Parthenium alpinum (Nutt.) Torr. & Gray (alpine feverfew): A Technical Conservation Assessment

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Bonnie Heidel and Joy Handley
Wyoming Natural Diversity Database
University of Wyoming, Dept. 3381
1000 E. University Avenue
Laramie, WY 82071

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Acknowledgements

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Authors' Biographies

Bonnie Heidel graduated with a Master's degree in Botany from Washington State University in Pullman, WA, working on the rare plants of northern Idaho. She obtained her Bachelor of Arts degree from Carleton College in Northfield, MN, majoring in Biology, with honors awarded for her senior thesis and membership granted into Sigma Xi, the society of scientific research. She worked on threatened and endangered species for the U.S. Fish and Wildlife Service regional office in Portland, OR, on plant species status compilation in the Midwest Regional Office of The Nature Conservancy in Minneapolis, MN, and on statewide sensitive species survey and research in natural heritage program positions in Helena, MT and in Bismarck, ND. She is currently Botanist of the Wyoming Natural Diversity Database, a research program of the University of Wyoming in Laramie, conducting botanical surveys and research, and providing technical information services throughout the state.

Joy Handley graduated *cum laude* with a Bachelor of Science degree from the University of Idaho in Moscow, ID, majoring in Range Resources. She worked as a range management specialist with the Salmon National Forest in Leadore, ID and as an assistant vegetation ecologist with the Colville Confederated Tribes in Nespelem, WA. She is completing her Master's Degree in botany at the University of Wyoming on a floristic inventory of the Payette National Forest in Idaho. She works at the Rocky Mountain Herbarium and at the Wyoming Natural Diversity Database.

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Parthenium alpinum (alpine feverfew). Photograph by William Jennings. Used with his permission.

SUMMARY OF KEY COMPONENTS FOR CONSERVATION OF *PARTHENIUM ALPINUM*

Status

Parthenium alpinum (Nutt.) T. & G. (alpine feverfew; syn. *Bolophyta alpina* Nuttall) is a regional endemic of northeastern Colorado, central and southeastern Wyoming, and northern New Mexico in five isolated population centers. As of 2003, it is no longer recognized as a sensitive species by the Rocky Mountain Region (Region 2) of the USDA Forest Service (USFS); its status at the forest level is under consideration. The NatureServe global rank for this species is vulnerable throughout its range (G3). It is ranked critically imperiled (S1) by the Colorado Natural Heritage Program, vulnerable (S3) by the Wyoming Natural Diversity Database, and imperiled (S2) by the New Mexico Natural Heritage Program. Of the 51 extant occurrences in Colorado and Wyoming, only two occurrences are on National Forest System lands; both of these are located on the Pawnee National Grassland in Colorado. In fact, these are the only occurrences rangewide on National Forest System lands.

Primary Threats

Parthenium alpinum is directly threatened by oil exploration, drilling, and associated activities; and by recreation, particularly off-road vehicle use. Both sets of activities may also introduce exotic species and accelerate erosion. Livestock grazing is the prevailing land use in *P. alpinum* habitat, but there are no signs of direct impact or evidence of this species' response to grazing. Several characteristics of *P. alpinum* deter or diminish the likelihood of grazing impacts including pubescence, production of flavonoids, short stature, and flowering prior to the grazing season. However, practices that concentrate livestock close to occurrences may result in negative trampling effects in the unconsolidated substrates typical of *P. alpinum* habitat. These practices include fencing, salt block placement, and water development. Outside of the Pawnee National Grassland, individual occurrences may also be impacted by mining, quarrying, new road development, and increased road maintenance activities. Most threats to *P. alpinum* from human activities are indirect or localized, but they may be very important to the viability of small populations or population segments.

Primary Conservation Elements, Management Implications and Considerations

Parthenium alpinum occurs in long-lived cushion plant communities on sparsely vegetated slopes and outcrops within grasslands, shrublands, or open woodlands. In all of these settings, vegetation cover is low (i.e., less than 20 percent), and the exposed microhabitats are maintained, in part, by wind erosion. While *P. alpinum* is long-lived and stress-resistant, it may be slow to establish, and its habitat may be slow to recover from destabilization. Trend data are not available for populations. No federally protected areas have been designated that include the conservation of this species or its habitat as an explicit goal. Thus, it is vulnerable to habitat loss and degradation. *Parthenium alpinum* occurs in Colorado on land managed by the Pawnee National Grassland for multiple-use. In Wyoming, the three largest occurrences are on lands managed for multiple-use by the Bureau of Land Management. Road construction and excavation for pipelines and quarries have reduced its habitat and population numbers, at least locally, in Wyoming. Maintaining the population viability of *P. alpinum* begins with maintaining its habitat.

Systematic survey of the species is not complete in all parts of the Pawnee National Grassland, which is the survey priority in Colorado. The priorities for survey work in Wyoming include efforts to relocate occurrences known only from historic collections and to evaluate whether the species reaches elevations as high as 7,000 feet, which would correspond with elevations at lower boundaries of National Forest System lands. Five conservation priorities are:

- Monitor occurrence and sub-occurrence numbers to determine baseline trends and conduct demographic research to help project trends.

- If there is evidence for grazing impact identified in the course of monitoring, or if there is an allotment management plan revision that may change patterns of grazing where the species occurs, evaluate the species' response to livestock grazing.

- If there is evidence for off-road vehicle impact identified in the course of monitoring, or if there is a transportation or recreation management plan revision that may change patterns of use where the species occurs, develop standards to avoid impacts.

- Determine the primary pollination vectors of *Parthenium alpinum* and rate of seed set to determine the success rate of pollination and the habitat requirements of the pollinator(s).

- Conduct molecular genetic research to understand population structures, breeding systems, relations between northern and southern populations, species' origin, and taxonomic relations between *Parthenium alpinum* and *P. tetraneuris*. Genetics research might be done in tandem with cytological research, expanding on limited chromosome count data for *P. alpinum*, *P. ligulatum*, and *P. tetraneuris*.

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INTRODUCTION

This assessment is one of many being produced to support the Species Conservation Project of the USDA Forest Service (USFS) Rocky Mountain Region (Region 2). *Parthenium alpinum* (alpine feverfew) is the focus of an assessment because at the time the assessment was initiated, it was a sensitive species in Region 2. It is still a species of concern due to its limited geographic range, high degree of habitat specialization, and low numbers of occurrences in the southern part of its range including the northeastern Colorado occurrences in and near the Pawnee National Grassland. A species of concern may require special management, so knowledge of its biology and ecology is critical.

Goal

Species conservation assessments are produced as part of the Species Conservation Project to provide forest and range managers, research biologists, and the public with a thorough discussion of the biology, ecology, conservation status, and management of certain species based on available scientific knowledge. The assessment goals limit the scope of the work to critical summaries of scientific knowledge, discussion of broad implications of that knowledge, and outlines of information needs. The assessment does not seek to develop specific management recommendations. Rather it provides the ecological background upon which management must be based and focuses on the consequences of change in the environment that result from management (i.e., management implications). Species assessments provide a reference for use in planning documents on USFS lands (Blankenship et al. 2001).

Scope

This species assessment examines the biology, ecology, conservation status, and management of *Parthenium alpinum* throughout its range, with specific reference to the geographic and ecological characteristics of the USFS Rocky Mountain Region under current environmental conditions. The range of this species lies primarily within Region 2, and it occurs on lands administered as part of the USFS Rocky Mountain Region in the Pawnee National Grassland of Colorado, administered as part of the Arapaho-Roosevelt National Forest/Pawnee National Grassland. Information on two closely-related species in Colorado is presented as it relates to *P. alpinum*.

In producing the assessment, refereed literature, non-refereed literature, herbarium records, and other sources were reviewed. Such data represent the most complete available information and draw from many years of information that were compiled for this species from Colorado, New Mexico, and Wyoming.

Treatment of Uncertainty

Science represents a rigorous, systematic approach to obtaining knowledge. Competing ideas regarding how the world works are measured against observations. However, because our descriptions for the world are always incomplete and our observations are limited, science focuses on approaches for dealing with uncertainty. A commonly accepted approach to science is based on a progression of critical experiments to develop strong inference (Platt 1964). However, it is difficult to conduct experiments that produce clean results in the ecological sciences. Often, observations, inference, critical thinking, and models must be relied on to guide our understanding of ecological relations. These scientific tools are to be used in concert with the most complete species status data to produce a robust analysis. The data and analyses presented in this assessment address all information and records produced as documentation of the distribution and biology of *Parthenium alpinum* in the Rocky Mountain Region. The strength of evidence for particular interpretations or ideas is noted, and alternative explanations are described where appropriate.

Publication on the World Wide Web

To facilitate their use in the Species Conservation Project, the species assessments are being published on the World Wide Web site of the USFS Rocky Mountain Region. Placing the documents on the Web makes them available to agency biologists and the public more rapidly than publishing them as books or reports. More importantly, it facilitates their revision, which will be accomplished based on guidelines established by the Rocky Mountain Region.

Peer Review

Assessments developed for the Species Conservation Project have been peer reviewed prior to release on the Web. This assessment of *Parthenium alpinum* was reviewed through a process administered by the Center for Plant Conservation, employing two recognized experts on 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

Parthenium alpinum was proposed as threatened by the Smithsonian Institution on the first list of potentially endangered and threatened plants of the United States (Ayensu and DeFilipps 1978), a list that was accepted as a petition under the Endangered Species Act (USDI Fish and Wildlife Service 1975). Eight years later it was downlisted as a 3C taxon (USDI Fish and Wildlife Service 1985) based on interpretation of the U.S. Fish and Wildlife Service that it was more abundant or widespread in Wyoming than previously known. *Parthenium alpinum* was designated sensitive by Region 2 of the USFS (USDA Forest Service 1994), but it was not on the list of designated sensitive species signed by the Regional Forest in the November 2003 update (USDA Forest Service 2003). NatureServe (formerly the heritage division of The Nature Conservancy) and the network of natural heritage programs give *P. alpinum* a global rank of vulnerable (G3), indicating that the species is "rare or local throughout its range or found locally in a restricted range" and known from 21 to 100 extant occurrences (NatureServe 2004).

In Colorado, *Parthenium alpinum* is ranked critically imperiled (S1), where it is known from five occurrences, one of which is historic (Colorado Natural Heritage Program 2004). The first discovery of the species in Colorado was made in 1978, and this record is defined as historic by Colorado Natural Heritage Program. In Wyoming, this species is ranked vulnerable (S3), where it is known from 50 occurrences, three of which are historic (Wyoming Natural Diversity Database 2004). A fourth historic record was relocated and is included in the tally of extant occurrences. *Parthenium alpinum* was on the first Wyoming endangered plant species list that accompanied the published flora (Dorn 1977). It was dropped from tracking as a Wyoming plant species of special concern in 1997, based on records produced through floristic surveys and impact assessment studies documenting that it was more common than previously known. It was removed from the list of species of potential concern in 2003 (Keinath et al. 2003) taking into account comments in a letter by Robert Dorn (1999) summarizing the results of an impact assessment study:

> "*... concerning Parthenium alpinum, we have now completed our survey of the proposed [CIG Medicine Bow Lateral] pipeline project and found this plant at numerous locations in Platte County, Wyoming. Specimens were collected in 21 different sections along the line. Some adjacent sections had the plants but collections were not made. The plants grow primarily on the east-west trending ridges that the line cuts perpendicularly. Thus the collections represent only a small sampling of the plants present. Judging from the potential habitat seen, there could easily be over a million plants in Platte County alone, and the species is also known from four other counties in Wyoming and one in Colorado… With these additional known localities in Platte County, it could justifiably be dropped from all lists.*"

In New Mexico, this species is ranked imperiled (S2) and is known from three occurrences in the state (New Mexico Natural Heritage Program 2002). There is not any form of state legislation or management policy in any of these states that protects this species.

Existing Regulatory Mechanisms and Management Plans

Parthenium alpinum was recognized as a sensitive species on the first list of the USFS Region 2 (USDA Forest Service 1994), but it is no longer designated a sensitive species with the list revision of November 2003. It was identified as a candidate for sensitive species designation by the Wyoming State Office of the Bureau of Land Management (Neighbours and Marriott 1991) but was not included when the Wyoming BLM sensitive plant list was established in 2001. There are no existing laws, regulations, or management and conservation plans that conserve this plant species.

Biology and Ecology

Classification and description

Systematics and synonymy

Parthenium alpinum (Nutt.) Torr. & Gray, Fl. N. Am. ii. 285. TYPE: "in the Rocky Mountains, towards the sources of the Platte, in about lat. 42 degrees, on shelving rocks at the summit of a lofty hill, near the place called the "Three Buttes" by the Canadians, 7,000

feet above the level of the sea." *Nuttall s.n.* (ISOTYPES: GH, Ph) (TOPOTYPE: DAO).

Synonyms: *Bolophyta alpina* Nuttall, Trans. Am. Phil. Soc. Ser. II. vii. (1841) 348. *Parthenium alpinum* was previously referred to by the synonym, *B. alpina*, by the USDA Forest Service (1994). Throughout the report, nomenclature is used that is consistent with the USFS Rocky Mountain Region following the PLANTS Database (USDA Natural Resources Conservation Service 2004).

Members of the genus *Parthenium* were first described by Linnaeus in *Species Plantarum* (1753) based on *P. hysterophorus*, from Jamaica, and *P. integrifolium*, from Virginia (Rollins 1950). The name is from the Greek "parthenos", meaning virgin (Cronquist 1994). Thomas Nuttall discovered *P. alpinum* and recognized its similarity to *P. integrifolium* but placed it in a new genus, *Bolophyta alpina* (Nuttall 1840). The name *Bolophyta* is from the Greek "bolus", meaning lump or clod, and "phyton" referring to plant.

The species epithet "*alpinum*" is misleading since the plant does not grow at alpine elevations (Weber and Wittman 2001). The type collection by Nuttall, reported at 7000 ft, is higher than the known range of the species in Wyoming and is likely to represent a rough elevation estimate. Its typically wind-blasted habitat on rocky high plains does resemble some alpine conditions. The common name "alpine feverfew" is used in Wyoming, the common name "plains feverfew" is used in New Mexico, and the common name "Wyoming feverfew" is used in Colorado.

In 1842, Torrey and Gray placed Nuttall's *Bolophyta alpina* into *Parthenium*, section Bolophytum. The section Bolophytum is native to the Western Hemisphere, comprised of only three species, occurring in Colorado, Wyoming and Utah. The other sections of the *Parthenium* genus are native to the West Indies, Bolivia, Argentina, and the United States (Cronquist 1994, Mears 1980). The genus *Parthenium* is differentiated from other genera of the Asteraceae by the fusion of the basal portion of the two subjacent sterile florets, the basal portion of the achene and its subtending phyllary (Rollins 1950). This fusion is sufficiently extensive to cause the phyllary and two florets to remain attached to the achene when it is shed. Species in the *Parthenium* genus also usually have only five fertile ray-florets.

Parthenium ligulatum and *P. tetraneuris* are the only other species in the section Bolophytum. *Parthenium alpinum* has the widest distribution of the three species, extending farther north and south. The two related species are both found in Colorado and tracked as species of special concern. They are geographically separated from *P. alpinum* and generally found at higher elevations. The original taxonomic rank of *P. ligulatum* was a variety of *P. alpinum* (Jones 1910), later elevated to species level (Barneby 1947). *Parthenium tetraneuris* was originally described as a species (Barneby 1947) and in 1950, Reed C. Rollins proposed *P. tetraneuris* as a variety of *P. alpinum* but this was not widely accepted. *Parthenium tetraneuris* is a tetraploid, while *P. alpinum* and *P. ligulatum* are diploid (2n = 36) (Rollins 1950, West and Waines 1988) and *P. tetraneuris* is treated as a tetraploid race of *P. alpinum* in the Colorado checklist by Hartman and Nelson (2002). *Parthenium ligulatum* and *P. tetraneuris* are not included in the scope of this report, pending clarification of their taxonomic status.

Parthenium alpinum and its congeners are herbaceous perennials with acaulescent growth forms. Rollins refers to the section Bolophytum as having a "dwarfed" growth form and large flower heads compared to other sections in the genus (Rollins 1950). The other sections of the genus do not include herbaceous perennials, though they do include herbaceous annuals, desert shrubs or small tropical trees (West and Waines 1988). Rollins (1950) hypothesized that woody, large-leaved members of the *Parthenium* genus are the most primitive, and did not attempt to connect the herbaceous species' lineages in the section Bolophytum with any of the woody species. It is possible that the section Bolophytum reflects an ancient evolutionary adaptation toward decreasing temperature as found in the Late Eocene. *Parthenium alpinum* is restricted to five population centers and is a habitat specialist. Isolated populations and habitat specializations are characteristic of paleoendemics (Stebbins and Major 1965), but the supporting genetics research has not been pursued in the case of *P. alpinum*.

Guayule (*Parthenium argentatum*) is a woody species in the closely-related section Parthenichaeta that is cultivated as a source of natural rubber, producing up to 20 percent of the plant's weight in rubber. It was widely used by the United States in World War II (Rollins 1950). Other *Parthenium* species with economical uses include *P. fruticosum*, which produces lactones inhibiting growth of insect larvae, and *P. hysterophorus*, which produces pollen that inhibits fruit set in other species through allelopathy on stigmas (Mabberley 1997). Other members of the genus are described as having various medicinal values, but most of these anecdotes have not been scientifically evaluated. One

species of *Parthenium* (*P. integrifolium* or wild quinine) is reported as a traditional burn treatment by Catawba Indians of eastern North America (Lewis and Elvin-Lewis 1977). There are flavonoids in all members of the genus, with highest flavonoid diversity in more southern species (Mears 1980). Flavonoids variously produce toxic effects on predators, pathogens, and competitors. One species, *P. hysterophorus*, has escaped as an exotic in India and is reported to produce a very severe skin disease (Lewis and Elvin-Lewis 1977).

History of the species

The patterns and process of documenting *Parthenium alpinum* distribution are presented below, and the results are summarized in the following distribution and abundance section. *Parthenium alpinum* was first collected by Thomas Nuttall in the 1834 Wyeth Expedition, and was formally named six years later by Nuttall (1840). The type locality of *P. alpinum* is not known with certainty (Goodman 1943). Goodman examined information on the Wyeth Expedition and from Nuttall's monograph. He deduced that this 1834 collection came from what is now central Wyoming and that "the source of the Platte" referred to the Sweetwater River. It was not seen again in the wild for over 100 years and was referred to in the botanical literature as "the legendary and long-lost *Parthenium alpinum*" (Goodman 1943, Locklear 1989, 1990). Acting on Goodman's information, H. D. Ripley and R. C. Barneby collected *P. alpinum* near Alcova, Wyoming and made another collection a few miles west of Lusk, Wyoming in 1947. However, the species was not in flower. Cedric L. "Ted" Porter collected it in flower at Alcova in 1948 and at Lusk in 1949. Two other Porter collections, in 1957 and 1959, were made near Guernsey Reservoir and in the Goshen Hole area respectively.

In Colorado, *Parthenium alpinum* was documented from three extant sites and one historic site in northeastern Colorado from 1978 to 1997, as mapped by Spackman et al. (1997); only one of these was on the Pawnee National Grassland in Colorado at Chalk Buttes. Information from Colorado surveys was summarized in O'Kane (1988) and Spackman et al. (1997). The latter is posted electronically on the Colorado Natural Heritage Program website (http://www.cnhp.colostate.edu/). *Parthenium alpinum* was considered but not found in rare plant species surveys across the Arapaho-Roosevelt National Forests and Pawnee National Grassland (Schwab 1992). In 2003 it was located by Robert Dorn and Frank Smith while surveying a proposed pipeline corridor for BioResources, Inc., regulated under the Federal Energy Regulatory Commission, on the Pawnee National Grassland and adjoining lands. They also documented a second, new occurrence on the Pawnee National Grassland. In 2003, Frank Smith and Cindy Johnson conducted extended surveys when the species was in flower to map the local occurrences and to provide more detailed estimate of numbers. In 2004 Dave McCullough and Kendrick Moholt (BioResources, Inc.) conducted further surveys on and near the pipeline right-of-way. As a result of these surveys, there are 17 discrete locations where it has been documented (summarized by Moholt 2004) interpreted as representing one new occurrence and expansion of one previous occurrence (Jill Handwerk personal communication 2004). The new occurrence is comprised of ten discrete locations on Pawnee National Grassland spanning a distance of over 1.5 miles.

In Wyoming, *Parthenium alpinum* was relocated at only one of the four historic collection record locales and has been documented at 49 additional sites from 1978 to present in central and southeastern counties. It is not known from lands administered by the USFS Rocky Mountain Region. Information from Wyoming surveys was summarized in Clark and Dorn (1979) and Fertig et al. (1994). Most of the Wyoming distribution data originated from floristic surveys as characterized by Hartman (1992) including Hartman and Nelson 1994, 1995; Roderick et al. 1999, Nelson 2002; and from environmental reviews, in addition to surveys conducted by Wyoming Natural Diversity Database (Fertig 1995, Heidel in preparation). Distribution was greatly expanded in a Platte County pipeline survey (Dorn 1999, Smith 1999). All records were processed and analyzed as part of this assessment. The original state species abstract (Fertig 2000) has been updated and is posted electronically on the Wyoming Natural Diversity Database website (http://www.uwyo.edu/wyndd).

Parthenium alpinum was first documented in New Mexico in 1984 (Spellenberg 1986). It is currently known from three occurrences in northeastern and northwestern New Mexico. Species status information for New Mexico is posted electronically on the New Mexico Natural Heritage Program website (http: //nmnhp.unm.edu/).

The largest sets of *Parthenium alpinum* specimens in Wyoming are maintained at the Rocky Mountain Herbarium (RM). Much of the RM distribution data is posted electronically on the Atlas of the Vascular Plants of Wyoming (University of Wyoming 1998). The *P. alpinum* specimens from Colorado are maintained at both Colorado State University (CS) and the University of Colorado (UC). The *P. alpinum* specimens from

New Mexico are maintained at the University of New Mexico (UNM). Additional specimens are on file at the Gray Herbarium at Harvard University, the herbarium of the Academy of Natural Sciences of Philadelphia (PH) and the Vascular Plant Herbarium at the Canadian Department of Agriculture in Ottawa (DAO), as well as slide files of Reed C. Rollins that are posted electronically: (http://www.huh.harvard.edu/libraries/archives/slides.html).

Non-technical description

Parthenium alpinum is a 2 to 5 cm tall, mat-forming, stemless perennial forb that arises from a deep woody caudex (**Figure 1**). The leaves are all in basal rosettes that crown branches of the woody caudex. The leaf blades are 1 to 3 cm long, linear to oblanceolate, whitish hairy, and smooth-margined. There are long tufts of multi-cellular, unbranched trichomes in the leaf axils. The hemispherical flower heads are usually one on each branch (monocephalous), they are sessile or pedunculate among the basal leaf rosettes, and 4 to 7 mm high, 5 to 10 mm broad (**Figure 2** and **Figure 3**). The phyllaries are broadly ovate to broadly orbicular. The disk florets are numerous and whitish or greenish. The five inconspicuous pistillate ray florets are whitish or greenish color and project above disk florets with corolla tubes that are expanded above. The achenes are flattened and glabrous, lack wings, and have a pappus that consists of two thick scales nearly as long as the corolla tube (Nuttall 1840, Rollins 1950, Clark and Dorn 1979, Fertig et al. 1994, Dorn 2001). Technical descriptions of *P. alpinum* are provided in Nuttall (1840), Clark and Dorn (1979), Dorn (2001), and Hartman and Nelson (1994). Photographs and illustrations are presented in Fertig et al. (1994), Fertig (2000), and Spackman et al. (1997) and in this report (**Figure 1**, **Figure 2**, **Figure 3**).

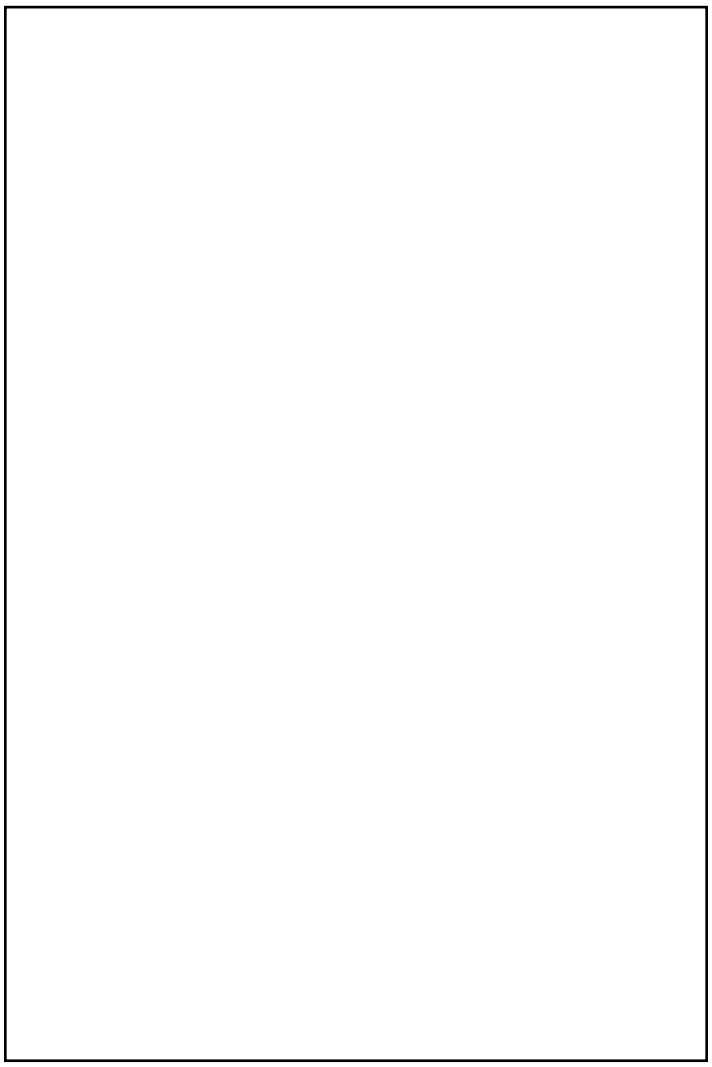

Figure 1. Illustration of *Parthenium alpinum* by Bonnie Heidel.

Figure 2. Photograph of *Parthenium alpinum* by William Jennings, from Spackman et al. (1997).

Figure 3. Photograph of *Parthenium alpinum* (whole plant) by Walter Fertig, from Fertig (2000).

Parthenium alpinum is closely related to *P. tetraneuris* and *P. ligulatum*. The former differs in having achenes that are hairy and winged, with outer phyllaries up to 4 mm wide (Weber and Wittman 2001). The latter two differ in having leaves that are oblanceolate, and ray flowers that are extremely short (1 to 2 mm). There is a difference of opinion whether *P. tetraneuris* is distinct from *P. alpinum*, as reflected in treatments of the Colorado flora by Weber and Wittman (2001) and Hartman and Nelson (2002). A comparison of species' characteristics is presented in **Table 1**, based on Barneby (1947), Rollins (1950), and Cronquist (1994).

Parthenium alpinum is inconspicuous in the field except for a short period in early spring when flowers are present (Clark and Dorn 1979). Basal leaves of the previous year persist and sometimes obscure the plant of the current year. When basal rosettes are close together, they may appear as a single miniature mat or mound rather than in distinct tufts. Rupert Barneby (1947) noted that: "The Bolophytas occur in local abundance, but are deceptively inconspicuous."

Vegetative specimens of another plant, *Hymenoxys acaulis*, look similar to *Parthenium alpinum* but have longer leaf blades with prominent

Table 1. Characteristics distinguishing *Parthenium alpinum* from related species. Includes other members of section Bolophytum.

Feature	*Parthenium alpinum*	*Parthenium tetraneuris*	*Parthenium ligulatum*
ligule	not present	not present	1 to 2 mm long
corolla-tube of ray-florets	expanded above	expanded above	contracted above
heads	peduncules <1 cm to sessile	peduncles 1 to 3 cm	sessile
leaf shape	linear to linear-spatulate or oblanceolate	linear to linear- spatulate or oblanceolate	spatulate
leaf nervation	usually prominently one-nerved	usually prominently three-nerved	obscurely one-nerved

midribs. Vegetative specimens of *Haplopappus acaulis* have longer leaves without tufts of hairs in the axils. Both *Hymenoxys acaulis* and *Haplopappus acaulis* are further distinguished from *P. alpinum* in flower by long-stalked heads and conspicuous yellow ray flowers (Fertig et al. 1994).

Distribution and abundance

Parthenium alpinum is a regional endemic that has its center of distribution on the high plains of Colorado and Wyoming, extending into New Mexico. The distribution of *P. alpinum* overlaps with that of two closely-related species, *P. ligulatum* and *P. tetraneuris* (**Figure 4**). However, the latter are not sympatric and are generally found at higher elevations. *Parthenium alpinum* has the widest distribution of the three species, extending farther north and south. The two related species are both in Colorado and are also tracked as species of special concern.

Parthenium alpinum occurs in one county in northeastern Colorado, five counties in southeastern and central Wyoming, and two counties in northeastern and northwestern New Mexico (**Figure 5**; Clark and Dorn, 1979, Spellenberg 1986, O'Kane 1988, Fertig et al. 1994, Hartman and Nelson 1995, Spackman et al. 1997, Fertig 2000, Dorn 2001, NatureServe 2004, USDA Natural Resources Conservation Service 2004.) The three-state distribution spans a distance of over 6 degrees latitude (over 400 miles) in five population centers and five corresponding ecoregions: the Denver Basin of northeastern Colorado, the Western Plains of southeastern Wyoming, the Sweetwater River Valley of central Wyoming, the Southwestern Tablelands of northeastern New Mexico, and the Arizona/New Mexico Plateau of northwestern New Mexico. However, its distribution and its habitat are not continuous within or between the five population centers.

Parthenium alpinum was first reported from Colorado in Fremont County (Harrington 1954), and specimens were correctly labeled *P. alpinum* var. *tetraneuris* but were mistakenly reported in some sources as *P. alpinum sensu stricto*. The first true collection of *P. alpinum sensu stricto* from Colorado was made in Weld County in 1978. There have been four other verified Colorado occurrences, all from two townships in Weld County. All Weld County occurrences are near the Pawnee National Grassland, but only two are on National Forest System lands.

In Wyoming, *Parthenium alpinum* is known from 47 extant occurrences and three historical records in central and southeastern counties. It is not known from lands administered by the Rocky Mountain Region of the USFS.

Parthenium alpinum was first discovered in New Mexico in 1984 (Spellenberg 1986). In the following decade it was collected in two other locales, and it is now known from Harding and McKinley counties. It is not known from lands administered by the USFS in New Mexico (Southwestern Region).

The sporadic pattern of distribution of *Parthenium alpinum* is similar to that of other cushion plants on the high plains, such as *Astragalus serioleucus* (Locklear 2002). However, underlying causes for these patterns have not been determined.

The total rangewide number of *Parthenium alpinum* occurrences and accompanying information on population size and extent are presented in **Table 2**, as compiled and maintained by Colorado Natural Heritage Program, New Mexico Natural Heritage Program, and Wyoming Natural Diversity Database. The two largest known occurrences in Colorado are both on the Pawnee National Grassland. The newly-documented occurrence at the Windmills site is comprised of nine suboccurrences that total 1,880 plants, in addition to one very large suboccurrence that was not counted past 1,000 plants but is estimated in the "thousands." The Chalk Butte occurrence has "approximately 200

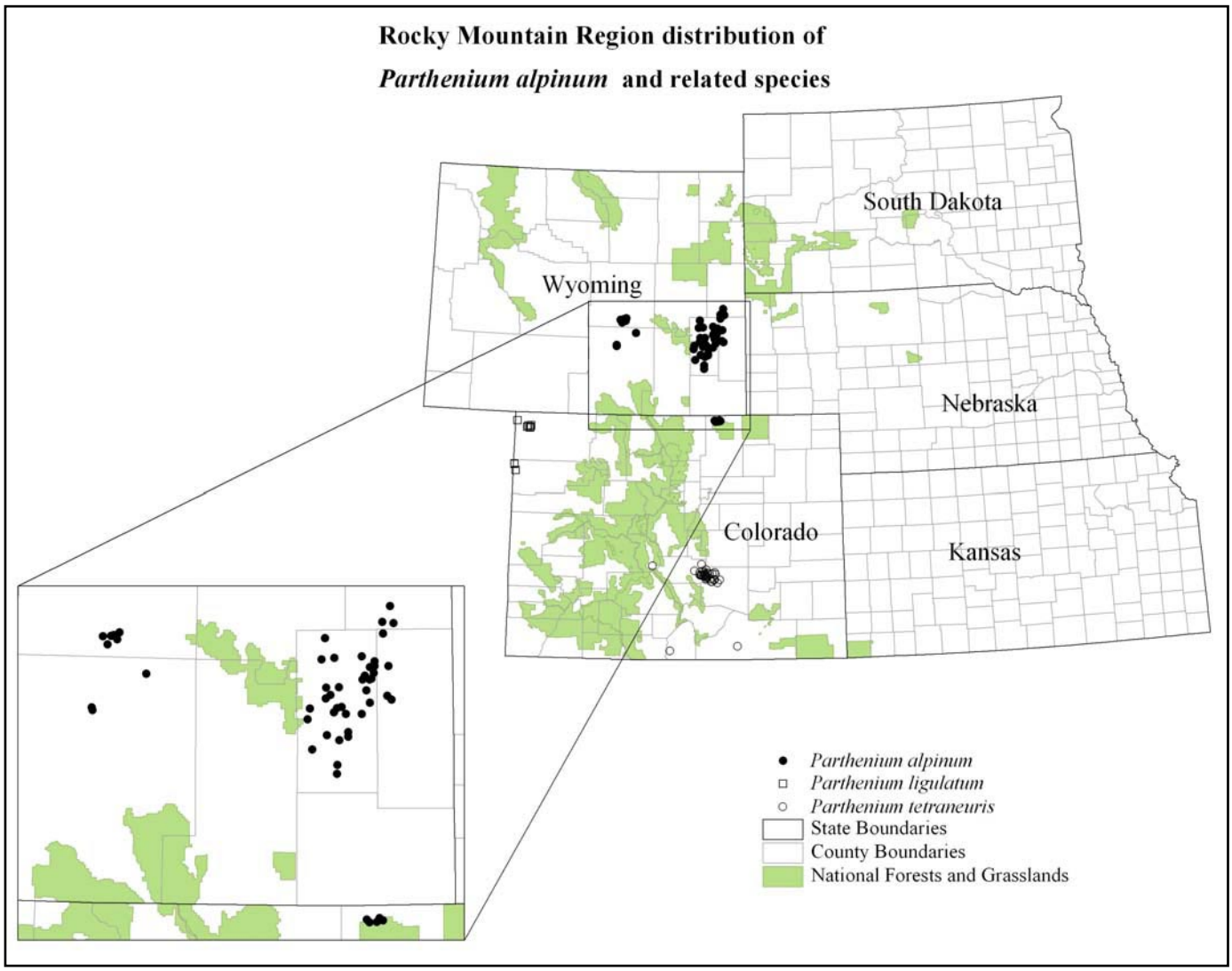

Figure 4. Rocky Mountain Region distribution of *Parthenium alpinum* and related species. Includes other members of section Bolophytum. Note: The distribution of *P. alpinum* also extends to New Mexico, and the distribution of *P. ligulatum* also extends to Utah and Nevada. Sources: Colorado Natural Heritage Program 2004, New Mexico Natural Heritage Program 2004, Wyoming Natural Diversity Database 2004.

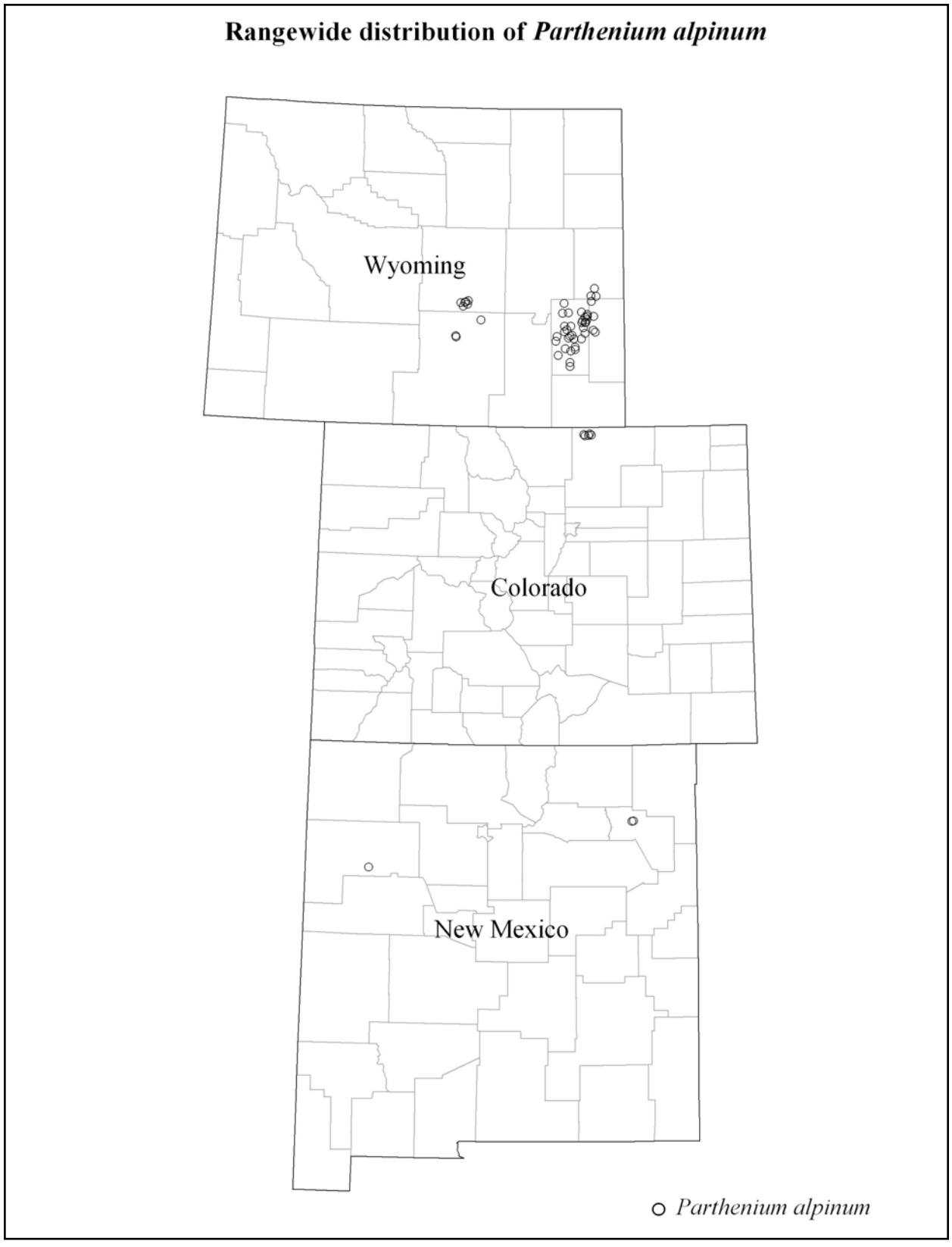

Figure 5. Rangewide distribution of *Parthenium alpinum*.

Table 2. Summary information for *Parthenium alpinum* occurrences rangewide. Includes element occurrence record number, management, county and state, estimated abundance, extent, elevation range, general habitat description, and associated species.

Site name (occurrence number)	Management	County, State	Estimated abundance	Extent (acres)	Elevation range (ft)	General habitat description	Associated species
Chalk Bluffs (CO001)	Eagle Rock Audubon Sanctuary; private	Weld, CO	200	15	5,700 to 5,800	Rocky slopes of sandstone cap rock with sparse to moderate vegetation.	*Lomatium nuttallii*, *Cryptantha cana*, *Astragalus gilviflorus*, *Bouteloua gracilis*.
Near Chalk Bluffs (CO002)	Pawnee National Grassland	Weld, CO	"low hundreds"	Not available (NA)	5,480 to 5,775	Rocky, south-facing, gravelly bench with other mat-forming species and a few grasses.	No information available.
Rockport (CO003)	State of Colorado; private	Weld, CO	"dozens of plants"	NA	5,600	Southeast-facing, rocky and sandy hillside and gravelly soil along road.	*Astragalus spatulatus*.
Rockport Roadside (CO004)	State of Colorado; private	Weld, CO	20	NA	5,500	Low hill and roadcut.	No information available.
The Windmills (CO005)	Pawnee National Grassland	Weld, CO	2,880+ (including one of 10 subpopulations numbering in "thousands")	NA	5,500 to 5,650	Sparsely vegetated, gravelly slopes with rocky outcrops.	*Gutierrezia sarthrae*, *Yucca glauca*, *Artemisia frigida*, *Arenaria congesta*, *Bouteloua curtipendula*, *B. gracilis*, *Opuntia polycantha*, *Elymus smithii*, *Oryzopsis hymenoides*, *Eriogonum* spp., *Aristida purpurea*, *Comandra umbellata*, *Euphorbia* spp.
Carrizo Creek (NM001)	Private	Harding, NM	NA	0.1	5,645	Bare limestone knoll.	*Senecio spellenbergii*, *Andropogon scoparium*, *Paronychia sessiliflora*, *Hymenoxys acaulis*.
Thoreau NE Quad (NM012)	BLM Farmington	McKinley, NM	"locally common"	NA	7,200	Mesa topped with Todilto Dolomite; tan soils, limey sands with limestone gravel in *Pinus edulis-Juniperus monosperma* community.	*Schizachyrium scoparium*, *Eriogonum shockleyi*, *Lesquerella fendleri*, *Hymenoxys argentea*.
Valencia Spring Quad (NM013)	Private	Harding, NM	NA	NA	5,540	Open, bare, calcareous knoll in *Bouteloua hirsuta* grassland.	*Bouteloua breviseta*, *B. curtipendula*, *Aristida* spp., *Senecio spellenbergii*, *Ipomopsis spicata*, *Castilleja sessiliflora*.
Round Top (WY001)	Bureau of Land Management (BLM) Casper; State of Wyoming	Goshen, WY	NA	NA	4,800	Limestone knoll in sagebrush grassland.	*Phlox alyssifolia*, *Erigeron ochroleucus*.
Whalen Canyon (WY002)	BLM Casper	Platte, WY	NA	NA	4,800	Limestone slopes in sagebrush mountain mahogany.	*Carex filifolia*, *Cercocarpus montanus*, *Euphorbia* spp.
Webb Canyon (WY004)	Private	Platte, WY	"common"	NA	5,200 to 5,460	Gravelly loam on hilltop in upland grassland, and roadcut and slopes below limestone cliffs.	*Paronychia depressa*, *Hymenoxys acaulis*, *Senecio canus*.
Little Cottonwood Draw (WY003)	Private	Platte, WY	"frequent"	NA	4,750	Sandy soil on ridgetop in rough breaks.	*Cercocarpus montanus*, *Haplopappus armerioides*, *Musineon* spp.

Table 2 (cont.).

Site name (occurrence number)	Management	County, State	Estimated abundance	Extent (acres)	Elevation range (ft)	General habitat description	Associated species
Hell Gap Quad (WY005)	Private	Platte, WY	NA	NA	5,300	No information available.	No information available.
Guernsey Reservoir (WY006)	Guernsey State Park; BLM Casper	Platte, WY	(historic - "locally abundant")	NA	4,400	On limestone and shale of the Guernsey Formation.	No information available.
Hell Gap Quad (WY007)	State of Wyoming	Platte, WY	(historic - "locally abundant")	NA	5,000	Dry sandy limestone outcrops.	No information available.
Silver Springs Quad (WY008)	State of Wyoming	Niobrara, WY	(historic – "common")	NA	5,100	Dry marly knolls and ridges, volcanic ash deposits of Miocene Age.	No information available.
Benton Basin Quad (WY009)	BLM Casper	Natrona, WY	NA	NA	6,400	Red, sandy-clay soil, Satanka Formation, and rocky calcareous ridges.	No information available.
Benton Basin Quad (WY010)	BLM Casper	Natrona, WY	"several thousand"	NA	6,300 to 6,380	Cushion plant communities on windy rim and bluffs of siltstone and fragmented limestone gravel deposits, lying above gypsum deposits and sandy plains.	*Phlox muscoides*, *Artemisia nova*.
Seminoe Dam Quad (WY011)	Seminoe Reservoir (Bureau of Reclamation); BLM Casper	Carbon, WY	NA	NA	6,300	Rocky, calcareous ridge.	*Phlox* spp., *Astragalus* spp.
Oregon Trail Historic Site (WY012)	State of Wyoming	Platte, WY	NA	NA	4,320 to 4,500	Rough breaks with scattered juniper and ponderosa pine interspersed with sandy areas.	*Juniperus scopulorum*, *Oenthera albicaulis*, *Koeleria macrantha*, *Penstemon erianthus* ssp. *erianthus*, *Bromus* spp., *Penstemon* spp., *Poa* spp.
Alcova Quad (WY013)	BLM Casper	Natrona, WY	NA	NA	5,500	Sandy-gypsum ridge.	No information available.
Silver Springs Quad (WY014)	BLM Newcastle	Niobrara, WY	NA	NA	5,700 to 6,020	Cracks in limestone pavement on ridgetop and adjacent stony slopes.	No information available.
Rawhide Buttes W Quad (WY015)	BLM Casper	Goshen, WY	NA	NA	5,680 to 5,860	Stony limestone slopes with scattered ponderosa pine.	No information available.
Haushar Ranch Quad (WY016)	Private	Platte, WY	NA	NA	4,960 to 5,060	Open, stony limestone slopes with scattered ponderosa pine.	No information available.
Glendo Reservoir (WY017)	Private	Platte, WY	NA	NA	4,950 to 5,000	Limestone outcrops and calcareous grasslands with juniper.	No information available.

Table 2 (cont.).

Site name (occurrence number)	Management	County, State	Estimated abundance	Extent (acres)	Elevation range (ft)	General habitat description	Associated species
Squaw Rock Quad (WY018)	BLM Casper; State of Wyoming	Platte, WY	"several thousand"	NA	5,220 to 5,430	Gravelly foothills terrace incised by drainages, dominated by *Rhus trilobata* with *Stipa comata-Carex filifolia* on calcareous gravelly loam, 1 percent slope and east aspect. The species is concentrated on wind-exposed microhabitats and to a lesser extent on later stages of secondary succession associated with burrows.	*Astragalus serioleucus*, *Phlox muscoides*, *Musineon divaricatum*, *Bouteloua gracilis*.
Natwick Quad (WY020)	State of Wyoming	Platte, WY	NA	NA	4,900	Calcareous slopes and sandy flats.	No information available.
Johnson Reservoir #3 (WY021)	Private	Platte, WY	NA	NA	4,500	Sandy slopes and lake margin.	No information available.
Lewis Flat Quad (WY022)	State of Wyoming	Platte, WY	NA	NA	4,900	Sandy slopes.	No information available.
Ferguson Corner Quad (WY023)	Private	Platte, WY	NA	NA	4,900	Sandy slopes and stream bottom.	No information available.
Alcova Quad (WY024)	BLM Casper	Natrona, WY	"locally common"	1 to 2	5,500	Gravelly, wind-swept, flat ridgetop dominated by Wyoming big sagebrush and low cushion plants.	*Hymenopappus filifolius*, *Musineon divaricatum*, *Townsendia incana*, *Astragalus spatulatus*, *Arenaria hookeri*.
Guernsey Quad WY(025)	BLM Casper	Platte, WY	NA	NA	4,780 to 4,960	Flat area with extensive limestone pavement above canyons dominated by juniper and mountain mahogany.	No information available.
Alcova Quad (WY026)	BLM Casper	Natrona, WY	10,000 to 15,000	80	5,500 to 5,700	Utah juniper-Wyoming big sagebrush-*Carex filifolia* grassland on Alcova limestone-gravel slope on north-facing ridge. Also occurs on conglomerate along ridgecrest, but absent from redbeds and shales on south slope of ridge and from sandy substrates in valley bottom.	*Lomatium orientale*, *Arenaria hookeri*, *Phlox hoodii*, *Arabis pendulina*, *Townsendia spathulata*, *Senecio canus*, *Lesquerella alpina*.
Silver Springs Quad (WY027)	Private	Niobrara, WY	NA	NA	5,340 to 5,500	Fine-grained black stone hill.	No information available.
Double L Ranch Quad (WY028)	BLM Casper; private	Platte, WY	NA	NA	5,600 to 5,750	Cobblestone slopes with grasslands in shallow swales and draws. Rocky ridge.	*Astragalus spatulatus*, *Eremogone hookeri*, *Artemisia frigida*.
Hightower SW Quad (WY029)	BLM Casper	Platte, WY	NA	NA	4,960 to 5,040	Sagebrush-grassland slopes and benches with fine gravelly soils and cobblestones.	No information available.

Table 2 (cont.).

Site name (occurrence number)	Management	County, State	Estimated abundance	Extent (acres)	Elevation range (ft)	General habitat description	Associated species
Wild Irish Reservoir Quad (WY030)	BLM Rawlins	Carbon, WY	200 to 500	1 to 2	7,960	Cushion plant community dominated by *Phlox muscoides* on windy east and south-facing rims on deep loamy soil covered by white, chalky-limestone gravel. Vegetative cover ca 10 to 20 percent. Restricted to area within 20 feet of rim edge. Absent from lower slopes in areas dominated by *Pinus flexilis* or tall forbs and from adjacent *Artemisia tripartita* grasslands on summit flats away from the rim.	*Sphaeromeria capitata*, *Haplopappus nuttallii*, *Cryptantha caespitosa*, *Potentilla ovina*, *Arenaria hookeri*, *Hymenoxys acaulis*.
Cassa Quad (WY031)	State of Wyoming	Platte, WY	350 to 480	5 to 7	4,700 to 4,760	Occurs in 2 main vegetation types: (1) cushion plant communities dominated by *Parthenium alpinum*, *Hymenoxys acaulis*, and *Haplopappus acaulis* on "gravel-pavement" soils or rocky, brownish clay-sandy soils of gently dipping south or east-facing slopes within sparsely vegetated openings in *Artemisia tridentata* var. *wyomingensis*/*Bouteloua gracilis*/*Stipa comata* grasslands; (2) bunchgrass community dominated by *Andropogon scoparius*, *B. gracilis*, and *Aristida purpurea* var. *longiseta* at edge of *Pinus ponderosa*/*Artemisia tridentata* var. *wyomingensis* savanna on rocky limey-sandstone outcrops.	*Muhlenbergia* spp., *Paronychia sessiliflora*, *Artemisia frigida*, *Thelesperma megapotamicum*, *Bouteloua curtipendula*, *Psoralidium tenuiflorum*, *Helianthus pumilis*.
Benton Basin Quad (WY032)	BLM Casper	Natrona, WY	"locally abundant"	NA	5,600 to 5,900	Sandy soil pockets and gravelly limestone-sandstone outcrops on northeast-facing slopes in open ponderosa pine/Utah juniper woodland in cushion plant communities.	No information available.
Seminoe Dam SW Quad (WY033)	Seminoe Reservoir (Bureau of Reclamation); BLM Rawlins	Carbon, WY	NA	NA	6,400	North-facing slopes and summit of siltstone-sandy limestone ridge just south of inlet, community of cushion plants/*Elymus spicatus* and scattered *Chrysothamnus nauseosus* on caprock summit and on slopes in openings amid *Artemisia nova*.	No information available.
Double L Ranch Quad (WY034)	BLM Casper; private	Platte, WY	NA	NA	5,400 to 5,700	Extensive rocky finger ridges and on adjoining habitats including gravelly grassland and mountain mahogany scrub.	*Machaeranthera grindelioides*, *Eremogone hookeri*, *Astragalus spatulatus*, *Viola nuttallii*.
Fort Laramie Quad (WY035)	BLM Casper, private	Goshen, WY	Occasional, widespread	10	4,300	Limey-sandstone ledges, limestone ridges and cobbly knolls.	*Cryptantha* spp., *Phlox hoodii*, *Stipa comata*, *Carex filifolia*, *Yucca glauca*, *Bouteloua curtipendula*.
Register Cliff Quad (WY036)	BLM Casper; State of Wyoming; private	Platte, WY	NA	NA	4,440 to 4,800	Rocky ridges and stony, gravelly, or sandy slopes among ponderosa pine, mountain mahogany and juniper.	*Eremogone hookeri*.
Ferguson Corner Quad (WY037)	Private	Platte, WY	NA	NA	4,800 to 4,900	Gravelly slopes and ridges of sandstone-limestone outcrops.	*Eremogone hookeri*, *Macheranthera grindelioides*, *Eriogonum* spp., *Paronychia* spp.

Table 2 (concluded).

Site name (occurrence number)	Management	County, State	Estimated abundance	Extent (acres)	Elevation range (ft)	General habitat description	Associated species
Herman Ranch Quad (WY038)	State of Wyoming	Platte, WY	NA	NA	4,720 to 4,900	Rolling grasslands with exposed knolls.	No information available.
Coleman Butte Quad (WY039)	State of Wyoming; private	Platte, WY	NA	NA	4,900 to 5,000	Low rocky outcrop on the plains and rocky slope.	*Astragalus spatulatus*, *Eremogone hookeri*.
Johnson Mountain (WY040)	Private	Platte, WY	NA	NA	4,850 to 4,900	Gravelly-rocky bluffs and flats above.	No information available.
Lewis Flat Quad (WY041)	State of Wyoming	Platte, WY	NA	NA	4,800 to 4,840	Roadside and right-of-way on gravelly grassland.	No information available.
Sibley Peak Quad (WY042)	Private	Platte, WY	NA	NA	4,900	Chalky outcrop.	*Astragalus spatulatus*, *Packera cana*.
Dwyer Quad (WY043)	Private	Platte, WY	NA	NA	4,600 to 4,700	Cobbley ridge.	*Astragalus sericoleucus*, *A. gilviflorus*, *Cryptantha cana*, *Eremogone hookeri*.
Dwyer Quad (WY044)	Private	Platte, WY	NA	NA	4,500 to 4,580	Rocky-gravelly bluffs.	No information available.
Guernsey Quad (WY045)	BLM Casper; private	Platte, WY	NA	NA	4,800 to 5,060	South-facing gravelly sandstone-limestone slope in bare saddle between adjacent ridges of mountain mahogany grassland. Also reddish-gray sandstone-limestone outcrops on north-facing upper slope and summit in cushion plant community surrounded by ponderosa pine-juniper savanna and on adjacent roadcuts.	No information available.
Guernsey Quad (WY046)	Private	Platte, WY	NA	NA	5,300	Cushion plant community on gravelly limestone plain on summit ridge in scattered *Juniperus scopulorum*.	No information available.
Wheatland Quad (WY047)	Private	Platte, WY	NA	NA	4,800	Gravelly slope and limestone outcrop.	*Cryptantha cana*, *Eremogone hookeri*, *Astragalus spatulatus*.
Wheatland Quad (WY048)	Private	Platte, WY	NA	NA	4,500	Cobbley knob.	*Paronychia* spp., *Eremogone hookeri.*
Hell Gap and Haushar Ranch (WY050)	Camp Guernsey	Platte, WY	NA	NA	4,900 to 5,100	Gentle to moderate upland slopes, on duff with interspersed sandstone cobbles.	*Juniperus scopulorum*, *Pinus ponderosa*, *Hymenoxys acaulis*, *Ribes* spp.
Baldy Mountain (WY052)	Camp Guernsey	Platte, WY	NA	NA	5,200	Rocky slopes and ridgetops, on limestone cobbles to sandy loam with sandstone cobbles, in pine/juniper woodland and upland *Artemisia* shrubland.	*Artemisia nova*, *Hymenoxys acaulis*, *Juniperus scopulorum*, *Pinus ponderosa*, *Poa* spp.
Herman Ranch (WY053)	Camp Guernsey	Platte, WY	NA	NA	4,475	Stony, calcareous knolls.	*Eremogone hookeri*, *Poa fendleriana.*

individuals." Three of the historic Wyoming records note the species as "common" or "locally abundant" on collection labels of C.L. Porter. There have not been efforts made to relocate the Porter collections, and their status is not known. Two of the recently-documented Wyoming occurrences have numbers of individuals estimated as "several thousand", and another had numbers estimated at "10,000 to 15,000" although 1,500 to 2,500 of the latter were located in the site of a proposed limestone quarry (Wyoming Natural Diversity Database 2002). Total estimated numbers of individual plants in Wyoming are probably in the millions (Robert Dorn personal communication 1997). Some of the recently documented Wyoming occurrences are extensive and span multiple sections, though they may be limited to narrow ridge lines that run continuously or intermittently for miles. The most extensive of recent surveys were for the CIG Medicine Bow Lateral pipeline project and the corridor route ran perpendicular rather than parallel to the distribution of potential habitat, so that surveys were not complete local surveys for the species (Dorn 1999). The collections cited by Dorn (1999) have been incorporated in Wyoming status information, and determinations have been made as to whether they represent new records, revisits to old records, or extensions of new and old records. The total numbers of individuals in New Mexico occurrences are not known.

Census of *Parthenium alpinum* is complicated by the fact that the species has a caudex that branches below ground and may grow between cobbles and rock fractures, so it is not possible to tell by casual observation whether basal rosettes occurring close together are separate individuals or part of the same individual. There may be different branching patterns and population density at different sites. The photograph in **Figure 2** represents part of one individual. The photograph in **Figure 3** probably represents seven individuals, though there may be intact connections, or the original connections may have decayed. Individual plants are usually much smaller than 30 cm in diameter and not usually crowded together. Compounding the difficulty of making an accurate census is the difficulty in distinguishing plants outside of the flowering period from other cushion-forming species in the same habitat.

Population trend

Quantitative populations trend data are unavailable for occurrences of *Parthenium alpinum* with the exception that researchers characterized many of the recently discovered populations in Wyoming as appearing stable (Fertig 2000). No single occurrence has repeated, quantitative census or estimates of population size. None of the revisits to documented sites provided re-evaluation of population numbers, but some documented greater occurrence extent than previously known. This is not proof that the occurrence expanded because it is not known that the collectors were in the same locales at both times.

Habitat

Parthenium alpinum occurs on sparsely vegetated slopes and outcrops within grasslands, shrublands or woodland openings between 5,450 and 5,800 ft. in Colorado, between 4,400 and 6,400 ft. in Wyoming, and between 5,400 and 7,200 ft. in New Mexico. The elevation range in Wyoming is lower than the elevations of the nearest National Forest System units. The original discovery of this species reportedly at 7,000 ft. elevation by Nuttall in what is now Wyoming may represent an occurrence that has not been relocated, or it may represent an inaccurate estimate of elevation.

Parthenium alpinum typically occupies cushion plant communities variously positioned on ridgetops, low hills, rims, benches, upper slopes or slope crests, and side-slopes. These represent exposed microhabitats that are maintained in part by wind erosion. At all sites, the vegetation cover is less than 20 percent. The directly associated species and vegetation structure vary somewhat between the five areas of distribution, but consistently include other cushion- or mat-forming species and early-flowering species (**Table 2**). Shortgrass steppe and ridge uplands comprises associated vegetation of Colorado sites and the Pawnee National Grassland in particular, dominated by combinations of *Bouteloua gracilis* (blue grama), *Buchloe dactyloides* (buffalograss), *Elymus smithii* (western wheatgrass), *Sporobolus cryptandrus* (sand dropseed), and *Schizachyrium scoparium* (little bluestem) (**Figure 6**; Maggie Marston personal communication 2002, Moholt 2004). Grassland or scrub comprises associated vegetation of New Mexico sites dominated by combinations of *Bouteloua hirsuta* (hairy grama), *B. glandulosa* (glandular hairy grama), *Juniperus monosperma* (one-seeded juniper), and *Pinus edulis* (pinyon pine) (New Mexico Natural Heritage Program 2002). Grassland, shrubland, or open woodland surround Wyoming sites, dominated by combinations of *Stipa comata* (needle-and-thread), *E. spicatus* (bluebunch wheatgrass), *Cercocarpus montanus* (mountain mahogany), *Artemisia tridentata* ssp. *wyomingensis* (mountain big sagebrush), *A. nova* (black sagebrush), *Rhus trilobata* (skunkbush), *J. osteosperma* (Utah juniper), *J. scopulorum* (Rocky

Mountain juniper), *P. flexilis* (limber pine), *P. ponderosa* (ponderosa pine), or *Pseudotsuga menziesii* (Douglas-fir) (**Figure 7**).

Parthenium alpinum consistently occupies thin-soil range sites that correspond with soils classified as entisols, lacking a well-defined profile because of persistent erosion and slow development. They fall within the cryic soil temperature regime. Gravel is often a conspicuous component of ground surface cover, whether the gravel is a vestigial layer or part of the substrate matrix. In Colorado the species is typically found on cobble outcrop cushion plant communities overlying siltstone or mudstone with vestigial conglomerate pavement. In New Mexico it is found on limestone uplands. In Wyoming it is found on limestone and dolomite, coarse gravel and cobble, and on some sandstones and shales.

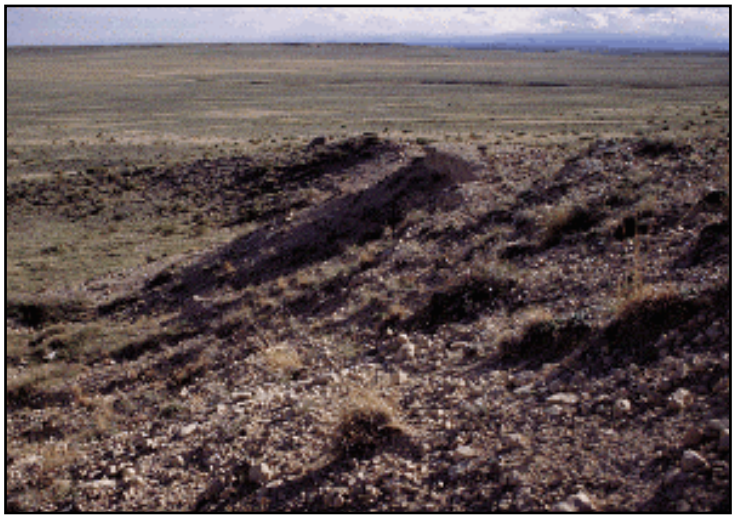

Figure 6. Habitat of *Parthenium alpinum* on cobble outcrops, Weld County, Colorado. Photograph by J. Sanderson and J. Burt, from Spackman et al. (1997).

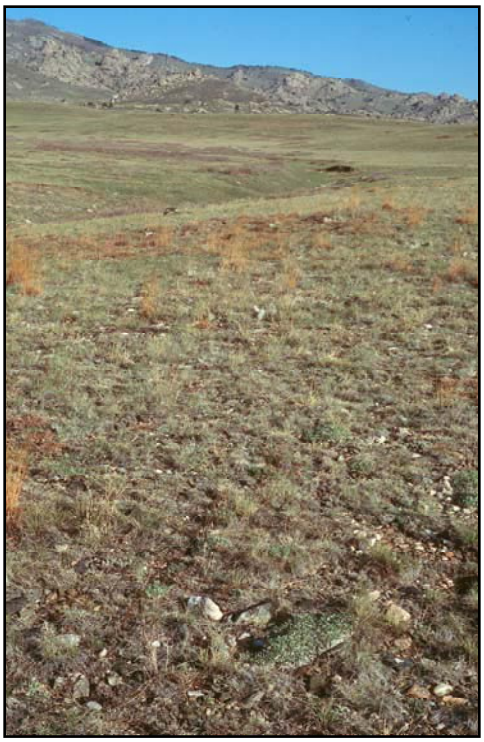

Figure 7. Habitat of *Parthenium alpinum* on gravel loam, Platte County, Wyoming. Photograph by Bonnie Heidel.

The northeastern Colorado substrates are Cenozoic deposits. The southeastern Wyoming bedrock substrates include the Hartville, Madison Limestone, and Arikaree formations, ranging from the Paleozoic to the Cenozoic age (Love and Christiansen 1985.) The central Wyoming bedrock substrates represent inter-bedded limestone and sandstone, including sandy-clay strata of Cretaceous (Mesozoic) deposits that are mainly marine deposits with or without inter-bedded fluvial strata. Colorado, Wyoming, and New Mexico occurrences appear to be positioned at the perimeter of ancient mountain ranges or outwash derived from them.

Soil characteristics of *Parthenium alpinum* have been characterized as part of propagation and plant breeding research. Soil samples were collected for analysis from eleven *P. alpinum* sites that span the species' distribution in Wyoming. The low conductivity values of 0.38 to 0.93 mmho/cm indicated that none of the soils were derived from gypsum (West and Waines 1988), even though gypsum is often present. This contradicts an earlier statement by Mears (1980) that some of the soils on which *P. alpinum* grows are derived from gypsum. The pH values were alkaline (7.6 to 8.1). Saturation percentage values between 26 and 49 percent indicated a wide range of water retention capacities (West and Waines 1988).

The climate of this species' range is characterized as continental, with peak precipitation during the time when the species flowers and begins to set seed in May. Average annual temperature and precipitation values, and mean May flowering temperature and precipitation values, vary slightly across the range of *P. alpinum*, as represented by climate data from the stations closest to the five population centers (**Table 3**). Both temperature and precipitation tend to increase toward the southern end of the species' distribution. The species typically occupies microhabitat where evapotranspiration and temperature extremes are elevated, so the values from the nearest meteorological stations are only rough indications of the climate experienced by the species.

The ecology of cushion plant species and cushion plant vegetation has been the subject of arctic-alpine research, but it is not addressed at lower elevations and temperate latitudes apart from regional pilot vegetation studies (e.g., Jones in preparation). The cushion plant growth form of *Parthenium alpinum* and those of alpine cushion plants both reflect the strong influence of wind and may have adaptive values that constrain evapotranspiration. The habitat of *P. alpinum* also has cryic soils in common with arctic-alpine settings, soils with low temperatures.

Table 3. Annual and May temperature and precipitation values in the vicinity of *Parthenium alpinum* sites. (From National Oceanic and Atmospheric Administration climate data – Western Regional Climate Center. 2002. Mean monthly precipitation data for Colorado, New Mexico, and Wyoming @ http://www.wrcc.dri.edu/summary/).

Station	Casper WSO Airport, WY (5,320 ft)	Wheatland, WY (4,630 ft)	Nunn, CO (5,190 ft)	Thoreau 5 ENE, NM (7,100 ft)	Roy, NM (5,888 ft)
Mean annual temperature (ºF)	45.4	49.24	47.28	50.2	51.9
Range in annual temperature (ºF)	32.1 to 58.7	46.35 to 53.76	44.96 to 49.24	35.9 to 64.5	37.3 to 66.4
Mean May temperature (ºF)	52.6	55.95	55.08	56.7	58.8
Range in May temperature (ºF)	38.7 to 66.6	48.97 to 66.32	48.52 to 58.35	40.7 to 72.6	43.6 to 74.1
Mean annual precipitation (in.)	12.02	13.04	13.91	10.71	15.44
Range in annual precipitation (in.)	6.56 to 20.48	7.44 to 21.65	10.92 to 18.32	5.23 to 17.13	6.57 to 33.86
Mean May precipitation (in.)	2.10	2.41	2.35	0.58	2.03
Range in May precipitation (in.)	0.3 to 6.46	0.04 to 7.13	0.82 to 5.50	0.00 to 2.18	0.00 to 6.05

It is not known whether *Parthenium alpinum* is capable of colonizing or persisting in disturbed habitat, but as a long-lived, woody, mat-forming species that has low seed production per flowering head, it does not appear to be particularly adapted for colonization. It occupies habitat that is sparsely vegetated and may be maintained by forces of wind erosion. In this setting, disturbances that foster sparse cover and exposed surfaces may be beneficial. Colonizing ability was considered in species survey work by the principal author in a population complex with current and abandoned road segments and a range of erosion features (Wyoming Natural Diversity Database 2002). Observations suggested that *P. alpinum* was favored at the intact edge of disturbance where the disturbance crosses the population, but the species did not follow disturbance or colonize disturbed habitat. In this same population, the species was most common in sparse vegetation that might possibly have been fostered by burrowing activity of ground squirrels (*Spermophilus* spp.), even though *P. alpinum* was absent from places that were recognizable as burrows (Heidel personal observation). By contrast, Colorado researchers reported that *P. alpinum* had re-established in a previously disturbed pipeline right-of-way (Moholt 2004). There is no information available regarding the species' response to fire. At all known sites, fuel loads are low. Fire at the sites is assumed to be infrequent. The vulnerability of its terminal buds to ground fire is not known.

Reproductive biology and autecology

Parthenium alpinum is a long-lived perennial with adaptations for stress resiliency and longevity, including a stout, deep, woody caudex; densely-hairy leaves; reduced stature in a cushion plant growth form; and high flavonoid concentrations. It has reproductive characteristics that are also consistent with that of a *K*-selected species (Pianka 1970) including high reproductive effort per propagule and multiple flowering times within the life cycle. A basic life cycle diagram for the species is provided in **Figure 8**.

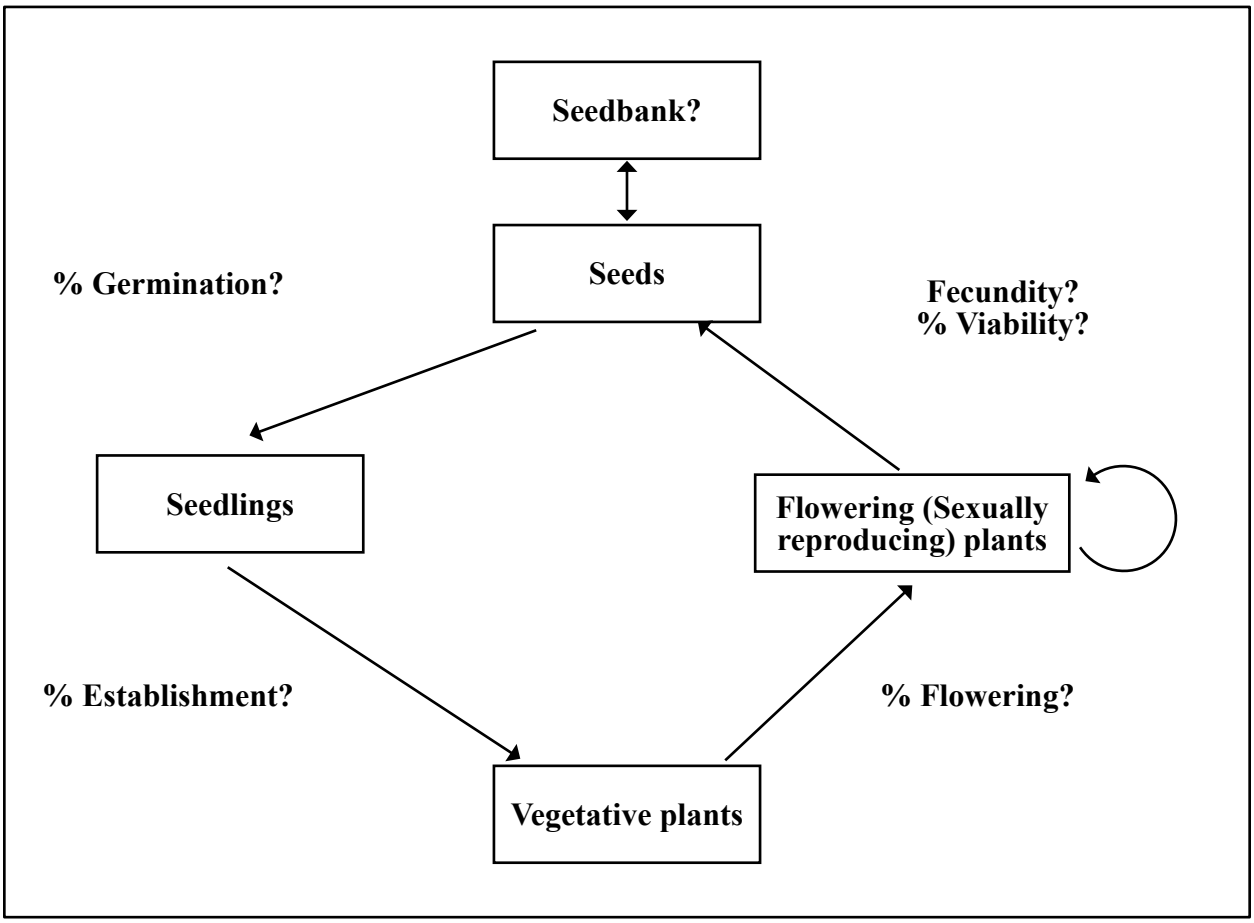

Figure 8. Life cycle diagram for *Parthenium alpinum*.

Parthenium alpinum flowers in early or mid-April through mid-May, varying with elevation, latitude, and with annual climate conditions. In the greenhouse, exposure to prolonged cold (vernalization) induced flowering (West and Waines 1988), suggesting that winter conditions are directly linked to flowering. Plants produce a single flower head per basal rosette. Each flower head has five pistillate ray florets that produce ovules (West and Waines 1988). Flower heads of the species in the section Bolophytum are large compared to the other sections of the genus *Parthenium* (Rollins 1950). The green leaves of the current year are surrounded by dead leaves of the previous year, which are much longer than the green leaves at flowering time. After flowering, the whitish to greenish flowers become discolored and overtopped by the leaves of the year (Heidel personal observation).

Parthenium alpinum lacks significant adaptations for vegetative reproduction and reproduces primarily by seed. However, the section Bolophytum has a cushion plant growth form and a branched rootcrown with outer branches that can become independent and produce new clusters of branches (Rollins 1950). The disintegration of the central woody caudex with age or damage signifies a break-up of the mat into autonomous units over the years, but there is not an associated high rate of mat growth that indicates this is a major mode of vegetative reproduction.

The subterranean woody caudex develops branches with additional basal rosettes as it grows, one basal rosette per branch. The number of branches determines the number of basal leaf rosettes, which in turn determines the potential number of flower heads.

Pollinators of *Parthenium* section Bolophytum have not been studied. Pollination of *P. alpinum* evidently requires outcrossing, as indicated by tests for self-incompatibility in which low pollen germination and growth were documented (West and Waines 1988). While many inconspicuous flowers in the Asteraceae are wind-pollinated, the relatively large flower head and low seed production of the *Bolophytum* section represent a high metabolic investment per seed that is usually associated with specialized pollination vectors, such as insect-pollination. The maturation of florets in the head is centripetal (Rollins 1950). This asynchronous development of the inner staminate disk florets and outer pistillate ray florets reduces the possibility of self-fertilization. The flower head of Asteraceae may have originally evolved as part of a bee-Composite co-evolution, but some researchers interpret the current trend as specialization for butterfly pollination (Mani and Saravanan 1999). In general, neither bees nor butterflies are active at the time in early spring when *P. alpinum* flowers. The Syrphidae family of dipteran flies is active early in spring and is a possible pollinator of the Asteraceae (Mani and Saravanan 1999). Beetles and thrips, members of the Coleoptera and Thysanoptera orders, respectively, are other possible pollinators that are active early in the spring and are generalists (Spellenberg personal communication 2004).

At maturity, the dispersal unit consists of the achene, 3 to 4 mm long, fringed on both sides by wing-like membranous extensions of the pappus (**Figure 1**). It represents the fertile ray floret fused to the two adjacent staminate florets and a subtending phyllary. The fusion of staminate to pistillate flowers contributes to the bulkiness of the propagule. It is not known whether there are animal dispersal vectors. The propagules may be carried short distances on wind. If there are not other dispersal mechanisms, seeds would be likely to fall closely around parent plants. The achenes mature in mid-summer. It is not known whether germination occurs in fall or spring, but there are no special pretreatments needed to propagate it from seed (Locklear 2002) so that germination is probably cued by soil moisture. Establishment presumably takes place with the formation of a deep, woody caudex.

Parthenium alpinum has been propagated by the same techniques used for guayale (Naqvi and Hanson 1982), in which achenes were cleaned by washing in water for 8 hours followed by mechanical threshing, and then planted in standard soil mix and grown in a greenhouse with a 14 hr light/10 hr dark period and 26 °C day/21 °C night temperatures. Seeds of this species are in the Center for Plant Conservation seedbank system, stored for conservation purposes at the Nebraska State Arboretum (Locklear 2002). Information is not available on rates of seed abortion or on seed viability. It is not known whether the species has a seedbank. In the absence of published information, mycorrhizal relations are not assumed.

Genetic studies on *Parthenium alpinum* are lacking. It is not known if northern population centers in Wyoming are genetically identical to smaller, more southern population centers in Colorado and New Mexico. Population structure information is also lacking and may shed light on the species' breeding systems and origin.

The range of morphological characteristics of *Parthenium alpinum* has not been correlated with environment, though the variable morphology among

specimens may reflect environmental conditions. Rollins (1950) reported that herbarium specimens have leaves that range from 1.5 to 6 mm in width and from 14 to 40 mm in length, with single flower heads and peduncles less than 10 mm long. Plants raised in the greenhouse took on a more vigorous growth form than those in the wild; and had leaf width from 2 to 12 mm, leaf length from 20 to 60 mm, and peduncles length from 10 to 30 mm long. In addition, greenhouse plants occasionally had two to three flower heads per basal rosette rather than one flower head (Rollins 1950).

An envirogram summarizing possible resources for *P. alpinum* is presented in **Figure 9**.

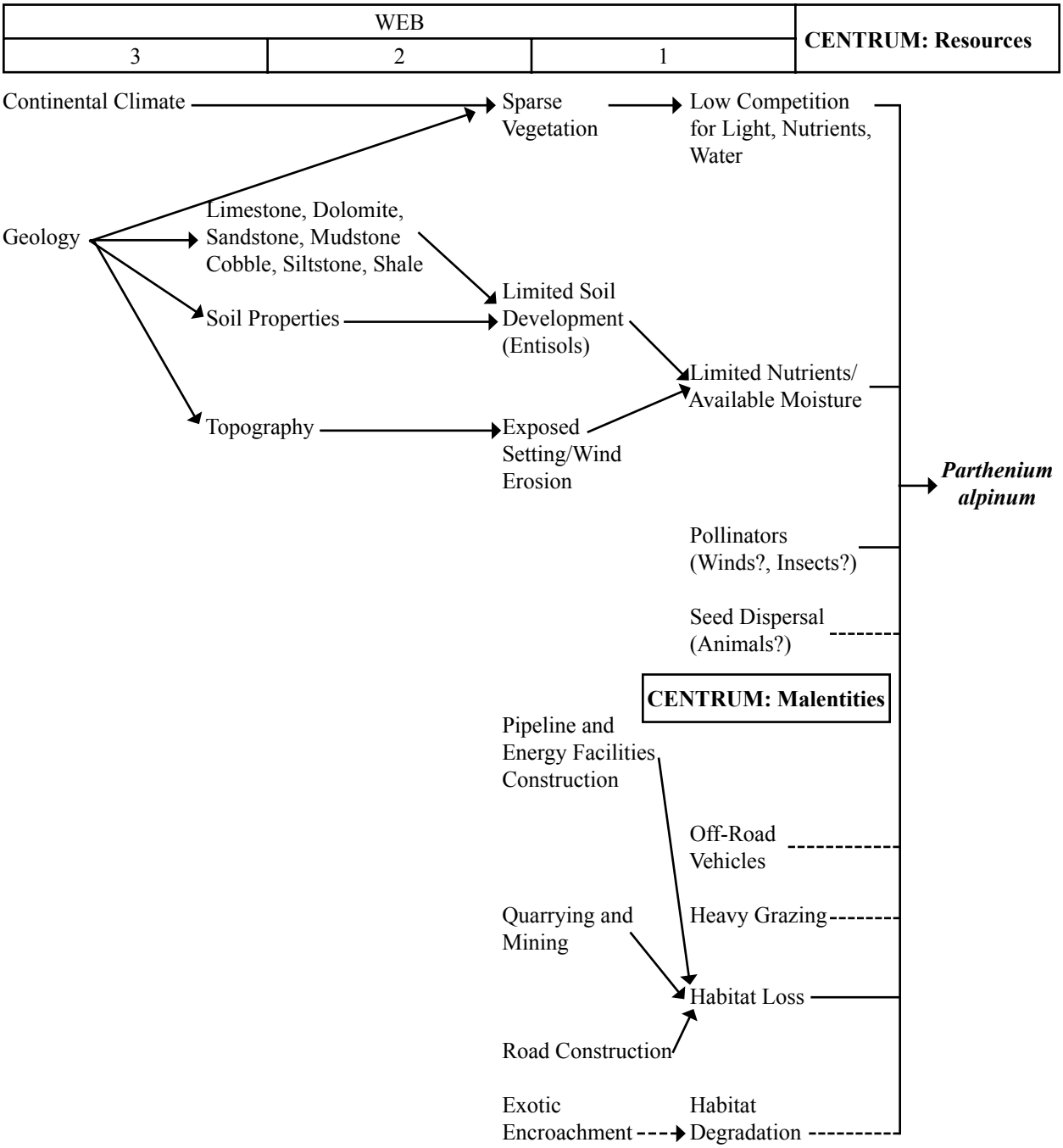

Figure 9. Envirogram for *Parthenium alpinum*.

The distributions of the three species of the section Bolophytum overlap, but the species are not sympatric, and there are no reports of hybrids in the wild. West and Waines (1988) were able to produce viable hybrids between *P. alpinum* and *P. tetraneuris* through cross-pollination in the greenhouse. They also produced hybrids between *P. alpinum* and the commercially-important woody relative guayule (*P. argentatum*). This cross could be important because *P. alpinum* is the most cold-tolerant species in the most cold-tolerant section in the genus. The capacity to cultivate guayule at higher latitudes would increase the range in which it could be grown in the United States for commercial purposes.

Demography

The Colorado and New Mexico population centers have very few occurrences, and the sizes of the occurrences are generally low or unknown, with the possible exception of one New Mexico occurrence where the species was noted as "locally common" (**Table 1**). Since *Parthenium alpinum* is an outcrossing species (West and Waines 1988), small population size may contribute to inbreeding depression. Review of herbarium specimens and plants in the field indicate that individual plants usually flower synchronously among flower heads of the same individual and among individuals of the same occurrence (Heidel personal observation).

There is limited information available on the sizes of occurrences, and there is no published information on age structure, stage structure, spatial distribution patterns, or relative numbers of flowering and non-flowering plants within any given occurrence. The age of individual *Parthenium alpinum* plants cannot be determined with certainty except at seed and seedling stages, so the life history diagram in **Figure 8** is conceptual. Considering the resilience of mature plants, it is likely that the early stages of life history that correspond with development of a woody caudex and transition from a single stalk to a cushion-forming cluster are the vulnerable stages of life history under field conditions.

Each successive year, the basal leaves emerge higher on the branches of the caudex, and leaf sheaths persist, so that a tally of persisting leaf sheaths offers a potential means of determining plant age. However, this requires partially excavating the plant, risking damage. Furthermore, it appears that new basal rosettes are produced over the life of a plant, so that any given basal rosette does not reflect the longevity of the parent plant. Tallies of 10+ intervals (10+ years old) are common among RM specimens, but it appears that leaf sheaths disintegrate when the basal rosette is much older than this. If basal rosettes routinely live over a decade, and are being added over time, then it is likely that individual plants routinely live for decades. The largest plants represented among RM herbarium specimens are probably among the oldest, with diameters exceeding 15 cm and producing over 50 basal rosettes. The northwestern New Mexico occurrence is reported to have plants typically forming mats 10 to 30 cm in diameter, which may represent the oldest or the fastest-growing individuals known.

Information on the rate of growth and rate of new basal rosette production is not available under field or greenhouse conditions. The basic life history diagram of *Parthenium alpinum* (**Figure 8**) does not provide a model for monitoring, but it is possible to monitor individuals and overall trends of a mat-forming perennial by measuring the total cover (cm^2) of individual plants within a permanent plot or belt transect in size classes (Caswell 1989, Elzinga et al. 1998, Heidel 2001).

Parthenium alpinum occurrence sizes vary by orders of magnitude. As a habitat specialist, the availability of suitable habitat appears to be the primary limitation to occurrence size. Surveyors have noted that not all patches of what would appear to be suitable habitat are occupied, so it is possible that seed production, seed dispersal, seed germination, or seedling establishment could also be limiting population growth.

CONSERVATION

Threats

Parthenium alpinum is threatened by any event that extensively disturbs its limited habitat. Ranching is the prevailing land use in *P. alpinum* habitat, and both occurrences of the species on the Pawnee National Grassland lie within an active cattle grazing allotment. The species' response to grazing has not been researched. Grazing threats were characterized as low in Wyoming (Fertig 2000), but in Colorado it was stated that effects could be adverse under heavy grazing (O'Kane 1988). Several of the species' characteristics deter or diminish the likelihood of grazing (pubescence, production of flavonoids, short stature, and flowering early in the growing season). Practices that concentrate livestock close to occurrences, including water developments, salt block placement, and fenceline construction, may result in indirect trampling impacts in the unconsolidated substrates, if not direct impacts to the species.

In the high plains of Colorado and Wyoming, *Parthenium alpinum* may be directly threatened by oil exploration, drilling, and associated activities. Two of the most productive surveys for this species were conducted as part of environmental reviews for pipeline corridors in Colorado and Wyoming, including the Cheyenne Plains Gas Pipeline corridor that crosses the Pawnee National Grassland and the CIG Medicine Bow Lateral corridor in Wyoming. While the species is vulnerable to localized impacts, it was noted in the Wyoming project that the proposed corridor ran perpendicular to the ridges occupied by the species and thus posed limited impact, and that the surveys provided very incomplete documentation of population size (from Dorn 1999).

Parthenium alpinum is potentially threatened by recreation, particularly off-road vehicle use. A designated motorcycle area lies within one mile of the Chalk Butte occurrence on the Pawnee National Grassland, and it is subject to heavy soil removal and erosion (Maggie Marston personal communication 2004). Off-road use is restricted to 6 months of the year and separated from the occurrence by a fence demarcating the special use area. There are no reports of off-road violations that have affected the species.

Energy development, recreational activities, and livestock grazing could introduce exotic species or foster erosion and destabilization. While there are no reports of noxious species present, other exotic species such as yellow sweetclover (*Melilotus officinalis*) are reported at three or more Wyoming sites and are in the vicinity of the Pawnee National Grassland occurrences. Yellow sweetclover has the potential to invade the sparsely-vegetated habitat occupied by *Parthenium alpinum*, fostering increased site productivity through nitrogen fixation that increases vegetation cover, light competition, and water competition, and that promotes long-term successional shifts. There are no reports of erosion and destabilization, but energy developments sites in Wyoming have not been resurveyed since the occurrences were initially documented.

Outside of the Pawnee National Grassland, individual occurrences may also be impacted by quarrying, mining, and new road construction or increased road maintenance activities such as grading, blading, slope destabilization, or indiscriminate herbicide treatment. Part of one Colorado occurrence adjoins a roadcut, and though the species is above the zone of roadcut activity, its exposed slope habitat may be destabilized by maintenance or expansion of the roadcut below (Bill Jennings personal communication 2002). One of the three largest Wyoming occurrences was surveyed for a proposed limestone quarry project, which would have removed occupied habitat but was not judged to be a viability threat to the population as a whole (Fertig 1995). In addition, most of the recently-documented Fort Laramie occurrence is located on coarse alluvial cobble deposits that cap ridgelines, and this part of its habitat is pocked by several old excavation pits where the species is present near the pit perimeter but absent from excavated areas (Heidel in preparation).

Most threats to *Parthenium alpinum* from human activities are localized but may be very important to the viability of small occurrences. An envirogram summarizing threats (malentities) to *P. alpinum* is presented in **Figure 9**.

Conservation Status in Region 2

Parthenium alpinum has a specialized suite of habitat requirements and an unusual distribution of discrete population centers in the Rocky Mountain Region, potentially making it vulnerable to habitat loss. Only two of its Colorado occurrences are on federal land (USFS), and only one of its New Mexico occurrences is on federal land (BLM), but the majority of Wyoming occurrences are on federal land (BLM). All of the *P. alpinum* occurrences on federal lands are on lands managed for multiple uses that generally include ranching and energy developments. It is also present in Guernsey State Park, Wyoming. *Parthenium alpinum* was at one time designated a sensitive species by the Rocky Mountain Region of the USFS (1994), and the sensitive policy and biological evaluation process resulted in the shifting of an oil exploration development at the Chalk Butte occurrence (Maggie Marston personal communication 2002). There have not been any other determinations to date that proposed projects on the Pawnee National Grassland would impact the species' viability. The species no longer has sensitive species status with the update of the Rocky Mountain Region sensitive species list (USDA Forest Service 2003). However, it may still be considered for forest designation as a species of local interest on the Arapaho-Roosevelt National Forest/Pawnee National Grassland. It does not occur on National Forest System lands outside of Region 2.

Potential Management of the Species in Region 2

The elements necessary for maintaining *Parthenium alpinum* viability in the Rocky Mountain Region center on maintaining its habitat in each of the

three population centers that fall within the Region, in particular on the Pawnee National Grassland as a nucleus for the northeastern Colorado population center.

Information is incomplete for evaluating minimum population viability requirements of *Parthenium alpinum*. Minimum viable populations are often on the order of 1,000 to 100,000 individuals according to Menges (1991). As a long-lived species with low fecundity, *P. alpinum* would require numbers at the low end of this range to maintain viability. The standards for ranking *P. alpinum* occurrences in terms of viability, condition, and landscape context are defined mainly in terms of population sizes, with populations of over 500 plants ranked as excellent (Fayette 1997). There is only one Colorado occurrence and three Wyoming occurrences of *P. alpinum* that are documented to have numbers of 500 or greater (they are all 1,000 or greater in number). The largest Colorado occurrence is on the Pawnee National Grassland, and all three Wyoming occurrences are entirely or primarily on lands managed by the Casper Field Office of the BLM, in both the central and southeastern population clusters of Wyoming. The number of plants in New Mexico is not known well enough to address viability.

Information Needs

There is a fundamental information need for systematic surveys of *Parthenium alpinum*. This includes surveys of its potential habitat in and near the Pawnee National Grassland in the vicinity of the Chalk Butte occurrence to document population distribution, extent, and size, and revisits to historic occurrence sites in Wyoming. Systematic survey may be made more efficient using photo-interpretation techniques or soils mapping information.

Five priorities for determining conservation elements of *Parthenium alpinum* are highlighted below.

1. Monitor occurrence and suboccurrence numbers to evaluate trends and conduct demographic research to project baseline trends.

Monitoring requires the ability to distinguish individual plants or at least conduct replicable mapping. Even though plant age cannot be determined, stage-class measurements can be defined in terms of plant size classes and can be used to effectively monitor long-lived, mat-forming perennials (Caswell 1989, Elzinga et al. 1997, Heidel 2001). The life history and demographic results produced from demographic research are to be used in assessing the need and direction for further population viability assessments.

2. If there is evidence for grazing impact identified in the course of monitoring, or if there is an allotment management plan revision that may change patterns of grazing where the species occurs, evaluate the species' response to livestock grazing.

Grazing response studies may be set up or monitoring studies may be revised to compare forage utilization and associated *Parthenium alpinum* grazing levels at a suite of sites, or by paired comparisons inside and outside portable exclosure cages. It might also be appropriate to consider the role of grazing in maintaining the sparse vegetation cover of *P. alpinum* habitat and whether idle (or rest) conditions are detrimental or not.

3. If there is evidence for off-road vehicle impact identified in the course of monitoring, or if there is a transportation or recreation management plan revision that may change patterns of use where the species occurs, develop standards to avoid impacts.

Any signs of mechanical damage and mortality need to be documented and quantified. The standards to be developed would depend on the nature of the damage incidents.

4. Determine the primary pollination vectors of *Parthenium alpinum* and the degree of seed set to determine the success rate of pollination and the habitat requirements of the pollinator(s).

Pollinator studies might be pursued by chronicling insect visitation, documenting pollen transport on visitors, testing pollinator fidelity, and examining seed viability levels associated with selective suites of pollinator exclusion screens.

5. Conduct molecular genetic research to understand population structures, breeding systems, relations between northern and southern populations, species' origin, and taxonomic relations between *Parthenium alpinum* and *P. tetraneuris*. Genetics research might be done in tandem with cytological research, expanding on the limited chromosome count data for *P. alpinum*, *P. ligulatum*, and *P. tetraneuris*.

DEFINITIONS

Acaulescent – Without a stem

Achene – A dry, one-seeded indehiscent fruit

Allelopathy – Chemical inhibition of one organism by another

Caudex – Woody, persistent stem below the ground surface

Centripetal – Towards the center or axis

Cryic – A soil with a mean annual temperature between 0 and 8 °C

Demography – Study of populations, especially growth rates and age or stage structures

Endemic – Native to, and restricted to a geographic area, usually referring to taxa of limited geographic distribution

Flavonoids – Water-soluble polyphenolic compounds with many purposes in plants including pigmentation and deterrent to herbivory

Floret – An individual flower in a definite cluster, as in the flower heads of the Asteraceae

Involucre – A set of bracts beneath an inflorescence

K- selection – Selection producing superior competitive ability in which rapid population growth is unimportant and the population is maintained at or near the carrying capacity of the habitat

Ligulate – With ray flowers in the Asteraceae

mmho/cm – The unit of conductance, as the reciprocal of an ohm (electrical resistance of a circuit in which a potential difference of one volt produces a current of one ampere)

Monocephalous – Single flower head per shoot

Oblanceolate – Lance-shaped and broadest toward the tip

Outcrossing – Mating of individuals; open pollination

Paleoendemic – Species with a limited geographical range but of considerable evolutionary age

Pedunculate – Inflorescence surmounting a flower stalk

Phyllary – An involucral bract of the Asteraceae

Pistillate – Flowers with pistils but lacking stamens

Population viability – Long-term survival probabilities that are conditioned by survival and fecundity rates

Propagule – Any part of an organism that is capable of giving rise to a new individual

Seedbank – Dormant seeds buried in soil

Spatulate – Broad and rounded at tip and long-tapering to base

Staminate – Flowers with stamens but lacking pistils

Sympatric – Related species occurring together in the same geographical area

Topoedaphic – Discrete combination of topographic and soil conditions

Trichome – Any hairlike outgrowth of the epidermis

NatureServe rank definitions:

- G Global rank refers to the rangewide status of a taxon.
- T Trinomial rank refers to the rangewide status of a subspecies or variety.
- S State rank refers to the status of the taxon in a state. State ranks differ from state to state.

For each global and state rank, whether at the species or subspecies level, each taxon is ranked on a scale of 1 to 5, from most vulnerable to extirpation to least as follows:

- 1 Critically imperiled because of extreme rarity (often known from five or fewer extant occurrences or very few remaining individuals) or because some factor of a taxon's life history makes it vulnerable to extinction.
- 2 Imperiled because of rarity (often known from 6 to 20 occurrences) or because of factors demonstrably making a taxon vulnerable to extinction.
- 3 Rare or local throughout its range or found locally in a restricted range (usually known from 21 to 100 occurrences).
- 4 Apparently secure, although the taxon may be quite rare in parts of its range, especially at the periphery.
- 5 Demonstrably secure, although the taxon may be rare in parts of its range, especially at the periphery.

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