most documented occurrences (31 of 33) are on lands managed by the Shoshone National Forest; the taxon does not occur on other national forests within Region 2 (Wyoming Natural Diversity Database 2006). *Townsendia condensata* var. *anomala* is listed as sensitive in USFS Region 2. While this designation does not obligate the agency in any legally-binding way to avoid harming a species, it does "direct" the use of a variety of approaches to prevent listing the taxon under the ESA (USDA Forest Service 1995, 2003). Thus, there is no guarantee that the taxon would be protected if changes in management or land use posed threats to its survival. Sensitive designation also directs the USFS to prepare conservation strategies for listed species. This preparation of a conservation strategy has not yet been undertaken for *T. condensata* var. *anomala*, in part because the conservation status of the taxon is unclear. Large areas of potential habitat remain unsurveyed, and the Townsend daisy may be more common than previously thought (Fertig 1998, Houston personal communication 2005).

One of the two occurrences not on National Forest System land is under private ownership; the other is on land managed by the BLM for multiple use (Wyoming Natural Diversity Database 2006). Management plans and/or conservation strategies for *Townsendia condensata* var. *anomala* have not been developed where the species occurs on BLM land.

Fourteen of the known occurrences of *Townsendia condensata* var. *anomala* are within designated wilderness areas on the Shoshone National Forest (Wyoming Natural Diversity Database 2006). Three occurrences are in areas under consideration for Research Natural Area (RNA) designation, including the Grizzly Creek potential RNA (Jones and Fertig 1999a) and the Sheep Mesa potential RNA (Jones and Fertig 1999b). RNAs and conservation strategies will be considered during the next revision of the Shoshone National Forest Land and Resource Management Plan. However, with new planning regulations under consideration, it is not clear when revision will take place (Houston personal communication 2005).

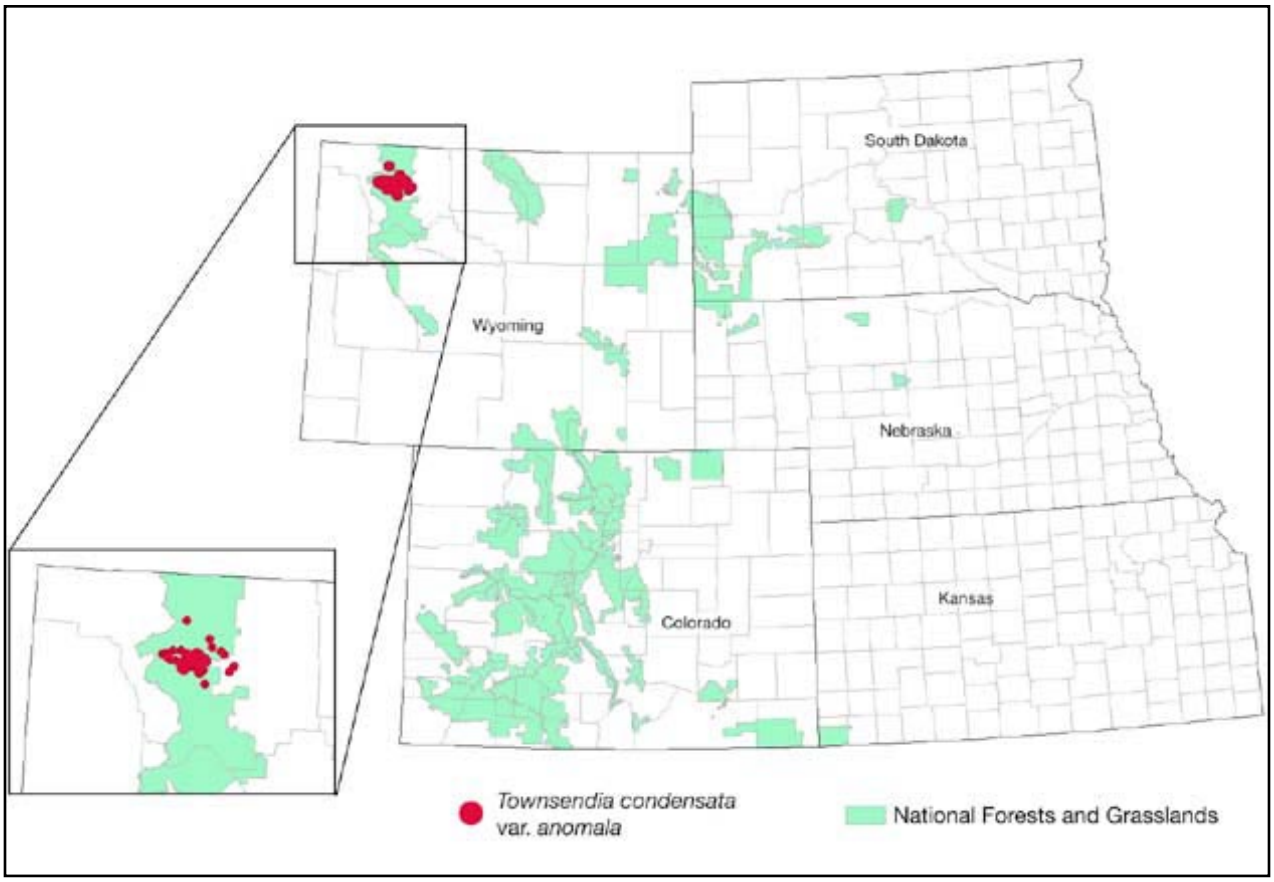

Figure 1. Map of National Forest System lands within USDA Forest Service Region 2, including the global range of *Townsendia condensata* var. *anomala* occurring in northwestern Wyoming (map by Wyoming Natural Diversity Database 2005; updated 2006).

Biology and Ecology

Classification and description

Classification and systematics

Townsendia condensata var. *anomala* is a member of the Asteraceae (sunflower family). The family is cosmopolitan and one of the largest families of vascular plants, represented by 1,535 genera and 23,000 species (Judd et al. 2003). The genus *Townsendia* is restricted to western North America, occurring mainly within the United States, with only a few species in Canada and Mexico. Within the genus, approximately 26 species (Beaman 1957) or 25 to 30 taxa (Whitton et al. 2001) are recognized; the numbers vary slightly due to disagreement on circumscription of taxa. Many have narrow distributions, and some are restricted to specific soils or rock types.

The taxonomic history of *Townsendia condensata* var. *anomala* is not straightforward. What was to become the holotype was collected at "Holm Lodge, about 40 miles west of Cody, Park County, Wyoming" in 1922 by von Schrenk (Heiser 1948). This material was placed in *T. scapigera* by Larsen (1927), and it represented the only material from Wyoming included within that taxon.

Heiser (1948) examined *Townsendia* material collected by von Schrenk. Based on his familiarity with *T. scapigera* in California and Nevada, he considered the von Schrenk material to be outside the range of variability for *T. scapigera*, and for any known species in the genus, thus justifying description as a new species. Heiser assigned full species status to the material, *T. anomala* Heiser, and he considered the species to be more closely related to *T. spathulata* than to *T. scapigera*. He did not discuss relationships with *T. condensata*.

Beaman (1957) placed *Townsendia anomala* in synonymy under *T. condensata*. He considered the material on which *T. anomala* was based to be

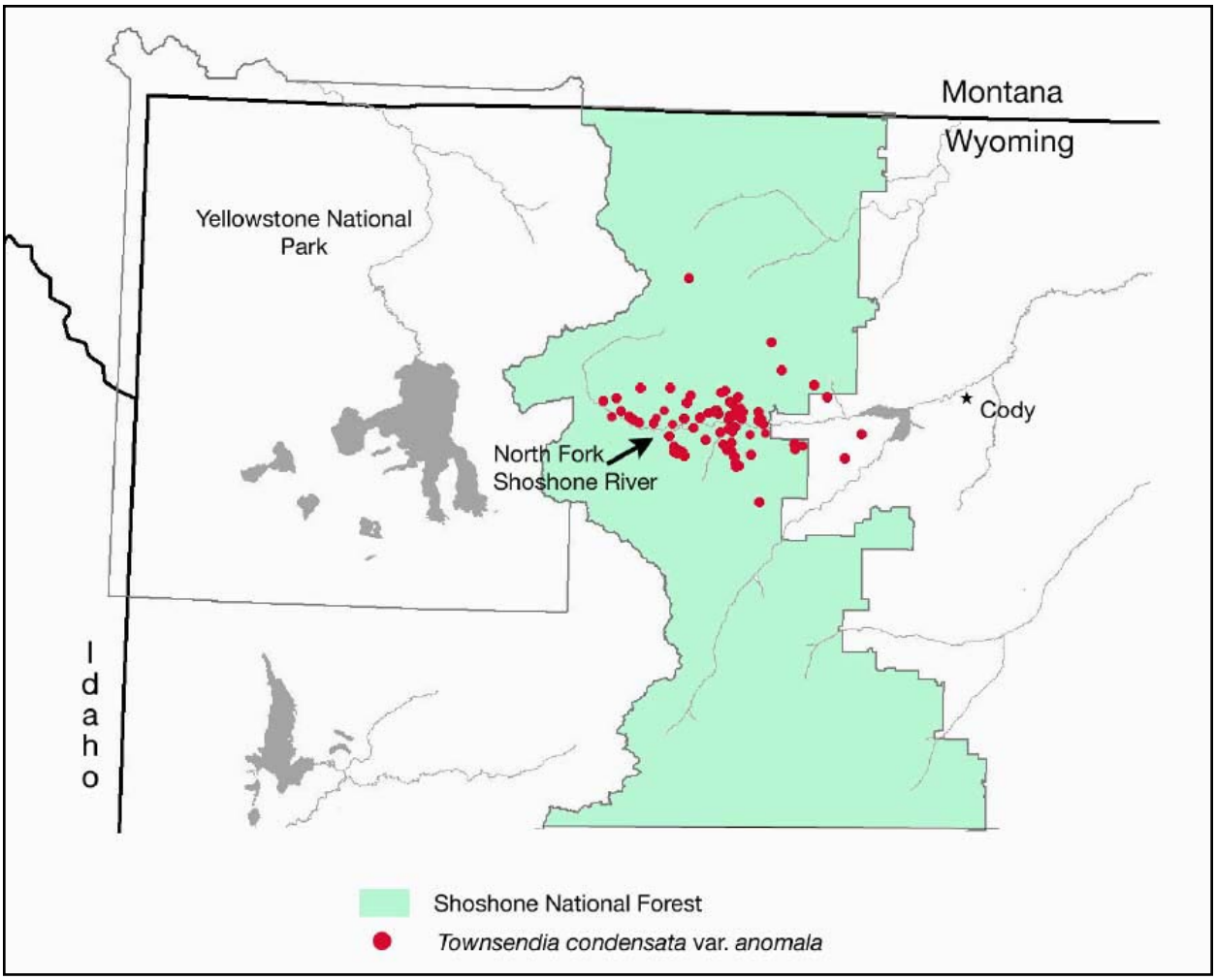

Figure 2. Global distribution of *Townsendia condensata* var. *anomala* (map by Wyoming Natural Diversity Database 2005; updated 2006).

only slightly different from some alpine forms of *T. condensata*, and within the range of variability for the latter species.

Dorn (1988) resurrected *Townsendia anomala* but assigned it varietal status, *T. condensata* var. *anomala*. He had significantly more material for study than had been available earlier and found clear differences between the two varieties, mainly in size and number of heads, and degree of stem development (Dorn 1988, Dorn personal communication 2004).

Research is currently underway to revise the taxonomy of *Townsendia* in western North America based on DNA markers (internal transcribed spacers [ITS]) (Whitton personal communication 2006). However, at the time of this writing, researchers had made little success in separating even full species in this genus with this type of marker.

A complete taxonomic classification of *Townsendia condensata* var. *anomala* is available online from the PLANTS database (USDA Natural Resources Conservation Service 2004). This classification is not the only one that is accepted (e.g., Judd et al. 2003), but disagreement over higher taxonomic levels is not relevant to biology and management. In contrast, disagreement over recognition of separate varieties is of great concern from a management perspective, as explained below.

Apomixis, taxon recognition and management implications: Assigning names to members of the genus *Townsendia* has been considered difficult since the early days of botanical exploration in North America (e.g., Gray 1880, Jones 1893). Recognition of the prevalence of apomixis (asexual seed production) in the genus has helped to explain some of the problems confronting early investigators (Beaman 1957, Whitton

et al. 2001, Thompson and Whitton 2003, Thompson and Whitton in prep.). Although apomixis may be of little interest to land managers, it can be an important factor in deciding whether populations should be recognized as distinct taxa, which in turn has significant management implications.

Apomixis is asexual seed production, and it is almost always correlated with polyploidy (extra sets of chromosomes) (Whitton et al. 2001, Judd et al. 2003, Archetti 2004). It differs from vegetative reproduction in that some genetic variation is maintained, as well as the advantages of seed dispersal. Apomicts thus may be able to maintain viable populations, at least in the short term (Judd et al. 2003).

A group of species with two or more taxa that reproduce through apomixis is referred to as an agamic complex. Whitton et al. (2001) reported that both diploid sexual and polyploid asexual populations are known for a number of species in the genus *Townsendia*. Thompson and Whitton (2003, in prep.) found that nearly all diploid forms of *T. hookeri* have associated polyploid forms. In other words, at least for some members of the genus *Townsendia*, apomictic polyploid plants are generated frequently from diploid sexual plants. If this situation was occurring for *T. condensata*, then recognition of separate varieties within the species might not be appropriate. *Townsendia condensata* var. *anomala* is not currently included in the group of taxa studied by Whitton and Thompson (Whitton personal communication 2006).

All specimens of *Townsendia condensata* examined by Beaman (1957) were apomictic, with the exception of the von Schenk specimens on which Heiser (1948) had based *T. anomala*. These were found to be sexual diploids. This suggests that *T. condensata* var. *anomala* is the parent diploid from which at least part of the polyploid "typical" variety is derived. Although there is evidence of a diploid/polyploid relationship between *T. condensata* var. *anomala* and var. *condensata*, little of the available material has been examined. More work is needed before drawing conclusions on relationships between the two taxa.

If the taxonomic community and the USFS no longer recognize separate varieties, then *Townsendia condensata* will no longer be listed as sensitive since the full species is sufficiently common to not be of conservation concern (Rocky Mountain Herbarium 1998, Dorn 2001). Whether to recognize sexual diploids and apomictic relatives as separate taxa is a decision beyond the scope of this assessment. However, readers should be aware that the controversy regarding the taxonomic status of the various populations of *T. condensata* has not ended.

Common names: There is some confusion surrounding the common name for *Townsendia condensata* var. *anomala*. A system of standardized common names has been developed for federal agencies (USDA Natural Resources Conservation Service 2004), but unfortunately, no distinction is made between *T. condensata* var. *condensata* and *T. condensata* var. *anomala*. Both varieties are recognized, but they have the same common name, cushion Townsend daisy. Because of the requirement to use USDA-accepted common names in this assessment, "Townsend daisy" and "cushion Townsend daisy" are used only when it is clear which variety is being discussed. The most widely used common name for var. *anomala* is "North Fork Easter-daisy" (Fertig et al. 1994, Fertig and Mills 2000, Heidel et al. 2002, Keinath et al. 2003, Houston personal communication 2005).

History of knowledge of the species

The holotype for *Townsendia condensata* var. *anomala* was collected by von Schrenk on the Howell Ranch, 40 miles west of Cody, Wyoming, on August 26, 1922 (Heiser 1948). A second collection was made the next day, also on the Howell Ranch at Holm Lodge. In 1952, Beaman and Preece collected additional material from the Holm Lodge area. The next collections of *T. condensata* var. *anomala* were made in the early 1970's by local resident and botanist Erwin Evert. Several general floristic projects associated with the Rocky Mountain Herbarium, University of Wyoming, were completed in the 1980's and 1990's and contributed additional records of both varieties of *T. condensata* (Kirkpatrick 1987, Snow 1989, Rosenthal 1998, Rosenthal 1999). Rare plant surveys by WYNDD staff were the first sources of detailed information on abundance and habitat for *T. condensata* var. *anomala* (Fertig 1997, Fertig 1998, Jones and Fertig 1999a, Jones and Fertig 1999b).

Although there has been no rangewide survey directed specifically at *Townsendia condensata* var. *anomala*, recent project area inventories on the Shoshone National Forest continue to add new information. In 2004 and 2005, surveys for plant species of concern were conducted on USFS lands in the drainage of the North Fork of the Shoshone River to provide baseline information for potential prescribed burn and mechanical removal projects (Taylor and Taylor 2004, Wyoming Natural Diversity Database 2006).

Marriott examined the extensive amount of material of *Townsendia condensata* available at the Rocky Mountain Herbarium, University of Wyoming, including specimens of both var. *anomala* and the typical variety. Eight "new" specimens of *T. condensata* var. *anomala* were found. Of these, six had either been identified as the typical variety or had been assigned the full species name without variety, resulting in omission from recent herbarium searches for var. *anomala*. Two specimens were found that had been determined to be var. *anomala* but had not yet been added to the main collection. Four specimens labeled var. *anomala* were found to be var. *condensata*. All annotations were reviewed by Hartman (personal communication 2005) and Nelson (personal communication 2005). This information has been incorporated into the databases maintained by WYNDD (Wyoming Natural Diversity Database 2006).

Non-technical description

Members of the sunflower family are characterized by a distinctive inflorescence – a "head" – in which flowers are small, densely-aggregated and surrounded by an involucre of bracts (**Figure 3**; Judd et al. 2003). In *Townsendia*, both "disk" and "ray" flowers are present. The former are strictly tubular; the latter have an elongate strap-like lip on one side. These ray flowers may look like petals at first glance, and superficially a head can resemble a single flower.

The following description is based largely on Fertig and Mills (2000), with some additional information from recent surveys (Taylor and Taylor 2004).

> *Townsendia condensata* var. *anomala* is a perennial, mat-forming herb with stems less than 4 cm tall. The leaves are spoon-shaped with long petioles (leaf stems) and are clustered in a basal rosette. The petioles and leaf blades are densely hairy with stiff, spreading or appressed hairs, except for the bare, rounded tips of the lowermost leaves. Plants have (1)3-15(25) flower heads borne on short branches among the leaves. Flower heads are 10-17 mm wide with sharp-tipped, lanceolate involucral bracts. The glandular ray flowers are white, pink, or lavender. Achenes (dry one-seeded fruit) are pubescent and have minutely bumpy-surfaces.

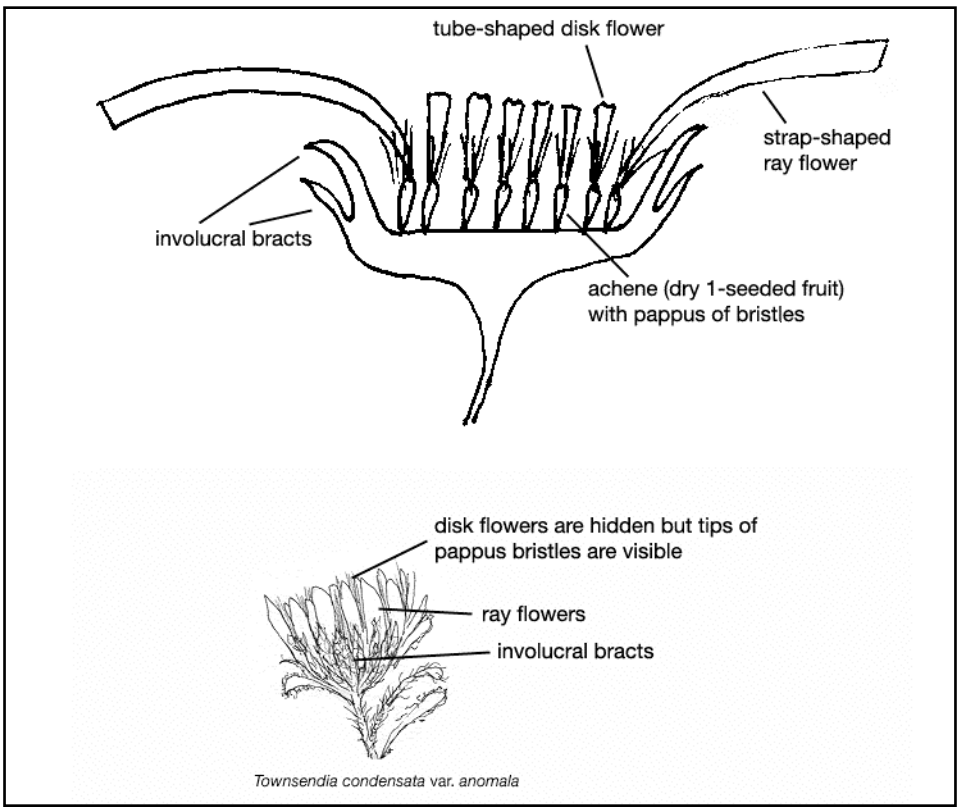

Figure 3. Diagram of the inflorescence characteristic of the sunflower family – a "head." The head in this example is radiate, with both ray and disk flowers present. Members of the genus *Townsendia* have radiate heads (bottom illustration, from Fertig et al. 1994; diagram by Marriott).

Beaman (1957) considered var. *anomala* to be within the range of variation of the typical variety and did not recognize separate taxa. Dorn (1988, personal communication 2004) recognized two varieties based on differences in the number of heads, head size, and stem development (**Table 1**). Marriott examined specimens of *Townsendia condensata* var. *anomala* and the typical variety at the Rocky Mountain Herbarium, as well as vouchers collected by Taylor and Taylor (2004). Most were easily assigned to variety using the characters identified by Dorn. However, some intermediates were found. In these plants, heads were intermediate in size between var. *anomala* and var. *condensata*. Heads were usually several per plant as in var. *anomala*. Stem development in the intermediates varied, but was less than in most individuals of var. *anomala*, or absent. Marriott did not annotate specimens, as additional study is needed to resolve taxonomic issues in the group.

Technical descriptions, photographs, line drawings, and herbarium specimens

All members of the genus *Townsendia* are difficult to identify. The two varieties of *T. condensata* are no exception, and their ranges overlap (Rocky Mountain Herbarium 1998, Dorn 2001). During herbarium study in preparation of this assessment, Marriott found specimens of both *T. condensata* var. *condensata* and var. *anomala* that had been misidentified. Any new reports of the taxon should have voucher specimens as documentation, and herbarium study is highly recommended to compare collections with known material. Drawings, photographs, keys, and descriptions should be used only as guides.

The following technical description is based largely on Heiser's (1948) original description of *Townsendia anomala*, with some additional information from Dorn (2001) and recent surveys (Taylor and Taylor 2004). Technical terms are defined in Harris and Harris (2001).

> Perennial up to 4 cm in height; leaves spathulate, 1 cm or less long, 3 mm or less wide, densely strigulose; heads (1)3-15(25), on leafy branches, short pedunculate; involucre 2-3 seriate, 6-8 mm wide; bracts of the involucre lanceolate, acuminate with wide membranaceous margins; rays about 15, 5-7 mm long, about 1 mm wide; pappus plurisetose, the setae of the disk-flowers slightly longer than that of the ray-flowers; achenes 3-4 mm long, lightly pubescent with short, thick, mostly simple or sometimes emarginated or short-bidentate hairs.

Figure 4 contains a line drawing of *Townsendia condensata* var. *anomala*. This drawing is included also in Fertig et al. (1994), Mills and Fertig (1996), Brooking (2000), and Fertig and Mills (2000). A photograph of the Townsend daisy is contained in **Figure 5**. Photographs can also be found in Fertig et al. (1994), Mills and Fertig (1996), and Fertig and Mills (2000). The largest collection of photographs is on file at WYNDD.

The holotype for *Townsendia condensata* var. *anomala* is deposited at the Missouri Botanical Garden, along with a second specimen collected in the same locality the next day. By far, the largest numbers of specimens of both varieties of the cushion Townsend daisy are located in the Rocky Mountain Herbarium (RM), University of Wyoming, Laramie, Wyoming. Marriott examined 36 specimens during preparation of this assessment, along with voucher material collected during recent project area inventories on the Shoshone National Forest (Taylor and Taylor 2004). The latter has not yet been added to the collection at the RM. Duplicates of some RM *T. condensata* specimens collected by Erwin Evert are deposited at the Morton Arboretum in Lisle, Illinois.

Distribution and abundance

Townsendia condensata var. *anomala* is restricted to the Absaroka Mountains of northwestern Wyoming,

Table 1. Morphological characters separating *Townsendia condensata* var. *anomala* from the typical variety. The taxa can be difficult to distinguish, and both grow in the northern Absaroka Mountains. Sources: Heiser 1948, Beaman 1957, Dorn 1988, Fertig et al. 1994, Marriott 2005 personal observation).

Character	***T. condensata* var. *anomala***	***T. condensata* var. condensata**
number of heads per plant	usually three to 15	usually one
head (involucre) width	10 to 17 mm	(17) 20 to 40 mm
stem development	heads on short stems	stems rarely apparent
leaf shape	narrowly spathulate	often more broadly spathulate

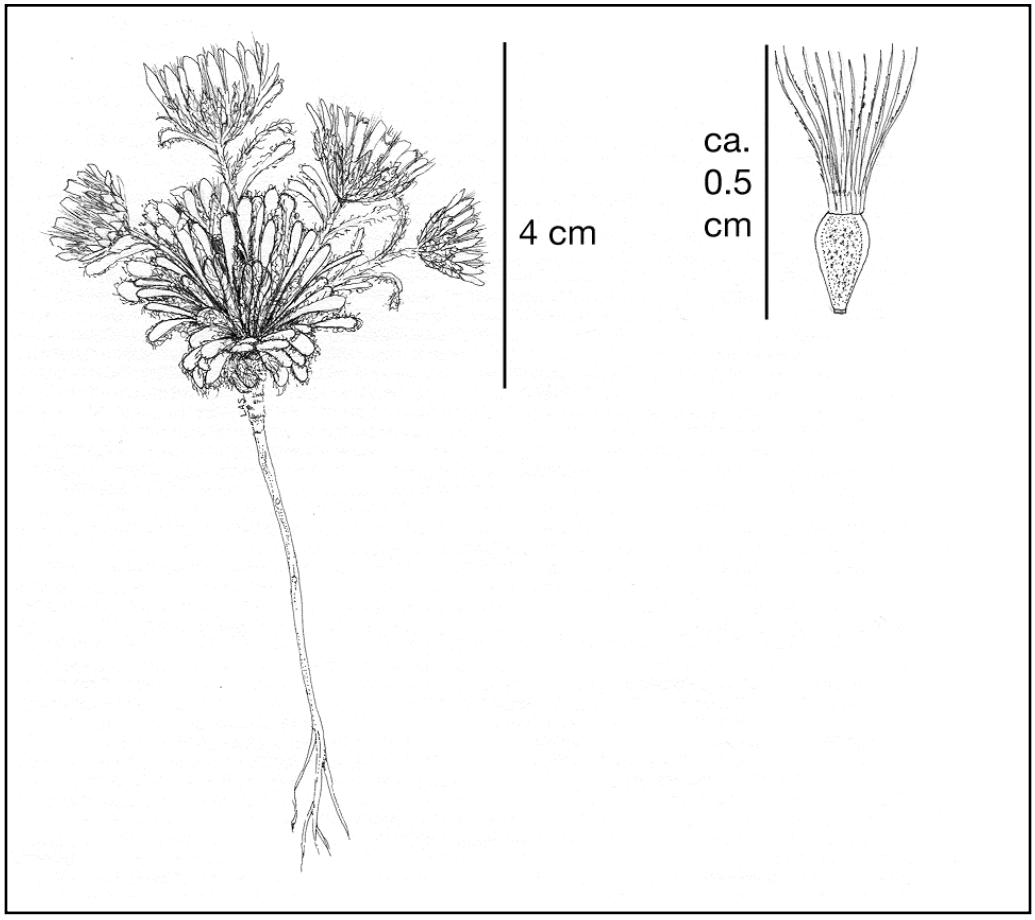

Figure 4. Line drawing of *Townsendia condensata* var. *anomala* and an achene showing pappus bristles; by Linda Shoemaker (modified from Fertig et al. 1994).

Figure 5. Photograph of *Townsendia condensata* var. *anomala*. Plant is less than 4 cm tall. Note achenes with pappus, visible in center of plants. Photograph courtesy of Wyoming Natural Diversity Database files 2005 and J. Whipple.

and its global range is entirely within USFS Region 2 (**Figure 1** and **Figure 2**). There are 33 documented occurrences. Of these, 31 are on Shoshone National Forest, two are on lands managed by the BLM (one of these is shared with Shoshone National Forest), and one is under private ownership. Occurrence data are summarized in **Table 2**. Complete element occurrence records and maps are on file at WYNDD.

Some *Townsendia condensata* var. *anomala* occurrences consist of multiple sub-populations. For example, one occurrence in the drainage of the North Fork Shoshone River is a system of ridges spanning 5 miles, and it includes 13 sub-populations. The term "sub-population" has been used in these situations for patches of plants within occurrences (Wyoming

Table 2. Location and management information for all known *Townsendia condensata* var. *anomala* occurrences (Wyoming Natural Diversity Database 2006). All occurrences are in Park County, Wyoming. See **Table 3** for information on occurrence size and habitat. Missing occurrence numbers are artifacts of data management and do not represent extirpated occurrences.

Occurrence Number	Date Last Observed	Location (brief)	Management/Ownership
1	7/2/2004	Absaroka Range; North Fork Shoshone River drainage, 9 colonies: (1) south end of ridge on east side of Libby Creek; (2) ridge on west side of Libby Creek; (3) ridge on east side of Mormon Creek; (4-7) ridge between Libby and Goff creeks; (8-9) ridge east of Goff Creek.	Shoshone National Forest, Wapiti Ranger District
2	7/3/2004	Absaroka Range, North Fork Shoshone River drainage; ridges between Elk Fork and Pagoda Creek.	Shoshone National Forest, Washakie Wilderness, North Absaroka Wilderness, Wapiti Ranger District
4	7/14/1996	Absaroka Range; South Fork Shoshone River drainage, 2 locations on the southeast slopes of Wapiti Ridge.	Shoshone National Forest, Wapiti Ranger District
5	6/27/1989	Northern Absaroka Range; Sweetwater Creek drainage, ridge east of Sweetwater Creek.	Shoshone National Forest, Wapiti Ranger District
6	8/24/1985	Absaroka Range; summit and north exposure of Trout Peak.	Clarks Fork Ranger District, Shoshone National Forest, North Absaroka Wilderness
7	8/21/1985	Absaroka Range; ridge northwest of Geers Point to Burnt Gulch on north side of Sunlight Creek.	Clarks Fork Ranger District, Shoshone National Forest, North Absaroka Wilderness
9	8/2/1983	Absaroka Range; North Fork Shoshone River drainage, in basin north of Jim Mountain at head of East Fork Big Creek.	Shoshone National Forest, North Absaroka Wilderness, Wapiti Ranger District
11	6/15/2004	Absaroka Range; North Fork Shoshone River drainage, ridge on divide between Sweetwater and Clearwater Creek.	Shoshone National Forest, North Absaroka Wilderness, Wapiti Ranger District
12	6/20/2004	Absaroka Range, north-south trending ridge east and north of Mummy Cave.	Shoshone National Forest, Wapiti Ranger District
13	7/3/2004	Absaroka Range; ridge west of Elk Fork Creek and along Elk Fork Creek Trail.	Shoshone National Forest, Wapiti Ranger District
14	6/4/1989	Absaroka Range; north-south trending ridge immediately east of June Creek.	Shoshone National Forest, Wapiti Ranger District
15	6/16/2004	Absaroka Range; North Fork Shoshone River drainage, north/south ridge system on the west and east sides and head of Aspen Creek. 3 main locations: (1) south end of ridge between Aspen Creek and Clearwater Creek; (2) canyon bottom; (3) ridge west of Aspen Creek.	Shoshone National Forest, North Absaroka Wilderness, Wapiti Ranger District

Table 2 (cont.).

Occurrence Number	Date Last Observed	Location (brief)	Management/Ownership
17	6/16/1997	Absaroka Range; North Fork Shoshone River drainage, 7 sub-populations scattered along slopes on west side of Clayton Mountain. Also on south side of summit rim of Clayton Mountain and saddle connecting Clayton Mountain and Double Mountain.	Shoshone National Forest, Washakie Wilderness, Wapiti Ranger District
18	7/26/1997	Absaroka Range; east slope, south side of Sheep Mountain.	Private land
19	6/12/2004	Absaroka Range; North Fork Shoshone River drainage, ridge system between Signal Peak and Anvil Rock.	Shoshone National Forest, North Absaroka Wilderness, Wapiti Ranger District
20	6/14/2004	Absaroka Range; North Fork Shoshone River drainage, ridge system along Horse and Grizzly Creeks. 5 main sub-populations (made up of 12 colonies): (1) 4 colonies at south end of ridge on west side of Horse Creek, (2) 3 colonies located on crest of divide between Horse Creek and unnamed drainage immediately west of Grizzly Creek, (3) 2 colonies on crest of divide between unnamed creek and west fork of Grizzly Creek; (4) 2 colonies on crest of divide between Sweetwater and Horse creeks; (5) 1 colony on ridge between Horse and Grizzly Creeks.	Shoshone National Forest, North Absaroka Wilderness, Wapiti Ranger District
21	7/1/1991	Absaroka Range; North Fork Shoshone River drainage, ridge between Chimney Rock and the north side of Elephant Head Rock.	Shoshone National Forest, Wapiti Ranger District
22	6/18/2004	Absaroka Range, North Fork Shoshone River drainage, north-south trending ridge system along the divide between Sheep Creek and the West Fork of Blackwater Creek.	Shoshone National Forest, Washakie Wilderness, Wapiti Ranger District
23	7/4/1990	Absaroka Range; North Fork Shoshone River drainage, ridge just east of Buttress Mountain (Sleeping Giant Mountain) on divide between Goff and Gunbarrel Creeks.	Shoshone National Forest, North Absaroka Wilderness, Wapiti Ranger District
24	6/9/1996	Northern Absaroka Range; on top of Sheep Mountain.	BLM Cody Field Office
25	6/22/1988	Northern Absaroka Range; summit and north-facing slopes of Four Bear (Black) Mountain and along Trout Creek Trail.	Shoshone National Forest, Wapiti Ranger District
26	7/2/2003	Northern Absaroka Range; Monument Mountain.	Shoshone National Forest, Wapiti Ranger District
27	7/6/2004	Shoshone National Forest; south slopes of Sleeping Giant Mountain west-southwest to Grinnell Creek.	Shoshone National Forest, Wapiti Ranger District
28	7/6/1989	Northern Absaroka Range; on ridge east of Clearwater Creek and on divide between Moss and Clearwater Creeks.	Shoshone National Forest, Wapiti Ranger District
29	6/30/2004	Absaroka Range; North Fork Shoshone River drainage, 9 sub-populations from ca 0.5 mile west of Clocktower Creek just west of Canyon Creek.	Shoshone National Forest, Wapiti Ranger District
30	6/22/2004	Absaroka Range; North Fork Shoshone River Drainage, ca 1/4 mile west of Newton Creek just north of highway.	Shoshone National Forest, Wapiti Ranger District
31	7/1/2004	Absaroka Range; North Fork Shoshone River drainage, ca 0.5 mile east of Gunbarrel Creek, ca 1.5 miles north of highway.	Shoshone National Forest, Wapiti Ranger District
32	7/5/2004	Absaroka Range; North Fork Shoshone River drainage, 1-1.75 miles west of Whit Creek and ca 1.75-2 miles south of highway.	Shoshone National Forest, Wapiti Ranger District
33	7/7/2004	Absaroka Range; North Fork Shoshone River drainage, ca 1/8 mile northwest of Eagle Creek, just south of highway.	Shoshone National Forest, Wapiti Ranger District

Table 2 (concluded).

Occurrence Number	Date Last Observed	Location (brief)	Management/Ownership
34	8/14/1997	Absaroka Range; North Fork Shoshone River drainage, north-south trending ridge system along the divide between Sheep Creek and West Fork of Blackwater Creek.	Shoshone National Forest, Washakie Wilderness, Wapiti Ranger District
35	7/31/1985	Absaroka Range; North Fork Shoshone River drainage, cirque basin at head of Canyon Creek.	Shoshone National Forest, Washakie Wilderness, Wapiti Ranger District
36	6/24/1988	Bighorn Basin/Absaroka Foothills; along Hardpan Creek, ca 1.5-2 miles north of South Fork Shoshone River.	Shoshone National Forest, Wapiti Ranger District, BLM Cody Field Office
37	7/13/1987	Absaroka Range; North Fork Shoshone River Drainage, ridges between Clocktower and Canyon creeks.	Shoshone National Forest, Washakie Wilderness, Wapiti Ranger District

Natural Diversity Database 2006). However, almost nothing is known regarding gene flow for *T. condensata* var. *anomala*, and neither "occurrence" nor "sub-population" should be interpreted as being based on gene flow. Organization of patches into occurrences had not been completed at the time of writing this assessment.

Occurrences are not evenly distributed through the range of the taxon. While most are within the drainage of the North Fork of the Shoshone River west of Cody (**Figure 2**), *Townsendia condensata* var. *anomala* has also been found in the drainage of the South Fork southwest of Cody, as well as in the Sunlight Basin area northwest of Cody. It is likely that additional occurrences will be found in the northern Absaroka Mountains as there remain large areas of unsurveyed potential habitat (Houston personal communication 2005).

A disjunct occurrence of *Townsendia condensata* var. *anomala* was reported from the southern Absaroka Mountains on the Shoshone National Forest southwest of Meeteetse, Wyoming, approximately 36 air miles south of the main range of the taxon (e.g., Fertig et al. 1994). During preparation of this assessment, Marriott examined the specimen on which this report was based and determined it to be var. *condensata*. Nelson (personal communication 2006) verified the determination.

Townsendia condensata var. *anomala* grows as scattered patches on suitable sites. Patch size apparently varies tremendously, as does distance between patches. Estimates of up to 1,000 plants have been reported for "sub-populations," with the range of 200 to 500 plants being more common (Fertig 1998). Taylor and Taylor (2004) reported much smaller numbers at survey sites, but those sites were smaller than areas that Fertig defined as "sub-populations." Many occurrences are based on herbarium specimens rather than on surveys, and the records contain no information regarding numbers of plants. Available information regarding occurrence size and structure (i.e., number and distribution of sub-populations) is included in **Table 2**.

Population trend

There are no reliable, repeat observations available for assessing population trends for *Townsendia condensata* var. *anomala*. Several sites have received multiple visits, with the species found each time, but it is unclear that the same area was surveyed during each visit (Wyoming Natural Diversity Database 2006). All Townsend daisy occurrences have been located or discovered since 1983, and relocated or discovered since 1996 (Fertig 1997). It does not appear that the taxon has been extirpated from any known sites, and it has been considered stable due to the ruggedness of its habitat (Mills and Fertig 1996, Fertig 1997, Heidel et al. 2002).

Habitat

Habitat information for occurrences of *Townsendia condensata* var. *anomala* is included in **Table 3**. All information presented below is from element occurrence records (Wyoming Natural Diversity Database 2006) unless otherwise noted. Some occurrence records are based on herbarium specimen labels with broad habitat descriptions characterizing the collection site, and some habitat types listed on labels may not apply to *T. condensata* var. *anomala*.

Table 3. Size and habitat information for all *Townsendia condensata* var. *anomala* occurrences (Wyoming Natural Diversity Database 2006). Size data are not available for all occurrences. See **Table 2** for information on location and management. Missing occurrence numbers are artifacts of data management and do not represent extirpated occurrences.

Occurrence Number	Occurrence Size	Elevation (ft.)	Site description
1	9 sub-populations located on 4 ridges spanning ca 3 miles. 2004-07-02: (between Libby and Goff creeks) 4 sub-populations with ca 2/3 flowering and 1/3 fruiting of 32 plants total. 2004-06-17: (just east of Goff Creek) 52% in flower, 48% vegetative of 21-50 plants. (ca 1/3 mile east of Goff Creek) 5 of 6 flowering and fruiting, 1 vegetative. 1996-07-31: (East Libby Creek) 92 flowering/fruiting plants and 350 vegetative rosettes observed in census by Fertig. Total population estimated at 2500-3500 plants. (West Libby Creek) Ca 300-500 plants on ridge and 50-75 on adjacent southwest slope. 1952-08-10: In flower. Reported as "abundant" by Beaman and Preece.	6,500 to 7,800	Occurs in 3 main vegetation types: (1) weedy *Chrysothamnus nauseosus* community at south end of ridge. High cover of *Bromus tectorum*, *Tragopogon dubius*, *Camelina*, *Lactuca serriola*, and *Melilotus officinalis*. (2) Community of scattered bunchgrasses (*Oryzopsis hymenoides*, *Elymus spicatus*) and scattered forbs and shrubs (mostly *Chrysothamnus nauseosus* and *Artemisia tridentata*) on brown andesite clay-gravel among boulder outcrops on ridgecrest. Typically found on concave-shaped, south and east-facing slopes. (3) Steep, loose slopes of 30-35% on gray-brown andesite clay-gravel with large patches of bare soil and rock in opening in *Pseudotsuga menziesii* forest. Community with scattered bunches of *E. spicatus*. Total cover 5-10%. Absent in forested areas or shady mesic valley between the two dry ridges.
2	17 sub-populations on ridge system spanning ca 5 x 5 miles. 2004-07-03: Two sub-populations surveyed with 1 flowering and two fruiting of 3 plants. 2004-06-11: 33% flowering and fruiting, 66% vegetative of 6 individuals. 2004-06-10: 95% flowering and fruiting, 5% vegetative. Ca 14 individuals. 1996-07-30: 9 medium to large colonies observed in survey by Fertig from foothills to timberline. (Cougar Creek) Population estimated at 700-1000 plants with only about 2-5% in flower or fruit. (Cougar and Pagoda Creek Divide) Locally abundant, with densities as high as 14 plants per 1.5 square meters in favorable sites. (Cougar and Pagoda Creek Divide, north Ptarmigan Mountain) Locally common at several timberline sites. Population estimated at 150-200 plants, with ca 25% in flower. (Upper Grace Creek) 50-75 plants observed in each of 2 colonies on adjacent low ridges. 1996-07-18: (North Fork Shoshone River) Several small populations of 3-5 plants each observed by Fertig.	6,100 to 10,200	Occurs in 4 main vegetation types: (1) steep south and west-facing slopes and ridgecrests in the foothills zone on brown andesite volcanic clay soil with surface of irregular gravel. Bare soil cover ca 35% and vegetative cover ca 20-30%. Community of scattered bunchgrasses (mostly *Elymus spicatus* and *Oryzopsis hymenoides*) and scattered shrubs (*Artemisia tridentata* and *Chrysothamnus nauseosus*). (2) Similar habitats to preceding, but at higher elevations (mid slopes in the montane zone) and restricted to openings on ridgecrests within *Pseudotsuga menziesii*/*Pinus flexilis* woods. (3) Subalpine and lower timberline openings on semi-bare, eroded slopes of light brownish-whitish clay gravel and andesite volcanic soil. Vegetative cover ca 25%. Absent from adjacent areas of alpine tundra and *Geum* turf. (4) Exposed gravel bars in the vicinity of stream channels with willow and poplars.
4	2 sub-populations in ca 2 miles. 1996-07-14: In flower and fruit. Collected by R. Hartman and D. Rosenthal. 1996-07-12: (Sec 7-8) In flower and fruit.	8,000 to 10,800	Volcanic ridgetop with rocky slopes.
5	3 sub-populations in ca 1 mile.	6,800 to 8,000	Fine volcanic talus and rocky, barren ridgetop. Also open, south-facing, sparsely vegetated slope.
6	No information.	11,400 to 12,244	North-facing rocky slopes and summit.
7	No information.	7,400 to 11,400	Alpine meadows, rocky slopes, and open ridges adjacent to coniferous woodlands.

Table 3 (cont.).

Occurrence Number	Occurrence Size	Elevation (ft.)	Site description
9	No information.	10,000 to 11,000	Tundra.
11	7 sub-populations spanning ca 1.5 miles on opposite sides of ridge. 2004-06-15: 1 individual with 24, mostly fruiting heads. 2004-06-13: 1 flowering, 1 vegetative out of 2 plants. 1996-07-16: 4 small colonies surveyed by W. Fertig. 24 plants observed; total population estimated at 100-200 individuals. Plants often in clusters of 4-6 and mostly in flower, fruit, or past fruiting.	6,400 to 7,600	Steep, south and east-facing slopes of dry, loose, brown andesite clay-gravel below andesite cliffs and alcoves. Community of scattered bunchgrasses (*Oryzopsis hymenoides*, *Elymus spicatus*, and *Leucopoa kingii*) on open slopes within woodland of *Pinus flexilis* and *Pseudotsuga menziesii*. Total vegetative cover sparse, typically 0-5%.
12	5 sub-populations in 1 mile along ridge. 2004-06-20: One of two sub-populations surveyed. One flowering, two fruiting, two vegetative of five individuals. 1996-07-29: 3 colonies. Largest population on ridgecrest contains ca 200-300 plants, with 5-10% in flower or fruit. Smaller populations on slopes often with only 2-3 flowering plants and low numbers of rosettes.	7,000 to 7,400	Found in 2 main vegetation types: (1) upper slopes and gently south-dipping summit flats of andesite volcanic ridge. Soil dry, brownish sandy-clay with surface layer of fine, bluish-brown, irregular volcanic gravel amid exposed bedrock. Community of scattered *Elymus spicatus* and low forbs in openings in limber pine and Douglas-fir woods. (2) Loose, clay scree and talus slopes below palisades-like andesite cliffs along ridgeline.
13	Three sub-populations spanning over 2 miles of valley slope.	6,100 to 7,800	Open, rocky ridgetop with scattered Douglas-fir and limber pine, and near creek in sagebrush-grassland and on gravelbars. Also east-facing, relatively barren slope of volcanic scree.
14	No information.	6,400 to 6,600	Dry, open, rocky northwest-facing slope in Douglas-fir forest with sparse vegetative understory.
15	Nine sub-populations in 1.5 miles, east and west of Aspen Creek. 2004-06-16: 2 sub-populations. 10% flowering, 20% fruiting, 70% vegetative. 19 individuals observed, probably more present. Five flowering and 2 vegetative plants. 2004-06-09: 80% flowering, 20% vegetative of 6 individuals. 1997-07-01: 4 small sub-populations. Plants may be locally common, but usually clustered, with wide patches of unoccupied habitat in between clusters. Densities as high as 13 flowering plants and 4 rosettes observed in areas of 20 x 20 feet in favorable microsites. Total population probably 200-300 plants.	6,300 to 7,600	Cushion plant and *Elymus spicatus*/*Oryzopsis hymenoides* bunchgrass communities in open, park-like forest of *Juniperus scopulorum*, *Pinus flexilis*, and *Pseudotsuga menziesii*. Soils loose, bare, sandy-clay scree derived from andesite cliffs. Vegetative cover usually sparse (even as low as 5%).
17	7 sub-populations spanning ca 1.5 miles of ridges branching off Clayton Mt. 1996-07-17: 6 small colonies observed by W. Fertig. (3 trailside colonies): First colony with 7 flowering plants and 11 vegetative rosettes widely scattered over 0.25 acre microsite of suitable habitat. Second colony with 8 flowering/fruiting plants and 25 vegetative rosettes. Third colony of 10-15 flowering plants. (2 downslope colonies): plants clustered, but very sparse. 7 flowering plants and 1 vegetative rosette observed in a 1 square meter area. (Clayton Mountain): several small sub-populations each with an average of 5 flowering individuals. Total population estimated at ca 50-100 plants.	7,600 to 10,000	Found in 2 main vegetation types: (1) southwest-facing slopes below low cliffs of reddish-brown, clay-gravel andesite in openings in *Pseudotsuga menziesii/Pinus flexilis* woods below timberline. Vegetative cover very sparse, ca 10%. (2) base of andesite cliffs on clay-gravel at top of talus slope at timberline. Cushion plant/bunchgrass community with total vegetative cover of 0-10%.
18	No information.	6,600 to 7,400	Rocky slopes and drainages with limestone and andesite.

Table 3 (cont.).

Occurrence Number	Occurrence Size	Elevation (ft.)	Site description
19	6 sub-populations in an area ca 0.5 by 2 miles. 2004-06-12: Seven flowering and one vegetative plants. Probably occurs all along ridge. 1997-06-26: 3 colonies surveyed by W. Fertig. In flower and early fruit. Largest colony with 100-150 plants, others with 20-25 plants each. Plants mostly semi-clustered. Vegetative rosettes (1-2 year old plants) also present.	6,300 to 7,900	Occurs in 2 main habitats: (1) *Artemisia tridentata* var *vaseyana*/*Elymus spicatus* community in openings in *Pseudotsuga menziesii/Pinus flexilis* woods on dry, loose, fine-textured scree slopes of volcanic andesite. (2) cushion plant/*Elymus spicatus-Oryzopsis hymenoides* bunchgrass community on south and west facing andesite slopes in openings in *Pseudotsuga menziesii* woods.
20	12 colonies from a 2 by 3 mile area. 2004-06-14: One flowering plant with 21 heads. 1997-08-15: 2 large colonies surveyed by W. Fertig. Individuals mostly past fruiting or vegetative. Population estimated at 100-300 plants. 1997-06-27: 8 colonies surveyed by W. Fertig. Populations mostly localized and consisting of widely scattered individuals (clearly not using all of the available habitat). Total population estimated at 400-500. Largest colony observed on the slopes on the east side of Horse Creek (41 flowering and fruiting plants and vegetative rosettes observed in survey, with a total colony population estimated at 200-300).	6,000 to 8,000	Occurs in 3 main habitats: (1) *Artemisia tridentata/Elymus spicatus* community with scattered *Chrysothamnus nauseosus* and *Oryzopsis hymenoides* on semi-barren east or southwest-facing slopes of dry, loose, shifting brown andesite clay with surface of small gravel. (2) Cushion plant/bunchgrass community in openings in *Pinus flexilis/ Juniperus scopulorum* woods on semi-barren southeast-facing ridges of loose andesite. Vegetative cover often 5-10% and bare soil cover 75-80%. (3) Sagebrush-grassland in scattered Douglas-fir and limber pine.
21	5 sub-populations in ca 1 x 0.5 mile. 1997-07-02: Population estimated at 300-500 plants in 5 main sub-populations. Plants clumped and in flower, fruit, and vegetative condition.	6,500 to 7,400	South and west-facing andesite volcanic gravel or sandy-clay slopes (with low gravel cover) in openings within *Pseudotsuga menziesii/Pinus flexilis* grove containing scattered *Elymus spicatus* and *Oryzopsis hymenoides* (or *Poa secunda* at lower elevations). Rock cover may be 80-90%, or as low as 25%. Vegetative cover typically 5-10% (or less).
22	6 sub-populations in 1 x 1 mile. 2004-06-18: In flower and fruit. Four plants. 1997-06-28: 5 small colonies observed in flower, fruit, and vegetative. Populations mostly sparse, but often clustered. 50-100 plants observed at the largest site. Density observed as 3-5 plants/sq meter at favorable microsites.	6,700 to 9,200	Occurs in 3 main habitats: (1) *Elymus spicatus* community on semi-barren andesite gravel slopes at edge of *Pseudotsuga menziesii* woods at lower elevations. (2) Brownish andesite volcanic clay with surface layer of small stones on west-facing slopes and ridgecrests at higher elevations in cushion plant-bunchgrass communities surrounded by open woods of *Pinus albicaulis*. (3) South-facing slope of volcanic scree surrounded by *Juniperus scopulorum*. Vegetative cover ranges from 25-60%.
23	No information.	10,300 to 10,400	Among boulders on ridgetop in fellfield/ cushion plant community and south-facing cliffs and talus at base of basalt flow.
24	No information.	7,200 to 7,700	Grasslands. Also on limestone outcrops and in meadows.
25	No information.	7,200 to 7,800	Open, rocky Douglas fir forest, and on summit and north-facing scree slopes.

Table 3 (concluded).

Occurrence Number	Occurrence Size	Elevation (ft.)	Site description
26	No information.	10,900	Summit fellfield and rocky alpine meadow.
27	Three sub-populations spanning over 1.5 miles of ridge. 2004-07-06: Vegetative. Three plants.	7,000 to 8,800	Loose, exposed shifting soil and rocky grassland. Ridge of volcanic talus dominated by bunchgrasses.
28	No information.	7,500 to 8,300	Open, rocky, sparsely vegetated ridgetop and open, rocky areas in sparse Douglas-fir forest.
29	9 sub-populations over ca 2 x 3 miles. 2004-06-30: 28% in fruit, 72% vegetative. Ca 50-100+ plants in 2 sub-populations. 19% in flower, 81% vegetative of 37 plants in 3 sub-populations. 2004-06-19: 61% in flower and fruit, 39% vegetative of 23 plants. 50% in flower, 50% in fruit in 2 sub-populations.	6,200 to 8,000	Open, rocky areas with scattered Douglas-fir, limber pine, Rocky Mountain juniper, black sagebrush, or cushion plants.
30	2004-06-22: 50% fruiting, 50% vegetative of 2 plants.	6,600	Steep, south-facing slope of red-brown, volcanic scree.
31	2 sub-populations in ca 1/8 x 1/4 mile. 2004-07-01: 50% in flower, 50% vegetative of 12 plants in 2 sub-populations.	7,100 to 7,300	South-southwest-facing, barren slope of rocky, volcanic talus.
32	6 sub-populations over ca 0.5 x 1.5 miles. 2004-07-05: 31% in flower, 69% vegetative of 36 plants in 6 sub-populations.	7,100 to 7,500	Northeast-facing slopes and ridges. Bunchgrass and cushion plant community on volcanic talus.
33	2004-07-06: 1/3 in fruit, 2/3 vegetative of 6 plants.	6,800 to 7,200	Southeast-facing, sparsely vegetated slop on volcanic talus. Bluebunch wheatgrass-forb community.
34	Two sub-populations in ca 1/2 mile along ridge. 1997-08-14: Both colonies in flower, fruit, and vegetative. Locally abundant, with total population estimated at 200-400 plants. Individuals in clumps of 3-8.	8,880 to 9,180	Brownish andesite volcanic clay with surface layer of small stones on ridgecrest in cushion plant communities surrounded by open woods of *Pinus albicaulis*.
35	No information.	10,000 to 10,600	Rocky meadow-tundra.
36	No information.	6,200 to 7,500	Foothills dominated by *Artemisia* and *Elymus*.
37	No information.	7,600 to 8,800	Open, rocky ridgetops with scattered Douglas-fir and limber pine.

The entire range of *Townsendia condensata* var. *anomala* is in the northern part of the Absaroka Mountains in northwestern Wyoming, with occurrences concentrated in the drainage of the North Fork of the Shoshone River (**Figure 2**). The Absaroka Mountains are a dissected volcanic plateau characterized by high peaks and ridges, steep slopes, rugged canyons, and high relief in general (Parsons 1978, Sundell 1993). Due to the nature of the underlying rock, much of the upland habitat is relatively dry (Parsons 1978) and consequently less vegetated compared with mountain ranges underlain by other substrates, such as granite.

Geologically, the area is known as the Absaroka volcanic province, dominated by andesitic volcanic rocks (**Figure 6**; Sundell 1993). Volcanism occurred between 53 and 38 million years ago. The original deposits have been extensively reworked and redistributed, and much of the rock underlying the area is technically sedimentary rock composed of volcanic

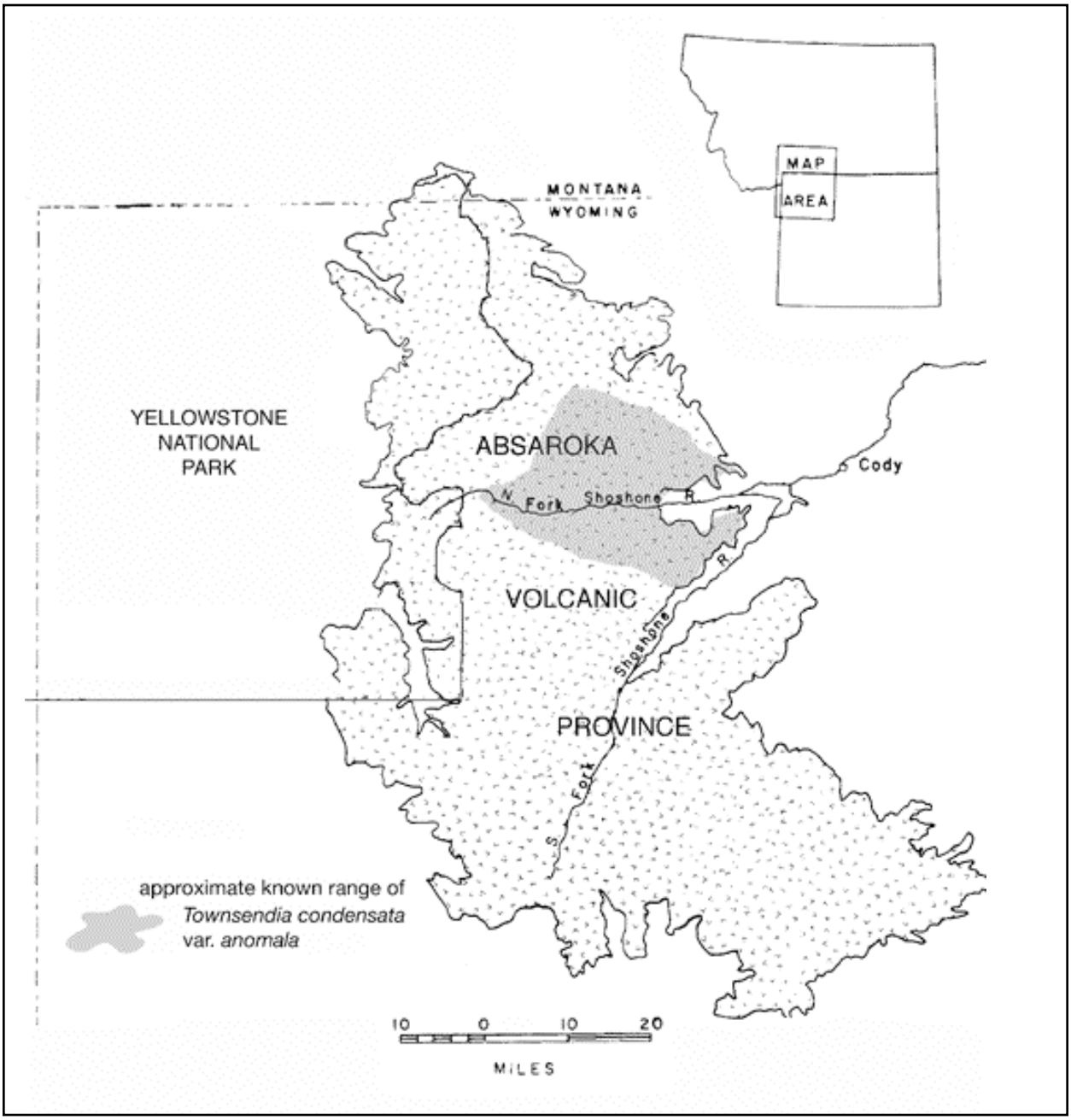

Figure 6. The Absaroka volcanic province showing the approximate known range of *Townsendia condensata* var. *anomala* (modified from Parsons 1978).

fragments. Rock types include volcanic sandstone, siltstone, claystone, conglomerate, and breccia. In some areas, original volcanic igneous rocks persist as outcrops standing above the surrounding slopes or ridgecrests. *Townsendia condensata* var. *anomala* was found to be associated with such outcrops at some sites, occurring on fine-grained soils at the outcrops' bases (Fertig personal communication 2004). *Townsendia condensata* var. *anomala* is not restricted to these habitats however, and it has been found on coarser soils, as well as in areas without igneous rock outcrops (Taylor personal communication 2005).

"Andesite and limestone" are listed in the habitat description for one occurrence of *Townsendia condensata* var. *anomala*, based on herbarium label information (Wyoming Natural Diversity Database 2006). This is a description of the collection site; the specific habitat of the Townsend daisy is unknown (Nelson personal communication 2005). It does not appear to grow on soils derived from limestone, but more survey is needed to confirm this.

Townsendia condensata var. *anomala* has been documented at elevations ranging from 6,000 to 12,000 ft. However, the specimen on which the high end of the elevational range is based approaches var. *condensata* in appearance, with larger heads. Earlier reports listed elevations as high as 13,150 ft. for the Townsend daisy, based on a disjunct site in the southern Absaroka Mountains (Fertig and Mills 2000, Heidel et al. 2002). The specimen underlying the report has since been annotated as var. *condensata* (see discussion under Distribution and abundance). *Townsendia condensata* var. *anomala* typically is found below the alpine zone, and it is most common at elevations below 9,000 ft. The typical variety generally is found at higher elevations, but there is some overlap (Dorn personal communication 2004, Fertig personal communication 2004). Interestingly, specimens of *T. condensata* that do not fit either variety well are from elevations that are high for var. *anomala*, but on the lower end of the elevational range of var. *condensata* (Marriott personal observation, Nelson personal communication 2005).

Most documented sites for *Townsendia condensata* var. *anomala* are on upland slopes and ridgecrests, or on scree below cliffs (**Figure 7a** and **Figure 7b**). Two occurrences are based in part on collections from gravel bars adjacent to streams but include mainly upland habitat. Another occurrence is based on a single collection that includes streamsides in the site description along with several other habitat types; the specific habitat of the Townsend daisy at this site is unknown (Nelson personal communication 2005). Taylor and Taylor (2004) found a single individual along a dirt road in a drainage bottom, where it was partially shaded by cottonwoods (*Populus* spp.); this is an unusual situation for this plant.

Riparian settings are unusual for *Townsendia condensata* var. *anomala*, and in the few more mesic or vegetated areas where it occurs, it is restricted to sparsely-vegetated microsites. In general, the harsh upland areas where this taxon grows are under-surveyed. Riparian areas have received relatively more attention, and yet the taxon is rare in those environments, confirming its preference for harsh upland sites (Hartman personal communication 2005, Heidel personal communication 2005, Houston personal communication 2005, Taylor personal communication 2005).

Townsendia condensata var. *anomala* has been found on slopes of all aspects. Sites vary from steep slopes to gently sloping ridgecrests and summits. On steeper sites, plants may grow on gently sloping or even concave microsites (Fertig personal communication 2004), but they are found on steep microsites as well (Taylor personal communication 2005). Soils at *T. condensata* var. *anomala* microsites have been described as clay-gravel, clay with a surface of irregular gravel, fine scree, sandy, sandy rocky, sandy loam, and sandy with a gravel top layer.

Many of the surveyed sites have been described as dry or very dry with partial to full sun. Sites are often exposed, and many have been described as windy, even in the summer. Winter winds are sufficient to prevent snow accumulation, contributing to the dryness of the habitat (Taylor personal communication 2005).

Associated species and vegetation types vary, but in all situations vegetative cover is sparse, as low as 5 percent or less. There is no consistent set of associated species; those reported by surveyors, (without specimens for documentation) are listed in **Table 3**. The most commonly reported associated vegetation types include a bunchgrass community dominated by *Elymus spicatus* (bluebunch wheatgrass) and *Achnatherum hymenoides* (Indian ricegrass), and cushion plant communities of varying composition. *Ericameria nauseosa* (rubber rabbitbrush) and *Artemisia tridentata* (big sagebrush) are significant components of the vegetation at some sites. Many sites are too sparsely vegetated to assign community type (Taylor personal communication 2005). *Townsendia condensata* var. *anomala* is absent from the more vegetated areas adjacent to occupied sites. Some sites are described as openings in forested

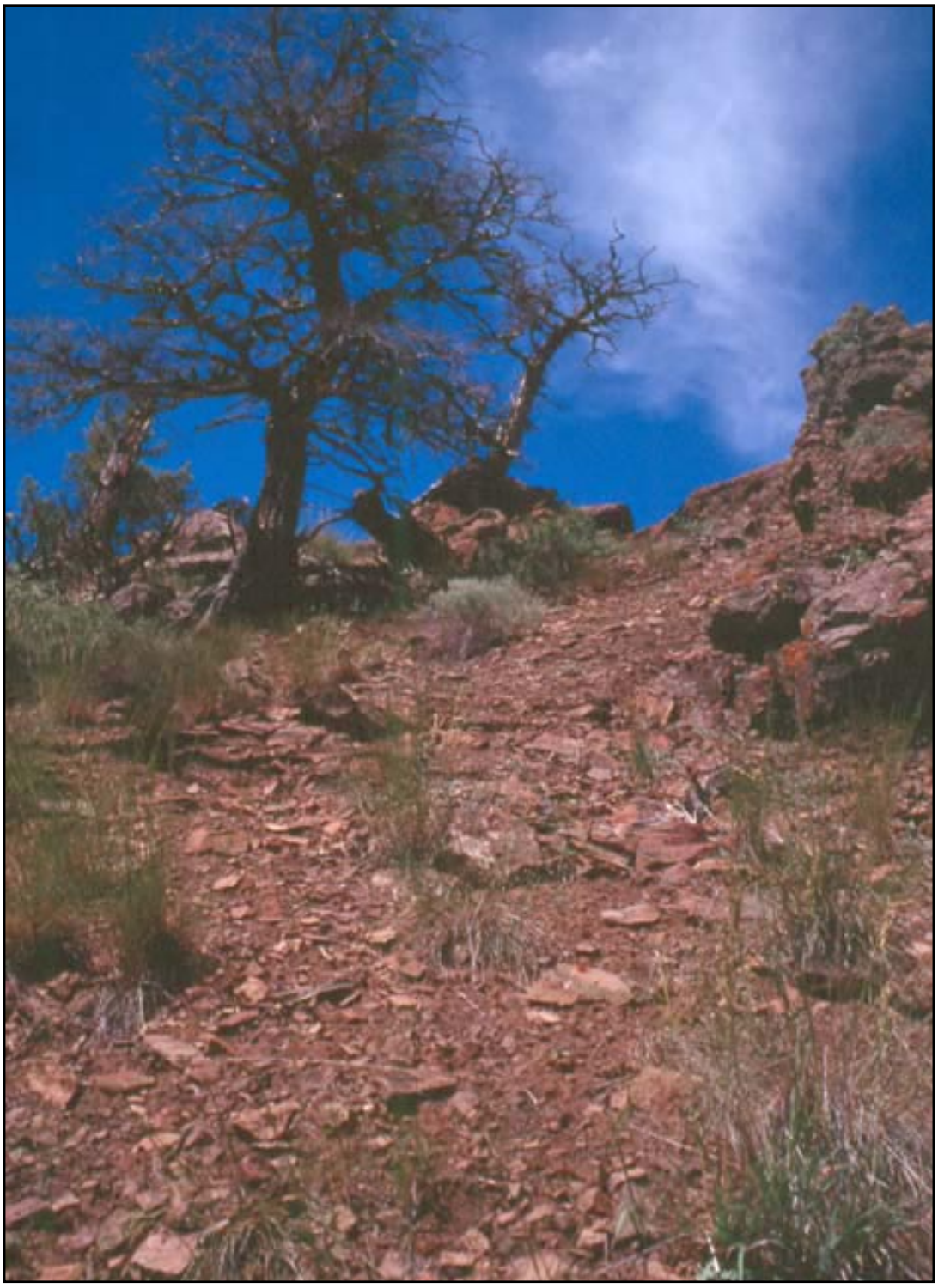

Figure 7a. Habitat of *Townsendia condensata* var. *anomala*: rocky slope of andesite clay-gravel soils below volcanic rock outcrops (from Wyoming Natural Divesity Database files). Photograph by W. Fertig.

Figure 7b. Habitat of *Townsendia condensata* var. *anomala*: sparsely vegetated volcanic soils near ridgecrest (from Wyoming Natural Diversity). Photograph by W. Fertig.

areas, or areas with widely scattered trees, typically *Pinus flexilis* (limber pine), *Juniperus scopulorum* (Rocky Mountain juniper) and *Pseudotsuga menziesii* (Douglas-fir).

Reproductive biology and autecology

Very little is known about most aspects of the biology of *Townsendia condensata* var. *anomala* (e.g., seed viability over time, germination requirements, age at first flowering, individual longevity). Topics for which there is some information available are included below. Much of this information comes from studies on other members of the genus, and caution is required in drawing conclusions specific to *T. condensata* var. *anomala*.

Townsendia condensata var. *anomala* is a perennial, mat-forming herb. While the longevity of individual plants is not known, its slender tap root suggests that it is not extremely long-lived. *Townsendia condensata* var. *anomala* has been described in the past as early seral, due to its sparsely-vegetated habitat (Fertig 1995), but more recent surveys indicate that it is not an early successional species. Seral ecosystems are still developing, in contrast with climax communities, which are relatively unchanging or persistent (Knight 1994). Early seral species are those that appear early in the developmental (successional) sequence. Although the habitat of *T. condensata* var. *anomala* is sparsely-vegetated, it appears *not* to be the result of recent disturbance, but rather harsh site conditions. It would be inappropriate to consider disturbance necessary for habitat maintenance.

Reproduction

Beaman (1954) successfully grew individuals of what is now recognized as *Townsendia condensata* var. *anomala* in the greenhouse and found them to be self-incompatible (i.e., obligate outcrossers). Beaman (1957) considered *T. condensata* var. *anomala* to be the sexual progenitor of the apomictic var. *condensata*. He did not recognize separate varieties but singled out the material collected by von Schrenk as being distinct and sexual, with all other material found to be apomictic (see Classification and systematics above). Beaman's work was based on limited material, including only three collections of var. *anomala*, all of which were from the same location.

Although many species pairs were infertile in the greenhouse, Beaman (1957) found little evidence of hybridization among members of the genus *Townsendia*

in the wild. Doubled chromosome numbers leading to apomixis, a frequent occurrence in this genus, were the result of autopolyploidy rather than hybridization. Polyploidy, apomixes, and taxonomic implications are discussed under Classification and systematics above.

Life history strategy

Townsend daisies are often called Easter-daisies since they bloom in the spring, around the time of Easter. *Townsendia condensata* var. *anomala* is no exception. In fact, it is one of the earlier plants to flower in the region and has been collected in flower as early as May 19 (Wyoming Natural Diversity Database 2006). Blooming begins even earlier most years, with plants at lower elevations producing flowers by Easter (Houston personal communication 2005). *Townsendia condensata* var. *anomala* blooms later at higher elevations, and plants with flowers have been collected as late as mid-August (Wyoming Natural Diversity Database 2006). Individual plants can have heads at different stages of development. Taylor and Taylor (2004) observed heads in bud, flower, and fruit on single individuals.

Seed dispersal

The achenes (dry, single-seeded fruit) of most members of the sunflower family are dispersed by wind, with pappus bristles aiding in transport (**Figure 3**; Judd et al. 2003). Achenes of *Townsendia condensata* var. *anomala* are topped with bristles and are surely wind-dispersed given the exposed windy nature of many sites (Taylor personal communication 2005).

Pollinators and pollination ecology

Beaman (1954) grew individuals of what is now recognized as *Townsendia condensata* var. *anomala* in the greenhouse and found them to be self-incompatible (i.e., obligate outcrossers; var. *anomala* is a sexual diploid; see discussion under Systematics). Outcrossing is facilitated by pollen vectors, but nothing is known regarding the pollinators for *T. condensata* var. *anomala*.

Beatty et al. (2004) noted in their conservation assessment of *Townsendia rothrockii* that no pollination studies had been undertaken for that taxon. They did not extrapolate from other members of the genus, mentioning only that most members of the Asteraceae family are well-equipped to attract pollinators due to their showy heads, which allow many flowers to be visited in a short time. Tepedino et al. (2004) found solitary bees to be the most important pollinators in *T. aprica*, also an obligate outcrosser. However, at this time no conclusions can be drawn regarding pollen vectors for *T. condensata* var. *anomala*. Pollinator specificity and plant-pollinator co-evolution are widespread and well-documented among flowering plants, and they are considered key factors in the evolutionary diversification of the group (Judd et al. 2002). This makes it difficult to extrapolate from one species to another in the absence of information for the taxon of concern. Similarly, it is impossible to extrapolate from other plants found in *T. condensata* var. *anomala* habitat since flower structure is likely more important than habitat in determining pollinator preferences.

Demography

There have been no demographic studies of *Townsendia condensata* var. *anomala*, nor is there sufficient information on which to base estimates of minimum viable population size. For example, lifespan, growth rate, seed production rate, and seed longevity of this taxon are all unknown.

Likewise, almost nothing is known regarding gene flow for *Townsendia condensata* var. *anomala*. Therefore, neither occurrences nor "sub-populations" within these occurrences should be interpreted as populations of plants, that is, representing groups of individuals linked by gene flow. Instead, these terms have been used to group patches of plants into units to get a rough idea of abundance and conservation status of the taxon (Wyoming Natural Diversity Database 2006). The relationship of these units to actual populations is unknown.

During recent inventories, some information was collected regarding age-class distribution at sites surveyed (Fertig 1997, Fertig 1998, Taylor and Taylor 2004). Both vegetative rosettes and flowering or fruiting individuals of *Townsendia condensata* var. *anomala* often are present. Surveys in 1996 and 1997 found that vegetative rosettes often significantly out-numbered flowering/fruiting plants, but this was not a consistent pattern. Taylor and Taylor (2004) did not find large numbers of vegetative rosettes during surveys in 2004.

Community ecology

There have been no studies of the community ecology of *Townsendia condensata* var. *anomala*, nor of any possible interspecific relationships. Its preference for sparsely vegetated sites suggests that it is a poor competitor with other plants, but this hypothesis has not been tested. Interaction with other plant species

is unknown, but it probably is unlikely given the sparseness of vegetation at sites. As discussed above, there is no consistent set of associated species, and all associated species reported on herbarium labels are undocumented (i.e., no specimens) (**Table 3**).

Invasive plant species have been reported for a few *Townsendia condensata* var. *anomala* sites (Taylor and Taylor 2004, Wyoming Natural Diversity Database 2006). Potential threats from invasive exotic species are discussed below under Threats.

No clear evidence of herbivory or browsing on *Townsendia condensata* var. *anomala* has been reported (Wyoming Natural Diversity Database 2006). Taylor and Taylor (2004) found the taxon in bighorn sheep winter range, but they reported no evidence of plant damage. There is no knowledge regarding parasites or diseases of *T. condensata* var. *anomala*.

The diagram in **Figure 8** includes generalized interactions between *Townsendia condensata* var. *anomala* and its environment. Most of the factors included are common to vascular plants in general. More specific interactions can be assumed with varying degrees of confidence, based on the life cycle and habitat of the taxon; the degree of confidence is indicated graphically.

CONSERVATION

Threats

Currently there are no known threats to the viability of *Townsendia condensata* var. *anomala* across Region 2. Overall, there is little overlap of its habitat and management activities. Recreation, grazing, and fire programs may impact the taxon at a few sites (Houston personal communication 2005), but recent surveyors reported no threats at almost all sites visited (Fertig 1997, Fertig 1998, Taylor and Taylor 2004). Potential threats have been identified at a few sites. These are discussed here in rough order of priority, based on likelihood. Several activities and processes that do not pose threats also are included as this information is important for management analysis. Threats to plants and threats to habitat are not segregated in these discussions because there is insufficient information at this time to make such an approach useful.

Invasive species

Surveyors have reported invasive plant species at two *Townsendia condensata* var. *anomala* sites. At one site, the Townsend daisy was found in an area with high cover of cheatgrass and several other non-native weedy species (Wyoming Natural Diversity Database 2006). Taylor and Taylor (2004) reported smooth brome as an associate at one site, but they listed no other exotic plant species for any of the sites surveyed. This result is notable as that project included documentation of any noxious weeds encountered. Cheatgrass occurred near some sites but was restricted to slightly more mesic swales and concave topography, and it was absent in the dry harsh habitat of *T. condensata* var. *anomala* (Taylor personal communication 2005). In addition to cheatgrass, Dalmatian toadflax and spotted knapweed are the invasive species most likely to be of concern (Houston personal communication 2005). In areas surveyed in 2004, both species appeared to be restricted to more mesic habitat than that of *T. condensata* var. *anomala* (Taylor personal communication 2005).

Herbicide use for dicotyledonous (broad-leaved) species where *Townsendia condensata* var. *anomala* is present would be detrimental to the plant. However, given restrictions on herbicide use in wilderness areas, as well as the absence of noxious weeds at most sites, herbicide impacts are not a concern for the taxon at this time.

Oil and gas development

Currently, there is no oil and gas development within the known range of *Townsendia condensata* var. *anomala*, and development has not been considered a potential conflict in the past. However, the Absaroka volcanic rocks overlie at least one basin very much like the Bighorn Basin (to the east) where oil and gas fields have been developed, and the same oil-bearing sedimentary strata probably are present (Sundell 1993). There has been only limited exploration of the area for petroleum, but there are some geophysical data that indicate the presence of a locally deep basin, and at least 36 hydrocarbon seeps have been documented. Based on these facts, Sundell (1993) considered at least two-thirds of the Absaroka volcanic province to have moderate or high potential for oil and gas accumulations in the underlying sedimentary rock.

Much of the Absaroka volcanic province lies within wilderness areas, and 14 occurrences of *Townsendia condensata* var. *anomala* have been documented within designated wilderness areas. Although this designation is assumed to restrict development, it cannot be ruled out. From the perspective of economic geologists, wilderness areas are off limits only until technology or need dictates otherwise. Sundell (1993) stated this point

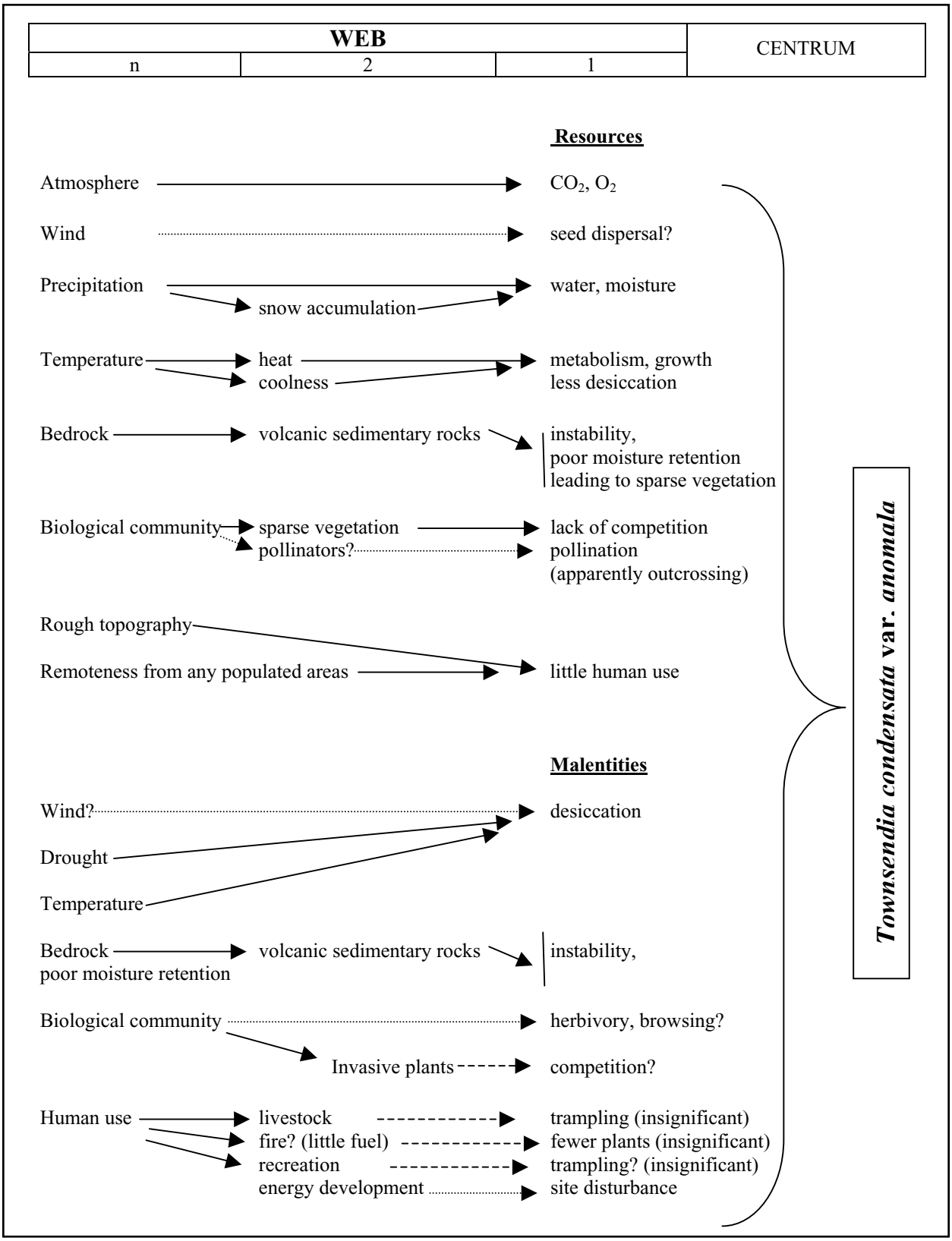

Figure 8. Diagram of key resources and malentities for *Townsendia condensata* var. *anomala*. Dotted lines indicate possible, but unknown, factors. Dashed lines indicate known or strongly suspected factors of insignificant impact to overall viability.

of view clearly in discussing the economic geology of the Absaroka volcanic province:

> "Economic mineral resources will be discovered within protected areas only if technology makes exploration and development compatible with wilderness values, or if extreme emergencies dictate development of the resource."

Recreation

Most known occurrences of *Townsendia condensata* var. *anomala* are in areas not used for recreation, such as steep slopes, ridgetops, and summits well away from trails (Wyoming Natural Diversity Database 2006). Taylor and Taylor (2004) identified trampling as a potential threat at two sites. One was a disturbed roadside where a single plant was found. At the second site, Townsend daisies were growing adjacent to a popular hiking/horse trail. *Townsendia condensata* var. *anomala* may be found in other areas with hiking trails, as survey for the taxon is incomplete. However, given the large amount of known and unsurveyed potential habitat outside areas used for recreation, it is unlikely that conflicts will affect more than a small fraction of the overall population of *T. condensata* var. *anomala* (Fertig 1998, Houston personal communication 2005).

Grazing

Fertig (1995) assessed the impacts of grazing on plant species of concern on the Shoshone National Forest, without differentiating between livestock and wildlife utilization. He concluded that *Townsendia condensata* var. *anomala* would not be affected by grazing due to its low stature. Vegetative cover typically is quite sparse where it grows, and sites are often steep and exposed, on slopes and rugged ridgecrests. Livestock use of these areas is probably infrequent or absent (Houston personal communication 2005). Taylor and Taylor (2004) found the taxon in an area used as winter range by bighorn sheep, but they did not note any damage to plants. *Townsendia condensata* var. *anomala* is an herbaceous perennial, and aboveground growth would be absent during the winter. No information is available regarding the palatability of this taxon.

Changes in hydrology

Heidel et al. (2002) noted that hydrologic change could affect *Townsendia condensata* var. *anomala* in habitat along streams. However, most known sites are on upland slopes and ridgecrests, or on scree below cliffs. Riparian settings are unusual for *T. condensata* var. *anomala*, and in the few mesic or vegetated areas where it occurs, it is restricted to sparsely-vegetated microsites. Two reported occurrences of the taxon are based in part on collections from gravel bars, but include mainly upland habitat (**Table 2**). Another occurrence is based on a single collection that includes streamsides in the site description along with several other habitat types (**Table 2**). However, the specific habitat of *T. condensata* var. *anomala* at this site is unknown (Nelson personal communication 2005). While hydrologic change may affect parts of some populations, it would not significantly impact the viability of the taxon across its range, due to its preference for upland sites.

Fire

The habitat of *Townsendia condensata* var. *anomala* typically is very sparsely vegetated. Less than 10 percent cover is not unusual (Wyoming Natural Diversity Database 2006), and these areas have insufficient fuels to burn. In 2004, prescribed burn areas were inventoried for plant species of concern (Taylor and Taylor 2004). All sites where *T. condensata* var. *anomala* was found were considered too sparsely-vegetated to carry fire.

Collection

The genus *Townsendia* is popular with rock gardeners, and many species are easily grown (Beaman 1954). Beaman successfully transplanted individuals of *T. condensata* var. *anomala* from the type locality to the greenhouse. *Townsendia condensata* var. *anomala* was not found on websites offering wildflower seeds and plants commercially. However, several sites listed *T. anomala* or *T. condensata* as available for sale (**Table 4**). Given the problems that exist with both nomenclature and identification in the group, it is unclear how much, if any, of this material is *T. condensata* var. *anomala*. In any case, it is unlikely that collecting is or would be the source of commercial seeds or plants given the inaccessibility of *T. condensata* var. *anomala* sites and the ease with which Townsend daisies are grown in the greenhouse.

Global climate change

Although *Townsendia condensata* var. *anomala*, like most plants, probably has specific climatic requirements, it is difficult to speculate on the possible effects of global climate change on the taxon. It occupies harsh, sparsely-vegetated sites with a specific rock/soil type. Its responses to global warming, cooling, drought, or increased moisture are impossible to predict.

Table 4. World Wide Web sources for *Townsendia condensata* seed and plants (accessed December 16, 2004). All seed source and nursery links listed by the North American Rock Garden Society (http://www.nargs.org/links/links.html) were checked. No sites were found that listed var. *anomala* or *T. anomala* for sale. However, given the confusion surrounding nomenclature and taxonomy for the group, it is not clear what material is being offered.

Site name	Web site address	Comments
Mt. Tahoma Nursery	http://www.backyardgardener.com	*T. condensata*; variety unclear (short stems)
Beaver Creek Greenhouses	http://www.rockgardenplants.com	*T. condensata* probably var. *condensata* (single large head per plant)

Conservation Status of Townsendia condensata var. *anomala* in Region 2

This section is intended to provide an assessment of the biological and ecological status of *Townsendia condensata* var. *anomala*, the trends and directions the taxon is taking, and the impacts of human activity. Conservation status is the result of multiple factors affecting rarity and endangerment. For example, a species represented globally by 15 populations found in remote areas with no human activity may not be of high conservation concern compared with one represented by 50 populations within areas actively developed for energy resources.

USFS Region 2 has used a system of eight criteria to evaluate species for sensitive designation (e.g., Heidel et al. 2002):

1) distribution within Region 2,

2) distribution outside Region 2,

3) dispersal capability,

4) abundance in Region 2,

5) population trend in Region 2,

6) habitat trend in Region 2,

7) habitat vulnerability or modification,

8) life history and demographics.

When this system was applied to *Townsendia condensata* var. *anomala* (Heidel et al. 2002), the USFS designated the taxon as sensitive. Its high rank resulted mainly from its limited distribution in Region 2 and globally, as well as apparent low abundance. The population trend of the taxon was considered stable, but there were no data to support this conclusion. Threats were considered low due to the wilderness status of many lands where *T. condensata* var. *anomala* occurs.

Assigning conservation status to *Townsendia condensata* var. *anomala* is complicated by conflicting factors, discussed earlier and summarized here. The taxon appears to be common within its range, but its global range is limited, and more survey is needed to show its full range. Many populations are small, but it is not clear that this is a risk to its overall viability. Large areas of habitat with high potential for additional occurrences still need to be surveyed. No reliable trend data are available. There is little conflict with current management and little impact from human use in general. Fourteen occurrences are located within wilderness areas; these are protected from disturbance under current conditions. Trampling or hydrologic change might affect parts of several occurrences, but these represent a very small fraction of the overall population of the Townsend daisy. It appears that *T. condensata* var. *anomala* is stable, and that its viability is not threatened. However, large gaps remain in our knowledge of the taxon. In addition, the Absaroka volcanic province has moderate to high potential for oil and gas accumulations in the underlying sedimentary strata, and future petroleum development cannot be ruled out.

Potential Management of Townsendia condensata var. *anomala* in Region 2

Implications and potential conservation elements

This section identifies known environmental and landscape elements and conditions that are essential for maintaining *Townsendia condensata* var. *anomala* in a well-distributed, functional, and viable condition across Region 2. We do not address improving habitat or increasing potential habitat. This discussion is simplified by the fact that the entire range of the taxon is within Region 2, and that most of the known occurrences are on the Shoshone National Forest. Thus, there is only one appropriate spatial and management scale to consider for this taxon (Roche personal communication 2005). However, limitations in our knowledge of the taxon make it difficult to draw conclusions regarding its viability and management needs.

For the Species Conservation Project, conservation elements have been defined as "environmental and landscape elements/conditions … essential relative to maintaining or restoring species across the region." (USDA Forest Service, no date). They should not be confused with management tools and practices, which are discussed in the next section. Some conservation elements for *Townsendia condensata* var. *anomala* can be identified based on its apparent habitat requirements. The sparsely-vegetated habitat that it occupies is not the result of recent disturbance, but rather harsh site conditions. *Townsendia condensata* var. *anomala* occasionally becomes established on disturbed sites, for example roadsides (one known example) and gravel bars (two known examples), but it is unknown how long such populations would persist. Most known sites are not disturbed, and it would be dangerous to conclude that disturbance is needed for habitat maintenance. In fact, upland populations could require many years to re-establish following disturbance, given the harsh conditions of those sites.

Besides habitat features, other elements may be essential for the continued viability of *Townsendia condensata* var. *anomala*; examples include pollinators, seed dispersal vectors or processes, and adequate reproductive isolation to prevent interspecific gene flow. However, we have no information on these topics for *T. condensata* var. *anomala*, nor do we know enough to extrapolate with confidence from other members of the genus. Similarly, it is impossible to extrapolate from other plants found in *T. condensata* var. *anomala* habitat. This situation is discussed in detail, specifically with regards to pollination, under Pollinators in the Biology and Ecology section.

At this time, there is no evidence that human activity is compromising essential conservation elements for *Townsendia condensata* var. *anomala*. Many known sites are within designated wilderness areas, and the taxon appears to be stable. In addition, potential habitat is under-surveyed (Houston personal communication 2005); the taxon probably is more abundant and widespread than currently documented.

In the Species Conservation Project, the USFS has directed authors to assess impacts of management activities on viability of taxa of concern. For many taxa, including *Townsendia condensata* var. *anomala*, there is insufficient information from which to draw conclusions regarding management activities and viability. Extrapolation from other species and from general literature must be done with extreme care. Minimum viable population size is a commonly-encountered example. The theoretical analysis of plant minimum viable population size by Frankel and Soule (1981) is often used in the absence of species-specific information. However, more recent studies based on specific taxa have shown that there is great variability among plants, and they clearly warn against overgeneralization (e.g. Byers and Waller 1999, Gitzendanner and Soltis 2000).

There currently is insufficient information to determine what constitutes viable self-sustaining populations of *Townsendia condensata* var. *anomala*. There is no information as to what constitutes a population for this taxon; for example, we do not know over what distances gene flow is possible between patches. In addition, large areas of potential habitat remain unsurveyed; thus, we do not know the distribution and abundance of the taxon and are unable to assess cumulative impacts. We know very little regarding breeding systems and nothing of pollinators and the effects of fragmentation on pollination. We do not know the effects of management activities on individuals, nor on the viability of the taxon within Region 2. We can, however, speculate fairly confidently that past and current management has had minimal impact because of the rugged, inaccessible nature of the taxon's habitat, as well as its location within designated wilderness areas. Our approach, therefore, has been one of caution when considering extrapolation, generalization, and synthesis.

Tools and practices

This section addresses techniques and strategies for managing *Townsendia condensata* var. *anomala*, including collecting additional information. We do not address improving habitat or increasing potential habitat but rather maintaining the existing occurrences and habitat. Most known occurrences of the taxon are within wilderness areas, where there has been little or no management activity. Due to this lack of management activity, there is no information on the impacts of specific management activities on the taxon (Roche personal communication 2005).

Inventory

Inventory has been defined as a "point-in-time measurement…to determine location or condition" (Elzinga et al. 1998). The term is commonly used interchangeably with "survey" although some authors distinguish between the two. For example, Palmer (1987) takes a narrower view, distinguishing between an inventory study and a survey study in the context

of monitoring. The former is a simple count whereas a survey study is based on sampling. In this assessment, survey and inventory are used interchangeably. Past surveys for *Townsendia condensata* var. *anomala* fit Elzinga et al.'s (1998) definition of inventory well.

Rare plant inventories are carried out for varying reasons, and Elzinga et al. (1998) recognized six possible objectives:

1) locate populations of a species,

2) determine total number of individuals of a species,

3) locate all populations of rare species in a specific area (often a project area),

4) locate all rare species occurring within a specified habitat type,

5) assess and describe the habitat of a rare species,

6) assess existing and potential threats to a population.

Prior surveys for *Townsendia condensata* var. *anomala* meet Elzinga et al.'s criteria for inventory, designed to address objectives 1, 3, 5, and 6 (Mills and Fertig 1996, Mills and Fertig, Jones and Fertig 1999a, Jones and Fertig 1999b).

Significant areas of potential habitat for *Townsendia condensata* var. *anomala* still need to be surveyed, mainly on the Shoshone National Forest (Houston personal communication 2005). Much of the habitat is difficult to access, requiring significant amounts of time, as the area is rugged with limited road access. *Townsendia condensata* var. *anomala* has been found at a few sites on or adjacent to BLM lands, and there is potential for additional sites in these areas. Its range may continue into Yellowstone National Park to the west, where relatively little floristic survey has been done. The eastern part of Yellowstone National Park is part of the Absaroka volcanic province, with the same rock types that underlie *T. condensata* var. *anomala* sites on the Shoshone National Forest (Sundell 1993). However, the western third of the corridor of the North Fork of the Shoshone River between Cody and the Park is apparently moister, with more vegetative cover. The sparsely vegetated sites preferred by *T. condensata* var. *anomala* may be absent (Taylor personal communication 2005).

Inventory projects must be designed with effectiveness and efficiency in mind since agency resources are often limited. The first question that must be addressed is whether additional inventory is justified. Even though large areas of potential habitat for *Townsendia condensata* var. *anomala* on the Shoshone National Forest remain to be surveyed, most will be difficult and time-consuming to inventory. Comprehensive inventory of all unsurveyed potential habitat may not be justified also because much of it is within designated wilderness areas where threats are unlikely. Therefore, project-specific inventory probably is more appropriate than survey of all potential habitat. By focusing on areas being considered for projects, resources would not be invested in lands where no management activities are planned. In fact, surveys for rare plants on the Shoshone National Forest currently are tied to projects, such as potential prescribed burns or mechanical removal (Taylor and Taylor 2004, Houston personal communication 2005).

If surveys specifically for *Townsendia condensata* var. *anomala* are to be conducted, several useful steps concerning rare plant survey should be noted. Surveyors not familiar with the taxon of concern should start any survey project by visiting known occurrences that are within the project area or are as close to the area as possible. It is helpful to "get a feel" for the taxon's habitat preferences, rather than relying entirely on secondary sources such as the literature, herbarium specimens, and database records. All locations should be precisely noted, utilizing at least two systems (e.g., Geographic Position System (GPS), topographic map) to ensure verification. Other data collection requirements will vary with the project.

Monitoring

Monitoring has been defined as the "acquisition and analysis of quantitative data that document the condition of a population or community over time" (Palmer 1987). Elzinga et al. (1998) define the term as "the collection and analysis of repeated observations or measurements to evaluate change"; thus observations need not be quantitative. Elzinga et al.'s (1998) concept of monitoring applies specifically to management, and it includes assessment of progress towards objectives.

No monitoring has been done for *Townsendia condensata* var. *anomala* aside from repeat visits to

some sites (Wyoming Natural Diversity Database 2006). These visits confirmed that the taxon was present, and in some cases, estimates of population size were made. However, consistent methods were not used in assessing population size.

Monitoring has become a common and important part of rare plant management programs. Palmer (1987) found that the number of newly initiated monitoring projects increased dramatically from 1974 to 1984, and the trend has continued (Elzinga et al. 1998). Monitoring is a key component in "adaptive management," providing measures of progress toward objectives as well as feedback on management effectiveness.

In spite of the increasingly widespread use of rare plant monitoring by government and private agencies, many such studies are poorly designed and do not provide the information needed (Palmer 1987, Elzinga et al. 1998). Plant species vary widely in features such as growth form, distribution of individuals within populations, and persistence of individuals over time, and monitoring programs must be species-specific. It would be inappropriate to recommend specific monitoring methods for *Townsendia condensata* var. *anomala* in this assessment, especially considering how little information is available for the taxon. Instead, we discuss issues and criteria that should be considered if monitoring is to be implemented.

The challenge of designing appropriate monitoring studies is not widely appreciated. Palmer (1987) looked at 109 rare plant and plant community monitoring programs, found major problems, and classified these problems that contribute to inaccuracy and inefficiency. There is strong pressure to include monitoring in rare plant management, and the following problems should be carefully considered in designing appropriate monitoring activities:

1) data analysis not planned in advance, resulting in inadequate sampling,

2) resources invested in species not of high priority,

3) no consideration of appropriate aspects or stages of plant's life cycle,

4) grossly inadequate sampling or no assessment of sampling adequacy,

5) no or inadequate controls,

6) no or inadequate replication,

7) no review of project design before implementation,

8) no report or publication of results.

Elzinga et al. (1998) also address many of these issues, and bring up others, such as between-observer variability. Staff turnover and funding fluctuations can further hamper monitoring programs (Marriott personal observation).

As with inventory, monitoring projects must be designed with effectiveness and efficiency in mind. The first question that must be addressed is whether monitoring is justified. To justify investment of limited resources, a target species must be of high priority based on rarity and endangerment (Palmer 1987, Menges and Gordon 1996, Elzinga et al. 1998). As was discussed earlier, the overall viability of *Townsendia condensata* var. *anomala* does not appear to be at risk. If a monitoring program is initiated, it should be low-intensity and require minimal investment of money and time (Palmer 1987, Menges and Gordon 1996, Elzinga et al. 1998).

Elzinga et al. (1998) add a second criterion for evaluating monitoring need. In the management context, monitoring is initiated only if opportunities for management change exist. "What can you do if a population is declining other than document its demise?" If there are no management alternatives, then precious resources should not be invested. Over much of the range of *Townsendia condensata* var. *anomala*, there are no management activities taking place in its habitat, and thus limited or no opportunity for management change.

Although *Townsendia condensata* var. *anomala* may not appear to meet Elzinga et al.'s (1998) requirement for opportunities for management change, its restricted distribution and small population size suggest that it could be vulnerable to unforeseen threats. If the taxon continues to be of conservation concern, a low-intensity monitoring program, perhaps done every few years, would be a cost-efficient way to detect large unforeseen changes or threats. A simple method involves visiting all or a sub-set of known occurrences to determine presence or absence, using a GPS unit to document patch location in some fashion; specific mapping procedures will be based on patterns of patch structure and distribution, which are not known

at this time. This approach is useful for taxa occurring as multiple small patches, such as *T. condensata* var. *anomala* (Elzinga et al. 1998).

If a monitoring program for *Townsendia condensata* var. *anomala* is to be implemented, the proposed design needs critical review, as has been demonstrated by the frequency of problems in monitoring (Palmer 1987). The design should be implemented initially as a pilot study since the first trial of a monitoring method inevitably reveals unanticipated problems (Elzinga et al. 1998, Marriott personal observation). Elzinga et al. (1998) provide step-by-step instructions for guiding monitoring plan development within the management context, as well as specific suggestions for maximizing consistency, efficiency, and accuracy.

Elzinga et al. (1998) consider the monitoring types described above as "resource monitoring" because they focus on the plant resource itself. In contrast, habitat monitoring measures progress towards meeting objectives or standards for habitat characteristics. Habitat monitoring is most effective when there is a clear understanding of the relationship between habitat parameters and the species of concern. However, for most rare plants, these data are lacking, and relationships between habitat parameters and species condition must be inferred from site characterizations (Elzinga et al. 1998). This is certainly the case for *Townsendia condensata* var. *anomala*, making habitat monitoring inappropriate.

Population or habitat management approaches

Few potential threats to *Townsendia condensata* var. *anomala* have been identified, and much of the taxon's habitat is outside areas of current management activities. It does not appear that conservation elements are being compromised. No management approaches beyond inventory and low-intensity monitoring can be suggested at this time. Project area inventories can identify sites to avoid due to potential impact on the species. If a management activity is found to overlap with *T. condensata* var. *anomala* habitat, and if it is determined that monitoring is needed, a taxon-, project-, and site-specific program will have to be developed (see Monitoring above).

If oil and gas resources are developed in the future, there will be the potential for conflict with *Townsendia condensata* var. *anomala*. Project area surveys will be needed to identify areas to avoid as well as the extent of cumulative impacts to the taxon. Even if exploration and development technology is compatible with wilderness values (Sundell 1993), site-specific assessment will still be needed to avoid occurrences of the Townsend daisy. If development overlaps significantly with the limited range of the taxon, monitoring programs would be needed as well (see discussion under Monitoring).

Information Needs

The harsh, dry, sparsely-vegetated upland habitat of *Townsendia condensata* var. *anomala* is relatively well-characterized, mainly due to the consistency among sites where the plant has been found. The three exceptions to this pattern are disturbed microsites in otherwise well-vegetated habitats (see Habitat section). In contrast, there is much that we do not know regarding the biology, ecology, and management needs of the taxon. From a management perspective, the four most important areas needing research are distribution and abundance, population trend, threats from invasive plant species, and systematics and taxonomy. These factors contribute to decisions on conservation status and management.

Studies of *Townsendia condensata* var. *anomala* have focused on documenting distribution, abundance, and habitat of the taxon. However, large areas of potential habitat remain to be surveyed, and it is likely that more occurrences will be found. The probability of finding significant range extensions for the Townsend daisy is less clear. Its range may continue into Yellowstone National Park to the west, where relatively little floristic survey has been done, but it is not clear that there is suitable habitat for the taxon there. It is possible that the conservation status of the taxon will need to be reconsidered once surveys throughout the range of the taxon are completed.

There is little information regarding population size and trends for *Townsendia condensata* var. *anomala*. Some occurrences have been surveyed, providing more detailed data on population size, but many occurrences are based only on herbarium specimens or visits to confirm presence. If *T. condensata* var. *anomala* continues to be of conservation concern, a low intensity monitoring program might be a first step towards revealing downward trends (see Monitoring section). At this time, the time and cost of intensive monitoring are not justified (see discussion in Monitoring section).

Invasive plant species may become a threat to *Townsendia condensata* var. *anomala*. Currently, most sites are not threatened by invasive plants, but the situation could change. Assessment of invasive species

could be incorporated into a low intensity monitoring program aimed at tracking gross population trends.

Intrageneric relationships within *Townsendia* are not well understood, and there is disagreement as to what constitutes separate species and subspecific taxa. Past research has suggested that *T. condensata* var. *condensata* is an apomictic derivative of var. *anomala*, and there is debate among plant taxonomists as to whether to recognize apomictic derivatives as separate taxa. With more material now available, relationships between the two varieties need to be reassessed, as well as implications for conservation status of *T. condensata* var. *anomala*.

DEFINITIONS

Agamic complex – a group of species with two to several taxa that reproduce asexually (Judd et al. 2003).

Agamospermy – asexual seed production; not involving fertilization of egg by sperm (Judd et al. 2003).

Andesite – a fine-grained, volcanic rock that lacks quartz and is composed mainly of feldspar and dark iron-magnesium silicates (Mears 1978).

Apomixis – asexual reproduction, usually used for asexual seed production (i.e., agamospermy), but also applied to the production of plantlets by vegetative propagules (Judd et al. 2003); in this document, apomixis is used synonymously with agamospermy

Autecology – biology and ecology of individual species as opposed to communities (Abercrombie et al. 1973)

Autopolyploidy – presence in a cell of three or more chromosome sets from the same species (instead of the usual two) (Judd et al. 2003)

Breccia – a sedimentary rock containing abundant angular fragments of rock (Parsons 1978)

Circumscription – delimitation ("drawing a line around") of any feature or features, as for instance determining the limits or boundaries of a taxon (Judd et al. 2003)

Community ecology – interactions within an assemblage of living organisms (Knight 1994)

Conglomerate – sedimentary rock composed of visible rock fragments ranging from boulders to small pebbles, usually embedded in fine-grained matrix (Parsons 1978)

Conservation element – environmental and landscape elements and conditions that is essential for maintaining a species in a well-distributed, functional and viable condition (USDA Forest Service Region 2; guidance to conservation assessment authors)

Conservation status – biological and ecological status, the trends and directions a species is taking, and impacts of human activity (USDA Forest Service Region 2; guidance to conservation assessment authors)

Holotype – sole specimen of a species or intraspecific taxon used as the type by the author of a name; the name-bearing specimen (Judd et al. 2003)

Inventory – point-in-time measurement … to determine location or condition (Elzinga et al. 1998); frequently used synonymously with survey

Isotype – duplicate specimen of the holotype, being a part of the same individual or gathering (Judd et al. 2003)

Monitor – acquisition and analysis of quantitative data that document the condition of a population or community over time (Palmer 1987); collection and analysis of repeated observations or measurements to evaluate change (Elzinga et al. 1998)

Outcrossing – transfer of pollen from the anthers of the flowers of one plant to the stigma of the flower of another plant, in contrast with self-pollination in the same flower or between flowers of the same individual (Harris and Harris 2001)

Phenology – study of periodical phenomena in plants, e.g. flowering (Abercrombie et al. 1973)

Polyploidy – with three or more sets of chromosomes in a cell (Judd et al. 2003), i.e. more than the usual two sets

Rank (Heritage) – NatureServe and Natural Heritage Program conservation status ranking system. Internet site: http://www.natureserve.org/explorer/granks.htm. Explanation of the heritage ranking system follows this list of definitions

Sensitive species (USDA Forest Service) – plants and animals for which population viability has been identified as a concern by a Regional Forester because of significant current or predicted downward trends in abundance or in habitat capability that would reduce distribution (USDA Forest Service 2003)

Systematics – science of organismal diversity; frequently used in a sense roughly equivalent to taxonomy

Taxonomy – classification of organisms; arranging species into groups and giving those groups names (Judd et al. 2003)

Taxon (pl. taxa) – group of organisms at any level in the taxonomic hierarchy (Judd et al. 2003). For example, a species is a taxon, as is a variety of that species

Heritage ranking system (from Keinath et al. 2003).

Heritage ranks are based on a system originally developed by The Nature Conservancy and its network of natural heritage programs (now coordinated by NatureServe [Arlington, Virginia]) to indicate the probability of extirpation, at both the global and state scales, of each plant and animal taxon. The following letters denote the spatial scale at which a taxon's status is scored:

G = Global rank: refers to the range-wide probability of extinction for a species

T = Trinomial rank: refers to the range-wide probability of extinction for a subspecies or variety

S = State rank: refers to probability of extinction from state for a given taxon

These letters are each followed by a numeric, 1-5 score:

1 = Critically imperiled because of extreme rarity (often <5 extant occurrences) or because some factor makes it highly vulnerable to extinction

2 = Imperiled because of rarity (often 6-20 extant occurrences) or because of factors making it vulnerable to extinction

3 = Rare or local throughout its range or found locally in a restricted range (often 21-100 known occurrences)

4 = Apparently secure, although it may be quite rare in parts of its range, especially at the periphery

5 = Demonstrably secure, although it may be rare in parts of its range, especially at the periphery

Some taxa receive non-numeric scores, indicating special situations:

H = Known only from historical records (typically pre-1970; varies by taxon)

A = Accidental or vagrant: taxon appears irregularly and infrequently

X = Believed to be extinct

U = Uncertain status: taxon possibly in peril but more information is needed

Some taxa may also receive rank modifiers, indicating other special situations:

B = Breeding rank: indicates the status of a migratory species during the breeding season; applied only to animals

N = Non-breeding rank: indicates the status of a migratory species during the non-breeding season; applied only to animals

Z = Rank not applicable: indicates that a migratory species is essentially absent or unrankable for the season in question (used with "B" or "N"); applied only to animals

Q = Questions exist regarding the taxonomic validity of a species, subspecies, or variety

? = Questions exist regarding the assigned numeric score

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