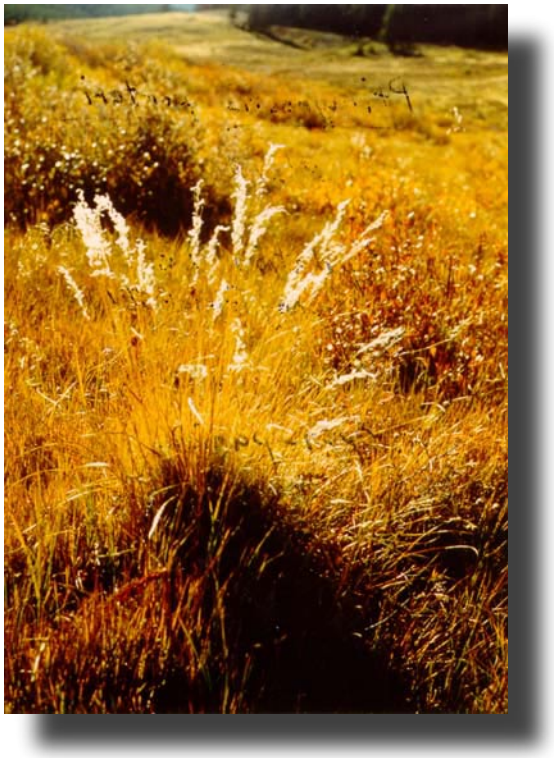
Ptilagrostis porteri (Rydb.) W.A. Weber (Porter's false needlegrass): A Technical Conservation Assessment



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AUTHOR'S BIOGRAPHY

Barry C. Johnston has a B.S. degree in Engineering Physics, from the University of Colorado, Boulder (1966), and a Ph.D. in Biology (Botany and Ecology) from the same university in 1980. His Ph.D. Thesis was a population and taxonomic study of three sections of the plant genus *Potentilla* (Rosaceae) in western North America. He worked for the USDA Forest Service as a seasonal-temporary botanist from 1976 to 1980, conducting field studies of rare plant populations throughout the Southwestern Region (1976) and Rocky Mountain Region (1977 to 1980). He was employed as an ecologist by the Rocky Mountain Region from 1981 to 1989, for that time also doing the work of Regional Botanist. During that period, he was active working on writing documents for the first round of forest plans in this region, especially direction for biodiversity, riparian areas, research natural areas, other special areas, and plant species.

In 1989, he moved to Gunnison, to work for the USDA Forest Service on an ecological classification of the Gunnison Basin, which was published in 2001. Since then, he has worked on various projects, including revegetation, weeds, problems of aspen regeneration, biological evaluations–assessments, inventory and monitoring for Gunnison sage grouse, a field guide to sedges of the Rocky Mountain Region, watershed assessments, the Bureau of Land Management's National Resource Inventory, and monitoring forested sites to prevent catastrophic wildfire in the Front Range of Colorado.

Selected publications include Proposed and Recommended Endangered and Threatened Plant Species of the Forest Service, Rocky Mountain Region (1979); Plant Associations of Region Two (Third Edition, 1987); Multiple Factors Affect Aspen Regeneration on the Uncompahgre Plateau, West-Central Colorado (2001); Ecological Types of the Upper Gunnison Basin (2001); and Field Guide to Sedges of the Rocky Mountain Region (2001). He has also authored numerous reports.

COVER PHOTO CREDIT

A closer view of *Ptilagrostis porteri* (Porter's false needlegrass). Photograph by author.

SUMMARY OF KEY COMPONENTS FOR CONSERVATION OF *PTILAGROSTIS PORTERI*

Status

Ptilagrostis porteri (Porter's feathergrass) is a species endemic to Park, Summit, El Paso, and Lake counties in central Colorado. However, the site in (or near) Lake County has not been seen since 1873. The total occupied habitat of this species is about 2.8 mi^2 (7.2 km^2) comprised of 29 sites. Eighteen of these sites are completely or partially on National Forest System lands. One site is located on Colorado State lands, and one site is on lands owned by the U.S. Air Force Academy. Fifteen sites with *P. porteri* are completely or partially on private lands. As yet this species has not been found on public lands managed by the Bureau of Land Management, but it is close in several places.

The total number of individuals known for *Ptilagrostis porteri* is more than 415,000. Individual populations range in size from six to over 400,000, but most populations contain between 100 and 2,000 individuals. Excluding one very large population, the average population size is around 900 individuals.

Although *Ptilagrostis porteri* is not a candidate for listing under the federal Endangered Species Act, both the USDA Forest Service and the Bureau of Land Management for Colorado list it as a sensitive species. The Colorado Natural Heritage Program gives *P. porteri* a rank of G2/S2, which means it is considered imperiled globally and within the state.

Primary Threats

Potential threats to the viability of *Ptilagrostis porteri* on National Forest System lands include hydrological alterations, placer and peat mining, grazing, and roads and trails. With the exception of small-scale placer mining at one site, none of these potential threats are documented as currently having an impact on *P. porteri* or its habitat on National Forest System lands.

Hydrological alterations can be a threat on private lands and result in de-watering of *Ptilagrostis porteri* sites or otherwise detrimentally change site hydrology. Water drainage structures have likely resulted in the decline or elimination of *P. porteri* populations and habitats on private lands, but this has apparently not been directly observed. Currently there are no such large-scale hydrology changes occurring on National Forest System lands. Detrimental changes in the hydrology of *P. porteri* habitats could occur in the future from activities on occupied sites or in watersheds above *P. porteri* habitats, such as large-scale timber harvest, heavy grazing, road construction and maintenance, development, or large wildfires.

Historic placer mining has apparently caused changes to or the elimination of some *Ptilagrostis porteri* populations. One site on National Forest System lands is at a small risk from small-scale placer mining. Peat mining has been a threat to *P. porteri* and has probably resulted in the decline or elimination of populations on private lands, but this threat has subsided considerably. Peat mining is not occurring in *P. porteri* habitats on National Forest System lands.

Livestock grazing at the current low to moderate levels such as we see on National Forest System lands surrounding *Ptilagrostis porteri* populations is not currently a threat. Heavy livestock grazing in the watersheds where this species occurs would have negative effects on its viability. There have potentially been effects of livestock grazing on *P. porteri* populations and habitats on private lands, but this has not been documented. The effects of elk and deer grazing and browsing are unknown and probably slight at this time.

Currently roads, trails, and recreational uses on National Forest System lands do not apparently pose a threat to *Ptilagrostis porteri* or its habitats. However, there are several sites that are vulnerable to illegal, off-road vehicle use, and several other sites that are close to popular trails. As motor vehicle use and trail use increase, these sites may be threatened in the future. The effects of roads, trails, and recreational uses on *P. porteri* and its habitats on private lands are unknown.

Other possible threats include large-scale timber cutting and intense road construction in the watersheds where *Ptilagrostis porteri* sites occur; neither of these activities is currently being considered or planned for National Forest System lands. As yet, invasive species and exotic species have not impacted known *P. porteri* populations or habitats, but they could increase in the future.

Primary Conservation Elements, Management Implications and Considerations

Ptilagrostis porteri habitats and populations on National Forest System lands appear stable in quantity and quality at this time. These should be monitored to ensure that they remain in stable equilibrium. Since more than 90 percent of all known *P. porteri* individuals are concentrated in one large site, conservation of this species is closely tied to the protection of this site.

An important factor for the conservation of *Ptilagrostis porteri* and its habitats is the management of sites and their watersheds to prevent adverse changes in hydrology. The conservation of *P. porteri* habitats also depends on managing livestock grazing in sites and their watersheds to prevent the degradation of riparian areas and wetlands. Placer mining, roads, trails, and recreational use need to be monitored to ensure that they do not cause detrimental impacts to any population or habitat of *P. porteri* on National Forest System lands. The conservation of this species and its habitats should be a stated goal in Forest Plans and other management plans; an interagency conservation strategy appears warranted.

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INTRODUCTION

This assessment is one of many being produced to support the Species Conservation Project for the Rocky Mountain Region (Region 2) of the USDA Forest Service (USFS). *Ptilagrostis porteri* (Porter's false needlegrass) is the focus of an assessment for several reasons: it is a rare species endemic to the Rocky Mountains in Colorado (**Figure 1**); it is the subject of an ongoing review by the U.S. Fish and Wildlife Service; and the Regional Forester of USFS Region 2 has designated it as a sensitive species (USDA Forest Service 2003). Within the National Forest System, a sensitive species is a plant or animal whose population viability is 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 its distribution (Forest Service Manual 2670.5 [19]). A sensitive species may require special management, so knowledge of its biology and ecology is critical. This assessment addresses the biology, ecology, conservation, and management of *P. porteri* throughout its range.

Goals

Species conservation assessments produced as part of the Species Conservation Project are designed to provide forest managers, 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 changes in the environment that result from management (i.e., management implications). Furthermore, this assessment cites management

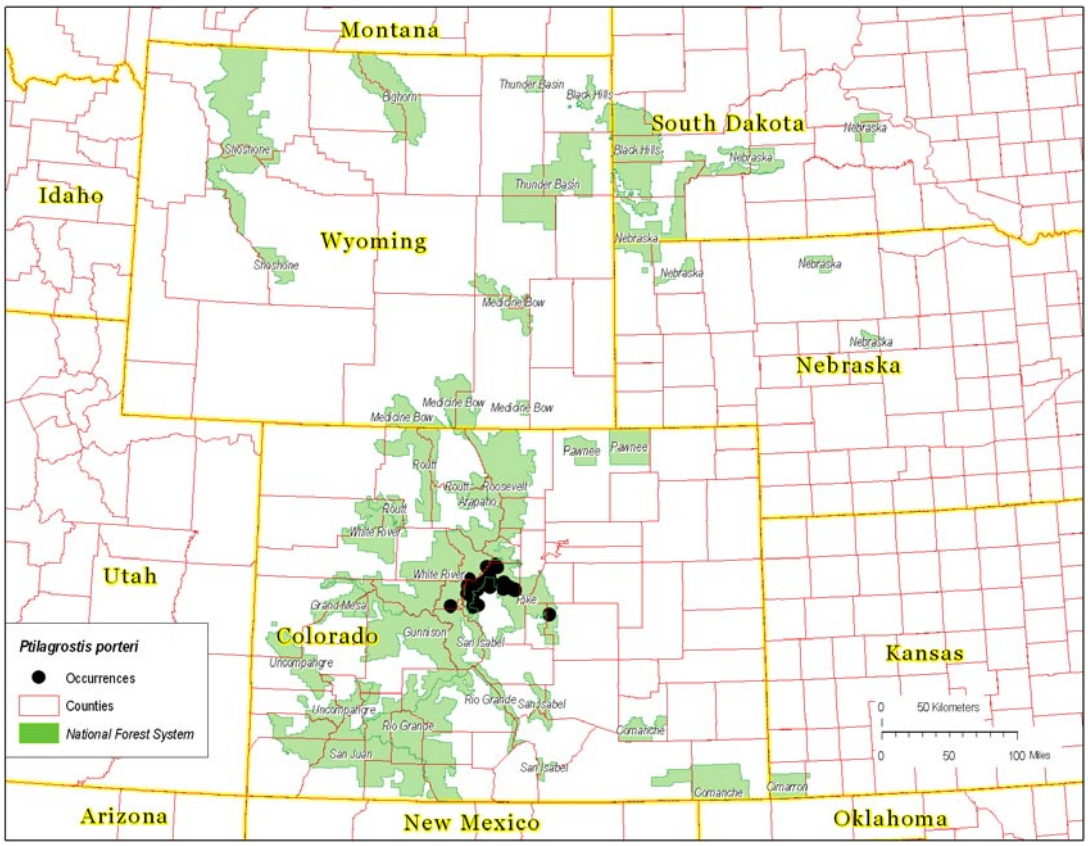

Figure 1. The range of *Ptilagrostis porteri* (black dots) in the context of the national forests and grasslands of USDA Forest Service Rocky Mountain Region.

recommendations proposed elsewhere and examines the success of those that have been implemented.

Scope

This assessment examines the biology, ecology, conservation status, and management of *Ptilagrostis porteri* in USFS Region 2 and in the context of the current environment rather than under historical conditions. Although some of the literature relevant to the species originates from field investigations outside the region, this document places that literature in the ecological and social context of the central Rockies. In producing this assessment, I reviewed refereed literature, non-refereed publications, research reports, and data accumulated by resource management agencies. An effort was made to consider and cite all documents and other sources relevant to the goals. Many reports or non-refereed publications on rare plants are often 'works-in-progress' or isolated observations on phenology or reproductive biology. They are thus reliable sources of information in spite of their not being formally published. Unpublished data (e.g., state natural heritage program records, herbarium records, USFS monitoring projects) were important in estimating geographic distribution and population sizes of this species. These data required special attention because of the diversity of persons and methods used in collection. Records that were associated with locations at which herbarium specimens had been collected at some point in time were weighted with more significance than observations only.

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 of the world are overwhelmingly incomplete and our observations are severely 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. However, it is difficult to conduct critical experiments in naturally occurring ecosystems, especially when those ecosystems are subject to historical and ongoing use and management. Therefore, while well-executed experiments represent the strongest approach to developing knowledge, alternative methods, such as observations, inference, good thinking, and models must be relied on to guide our understanding of features of biology. In fact, careful, unbiased observation and inference have been responsible for most scientific progress, especially in biology (Mueller-Dombois and Ellenberg 1974). In this assessment, the strength of evidence for particular ideas is noted, and alternative explanations are described when appropriate.

Publication of Assessment on the World Wide Web

To facilitate their use, species conservation assessments are being published on the Region 2 World Wide Web site. Placing the documents on the Web makes them available to agency biologists, other agencies and organizations, and the public more rapidly than publishing them as reports. More important, Web publication of these assessments facilitates their revision, which will be accomplished based on guidelines established by Region 2.

Peer Review

Assessments developed for the Species Conservation Project have been peer reviewed prior to their release on the Web. This assessment was reviewed through a process administered by the Society for Conservation Biology, employing at least 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

Ptilagrostis porteri, a species endemic to central Colorado, is designated as sensitive by both USFS Region 2 (USDA Forest Service 2005), and the Bureau of Land Management (BLM) for Colorado (USDI Bureau of Land Management 2004). This species is not federally listed under the Endangered Species Act as threatened or endangered nor is it currently a candidate for listing (USDI Fish and Wildlife Service 2005). *Ptilagrostis porteri* has recently been petitioned for listing as threatened or endangered (Center for Native Ecosystems et al. 2002), but the U.S. Fish and Wildlife Service has issued a finding that the information available does "not present substantial scientific or commercial information indicating that listing this species may be warranted" (Mayo 2005).

A status report was completed for this species in 1981 (Johnston et al. 1981) and revised in 1982 (Johnston and Hendzel 1982). A subsequent status

review was completed for the species in 2001; it recommended the protection of *Ptilagrostis porteri* populations and their habitat (Pollock 2001).

The State of Colorado does not have legislation or regulations protecting any plant species, except the state flower, *Aquilegia coerulea*. The Colorado Natural Heritage Program (2005a) gives *Ptilagrostis porteri* a rank of G2/S2. The G2 rank means that "the species [*Ptilagrostis porteri*] is … globally imperiled; typically 6 to 20 occurrences" while the S2 rank means that the species is "state imperiled; typically 6 to 20 occurrences".

Most of the occurrences of *Ptilagrostis porteri* are on National Forest System lands or private lands in Park County, Colorado, with a small occurrence in adjacent southern Summit County, Colorado (**Table 1**). There is also an occurrence about 30 miles disjunct in northwestern El Paso County, Colorado, on lands owned by the U.S. Air Force Academy. An old record of an occurrence from Twin Lakes, now in southern Lake County, has not been verified, and there is some doubt whether the occurrence is in Lake County or some other county (**Figure 2**). Within the National Forest System, the known occurrences are mostly on the South Park and South Platte Ranger Districts of the Pike National Forest; the small population in southern Summit County is on the Dillon Ranger District of the Arapaho National Forest, which is administered by the White River National Forest (**Table 1**).

One of the populations of *Ptilagrostis porteri* occurs on State of Colorado lands, as part of the Michigan Creek-Teter State Wildlife Area. Apparently there are no occurrences of this species on land managed by the BLM (Culver 2004). There is a patchwork of ownership patterns in South Park among private, state, and BLM lands. Since most of these lands are unexplored for *P. porteri*, more sites are expected to be found on state or BLM lands in the future.

Existing Regulatory Mechanisms, Management Plans, and Conservation Strategies

The Clean Water Act provides provisions with objectives to restore and maintain the chemical, physical, and biological integrity of the Nation's waters (33 U. S. Code 1251). *Ptilagrostis porteri* occurs in isolated wetlands, which historically were interpreted to fall under navigable waters of the United States. In order to conduct ground-disturbing activities in wetlands on private or public land, a permit is required under Section 404 of the Clean Water Act, and application must be made to the U.S. Army Corps of Engineers for such a permit. While several state and federal agencies hold blanket wetland permits, those usually extend only to streams. For wetlands not directly associated with a stream, the agency must apply for an individual permit. The U.S. Fish and Wildlife Service has an advisory role in the permit process and can recommend denial of a permit for various reasons (e.g., the wetland is irreplaceable or not reclaimable). As a matter of policy, the Mountain-Prairie Region (Region 6) of the U.S. Fish and Wildlife Service considers fen wetlands to be irreplaceable and so would recommend that a permit be denied (Hartman 1999).

This permit process changed dramatically in 2001 when the U.S. Supreme Court decided that isolated intrastate non-navigable waters could not be protected under the Clean Water Act (Downing et al. 2003). The wetlands in which *Ptilagrostis porteri* occurs are considered "isolated wetlands" because they are isolated from navigable waters. However, in their ruling the Supreme Court implied that isolated waters might be considered "waters of the United States" (as the Clean Water Act requires) if a "significant nexus" could be established between these isolated wetlands and the navigable waters (Supreme Court of the United States 2001). Scientists are working to try to establish such a connection so that these isolated wetlands can be protected under the Clean Water Act, but at the present time it is uncertain whether they are protected (Nadeau and Leibowitz 2003, Comer et al. 2005a, Comer et al. 2005b).

In the meantime, individual permits must still be applied for with the U.S. Army Corps of Engineers for ground-disturbing activities in wetlands. While several states have passed laws or issued regulations to fill the apparent gap caused by the 2001 ruling, Colorado has not yet done so. In most of the recent situations in Colorado, how these permit applications were handled by local Corps of Engineers officials was subject to their interpretation of the law and the Supreme Court ruling. In some cases, they considered a permit application to be covered under the Clean Water Act if surface water was connected to the wetland. This is a situation that is in considerable flux, and perhaps it will be resolved in the years to come.

Wetlands on National Forest System lands, including all *Ptilagrostis porteri* sites, are also protected by a presidential executive order (Carter 1977) and the National Forest Management Act, where "protection is provided for streams, streambanks, shorelines, lakes,

Table 1. Known sites (29) for *Ptilagrostis porteri* in USDA Forest Service Rocky Mountain Region. Numbers in the first column correspond with numbers in symbols in **Figure 3**. There are no numbers 19 or 23.

Site	Name	County	Quadrangle	Management/ Ownership	Special management area	Elevation (ft.)	Year last observed	Sources[1]	Publications and reports
1	Geneva Park 1	Park	Mount Evans	Pike National Forest South Platte Ranger District	None	9,600 to 9,720	2005	R. Gierisch 1966-1970 (COLO), P. Lucas 1978, B. Johnston 1981-1984, L. Schleuter 1989, T. Schwab 1989	Johnston et al. 1981, von Ahlefeldt 1999, Sanderson 2000, Pollock 2001, Spackman et al. 2001, Colorado Natural Heritage Program 2005
2	Geneva Park 2 (Geneva Creek)	Park	Mount Evans	Pike National Forest South Platte Ranger District	None	10,000	2005	R. Gierisch 1970 (COLO), S. Spackman 2000	Sanderson 2000, Pollock 2001, Spackman et al. 2001
3	Long Gulch – A & B	Park	Topaz Mountain	Pike National Forest South Park Ranger District	None	10,020 to 10,070	2005	W. Weber 1966 (COLO), P. Lucas 1978, B. Johnston 1981-1984, L. Hendzel 1982, J. Von Ahlefeldt 1989, T. Schwab 1989, S. Howard 1997-2001, S. Spackman 2000	Johnston et al. 1981, Johnston and Hendzel 1982, von Ahlefeldt 1989, Sanderson 2000, Pollock 2001, Spackman et al. 2001
4	Twin Lakes	Lake?	Unknown	Unknown	Unknown	Unknown	1873	J. Wolf 1873 (NY)	Johnston et al. 1981, Pollock 2001
5	Buckskin Creek	Park	Alma	Possibly Pike National Forest South Park Ranger District; Possibly private land	None	11,100 to 11,500	1959	E. W. Stevens 1959 (COLO, CS)	Johnston et al. 1981, Sanderson 2000, Pollock 2001, Colorado Natural Heritage Program 2005
6	Monte Cristo Creek	Summit	Breckenridge	White River National Forest Dillon Ranger District	None1	1,800	2000	Price 1979 (COLO), B. Johnston 1981-1989, T. Schwab 1989, Powell 1996, S. Spackman 2000	Johnston et al. 1981, Johnston and Hendzel 1982
7	Lost Park Campground	Park	Topaz Mountain	Pike National Forest South Park Ranger District	Lost Park State Natural Area (Registered)	9,840	2005	Schubert 1954 (CS, COLO), B. Johnston & L. Hendzel 1982-1984, S. O'Kane 1984, J. Von Ahlefeldt 1989, T. Schwab 1989, E. Holt 1998, B. Madsen & S. Howard 1999-2000	Johnston and Hendzel 1982, von Ahlefeldt 1989, Sanderson 2000, Pollock 2001, Spackman et al. 2001
8	Lost Park – B (South Fork Lost Creek)	Park	Topaz Mountain	Pike National Forest South Park Ranger District	Lost Park State Natural Area (Registered)	10,100 to 10,300	1989	B. Johnston 1981-1982, S. O'Kane 1984 (RM)	Von Ahlefeldt 1989, Pollock 2001

Table 1 (cont.).

Site	Name	County	Quadrangle	Management/ Ownership	Special management area	Elevation (ft.)	Year last observed	Sources[1]	Publications and reports
9	East Lost Park	Park	Windy Peak	Pike National Forest South Park Ranger District	East Lost Park State Natural Area (Registered); Lost Creek Wilderness	9,720 to 9,840	2005	B. Johnston & L. Hendzel 1983-1984, O'Kane 1984 (RM), S. Spackman & A. Panjabi 2000	Von Ahlefeldt 1989, Cooper 1991, Sanderson 2000, Pollock 2001, Spackman et al. 2001, Lamb et al. 2003
10	Beaver Creek 1 (lower)	Park	Alma	Pike National Forest South Park Ranger District	None	10,440	2005	L. Hendzel 1983, D. Culver 2000	Sanderson 2000, Pollock 2001, Spackman et al. 2001, Colorado Natural Heritage Program 2005
11	Beaver Creek 2 (middle)	Park	Alma	Pike National Forest South Park Ranger District and private land	None	10,930 to 10,970	2005	B. Johnston 1983, S. Howard & B. Madsen 2000	Sanderson 2000, Pollock 2001, Spackman et al. 2001
12	Palmer Peak	Park	Como	Pike National Forest South Park Ranger District	None	11,600 to 12,000	1986	K. Marr 1986 (COLO)	Pollock 2001, Sanderson 2001
13	Hollthusen Gulch	Park	Como	Private land and Pike National Forest South Park Ranger District	None	9,800 to 10,300	1995?	Sanderson 1995	Sanderson and March 1996, Sanderson 2000, Pollock 2001, Spackman et al. 2001
14	Crooked Creek Spring	Park	Como	Pike National Forest South Park Ranger District and private land	None	9,800 to 10,200	2000	Sanderson and March 1996, S. Spackman 2000	Sanderson 2000, Spackman et al. 2001
15	Sacramento Creek 1	Park	Fairplay West	Private land and Pike National Forest South Park Ranger District	None	11,200	2000	T. Schwab 1989-1990	Sanderson 2000, Pollock 2001, Spackman et al. 2001
16	Little Sacramento Creek	Park	Fairplay West	Private land	None	10,400 to 11,600	2000	S. Spackman 2000	Sanderson 2000, Pollock 2001, Spackman et al. 2001

Table 1 (cont.).

Site	Name	County	Quadrangle	Management/ Ownership	Special management area	Elevation (ft.)	Year last observed	Sources[1]	Publications and reports
17	Little Sacramento Creek 2	Park	Fairplay West	Private land and Pike National Forest South Park Ranger District	None	10,230	2000	T. Schwab 1990, S. Spackman 2000	Sanderson 2000, Pollock 2001, Spackman et al. 2001
18	Warm Springs	Park	Fairplay West	Private land	The Nature Conservancy owns easement	9,980 to 10,300	2000	A. Carpenter 2000	Pollock 2001
20	Teller Mountain (Upper Hall Valley)	Park	Montezuma	Pike National Forest South Platte Ranger District and private land	None	11,500 to 11,900	1993	B. A. Siems 1993	Pollock 2001, Spackman et al. 2001
21	Abyss Trailhead	Park	Mount Evans	Pike National Forest South Platte Ranger District	None	9,600 to 9,640	2000	P. Murphy & N. Lederer 1995, S. Spackman 2000	Colorado Natural Heritage Program 2005
22	Farish Recreation Area	El Paso	Palmer Lake	U.S. Air Force Academy and Pike National Forest Pikes Peak Ranger District	None	9,100	2001	P. Murphy 1991 (COLO), Weber 1993 (COCO, COLO), Ellingson 1993 (COLO), D. Anderson & others 2000	Culver 2004, Pollock 2001
24	High Creek Fen	Park	Garo	Private land	Owned by The Nature Conservancy; High Creek Fen State Natural Area (Designated)	9,180 to 9,320	± 2002	N. Lederer & others 1996 (COLO)	Cooper 1991, Cooper 1996, Sanderson and March 1996, Pollock 2001, Spackman et al. 2001
25	South Fork South Platte	Park	Jones Hill	Private land	None	9,440 to 9,510	2000	D. Culver 2000	Pollock 2001, Spackman et al. 2001
26	(North) Tarryall Creek	Park	Milligan Lakes	Private land	None	9,300 to 9,700	1990+	D. Cooper 1990 (COLO)	Pollock 2001, Sanderson 2001
27	Fremont's Fen (Michigan Creek Fen)	Park	Milligan Lakes	Private land and State of Colorado land	Part in Michigan Creek–Teter State Wildlife Area	9,500 to 9,800	1995+	Von Ahlefeldt 1989, D. Cooper 1989 (COLO, RM)	von Ahlefeldt 1989, Sanderson 2000, Pollock 2001, Spackman et al. 2001

Table 1 (concluded).

Site	Name	County	Quadrangle	Management/ Ownership	Special management area	Elevation (ft.)	Year last observed	Sources[1]	Publications and reports
28	South Jefferson (Creek)	Park	Milligan Lakes	Private land	None	9,400 to 9,500	1995+		Sanderson 2000, Pollock 2001, Spackman et al. 2001
29	Wahl Ranch (Silverheels Ranch House)	Park	Jefferson	Private land	Conservation easement pending	9,420 to 10,200	2000	D. Cooper 1990 (COLO), Sanderson and March 1996	Sanderson 2000, Pollock 2001, Spackman et al. 2001
30	Old House (Creek)	Park	Observatory Rock	Pike National Forest South Park Ranger District	None	9,350 to 9,400	2005	V. Branch & S. Lamb 2005	
31	Geneva Creek W5	Park	Mount Evans	Pike National Forest South Platte Ranger District	None	9,860 to 9,930	2005	D. Bathke 2004 (S. Platte)	Bathke 2005

[1]Numbers are the dates of study or specimen collection. Herbarium specimens are denoted by citation of the herbarium in parenthesis. Abbreviations for herbaria:

COCO – Colorado College, Colorado Springs.

COLO – University of Colorado, Boulder.

CS – Colorado State University, Fort Collins.

NY – New York Botanic Garden, Bronx.

RM – Rocky Mountain Herbarium, University of Wyoming, Laramie.

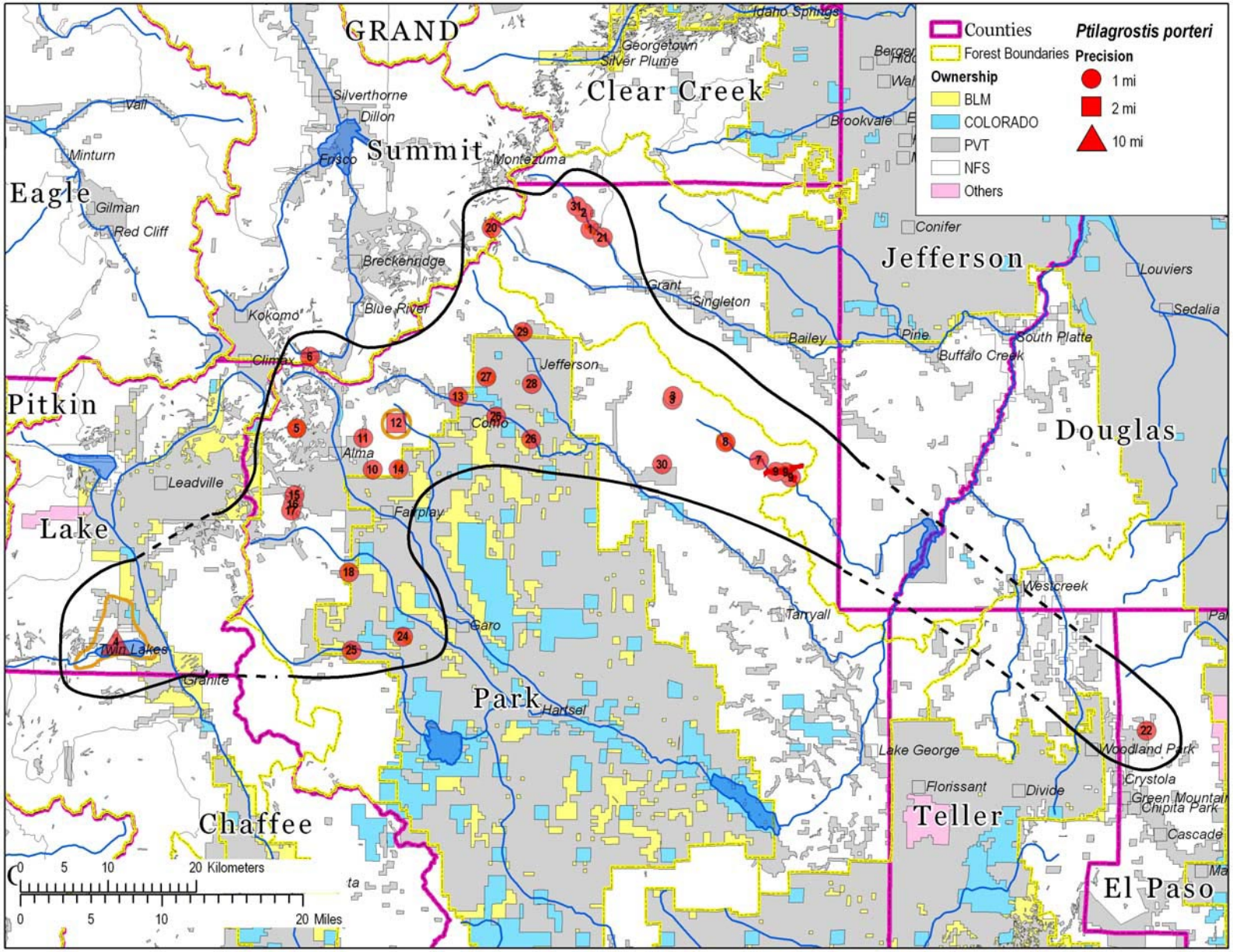

Figure 2. The total worldwide distribution of *Ptilagrostis porteri* encompassing northern South Park and surrounding areas (Sanderson and March 1996, Spackman and others 1999, Spackman and others 2001, Colorado Natural Heritage Program 2005b, Branch 2006). The triangle in the lower left of the distribution represents the old Twin Lakes record, not precisely known. Numbers in the symbols refer to dot numbers in **Table 1** and **Table 2**.

wetlands, and other bodies of water from detrimental changes" (Public Law 94-588, section 6(g)). These are implemented through the Forest Service Manual, in which one objective is "to minimize destruction, loss, and degradation of wetlands," a quotation from the presidential executive order, and a policy is to "preserve and, where needed and feasible both economically and technically, enhance the natural and beneficial function and values of wetlands" (USDA Forest Service 2004).

In USFS Region 2, wetlands are also protected by the Watershed Conservation Practices Handbook (USDA Forest Service 1996b). Many sections of this handbook apply to wetlands, including fens. A few of the more important relevant sections are excerpted below.

- ❖ allow no action that will cause long-term change away from desired condition in any riparian or wetland vegetation community; in degraded systems, progress toward desired condition within the next plan period
- ❖ locate new concentrated-use sites outside wetlands always
- ❖ maintain long-term ground cover, soil structure, water budgets, and flow patterns of wetlands to sustain their ecological function
- ❖ avoid long-term reduction in organic ground cover and organic soil layers in any wetland, including peat in fens
- ❖ avoid any loss of rare wetlands such as fens since they cannot be replaced in-kind.

The Watershed Conservation Practices Handbook is incorporated into all Forest Plans, and it will be incorporated into the upcoming Forest Plan for the Pike and San Isabel National Forests.

Ptilagrostis porteri is not included on the National Wetland Plant List (U.S. Fish and Wildlife Service 1996), but the Californian species *P. kingii* is rated as "Facultative Upland – Usually occurs in non-wetlands (34%-68%) but occasionally found in wetlands (1%-33%)" (USDA Natural Resources Conservation Service 2004). What is known about the habitats of *P. porteri* leads to it being classed "Facultative Wetland – Usually occurs in wetlands (67%-99%) but occasionally found in non-wetlands."

In its occurrences on National Forest System lands, *Ptilagrostis porteri* is a sensitive species, and it has been ever since the Rocky Mountain Region's Sensitive Species List was first made. This means that a Biological Evaluation must be written for every USFS action for which environmental analysis is required under the National Environmental Policy Act, if the proposed activity might occur in or near *P. porteri* habitats or might potentially impact its populations or individual plants (USDA Forest Service 2005).

The largest population of *Ptilagrostis porteri* (East Lost Park) is within the Lost Creek Wilderness, which is protected from timber harvest and incursion by motorized or mechanized vehicles (USDA Forest Service 1983). It will be considered for Research Natural Area or Special Area status in the upcoming Forest Plan for the Pike and San Isabel National Forests.

In Colorado, a state-designated natural area is an area where a voluntary agreement has been developed between the State of Colorado and landowners to protect the area (Colorado Natural Areas Program 2006a). The only designated Colorado state natural area that contains a population of *Ptilagrostis porteri* is High Creek Fen, which is privately owned by The Nature Conservancy (Spackman et al. 2001, Colorado Natural Areas Program 2006b). This natural area contains one of the smallest populations of this species (**Appendix A**).

The Lost Park Campground and East Lost Park populations of *Ptilagrostis porteri* are within the East Lost Park Natural Area, and the Lost Park-B population is within the Lost Park Natural Area. Both of these are registered state natural areas, which means that the area is on a list, but it does not have a cooperative management agreement and the boundaries have not been agreed upon (Colorado Natural Areas Program 2006). The three Sacramento populations, which are mostly on National Forest System lands, are within an identified state natural area, which means that the area shows potential but has not been fully inventoried for natural area status. These potential and proposed state natural areas may be considered for further status by the Pike and San Isabel National Forests next year during the upcoming Forest Plan revision process.

Most populations of *Ptilagrostis porteri* in Park County (including all of the largest populations) are components within potential conservation areas described and recommended in Spackman et al. (2001).

In fact, this species is a major feature of their report. Many of these potential conservation areas are large, typically including much more area than occupied by *P. porteri* populations. While potential conservation areas carry no legal or management requirements or obligations, they are the scientific best estimate of areas that would contain all important occurrences, processes, and functions necessary to maintain the values for which the site is designated (Spackman et al. 2001).

The South Park Wetlands Focus Area Committee, a cooperative program sponsored by the Colorado Division of Wildlife, has received grants and made significant progress in recent years in acquiring conservation easements on more than twenty private land parcels in South Park (Leutzinger 2004). There is at least one *Ptilagrostis porteri* site on their list, which reportedly has a conservation easement, and a process is in place to develop a management agreement for protection of the *P. porteri* population there. One site on private lands, Wahl Ranch, has reportedly been purchased by Colorado Open Lands, and a process is in place to protect it using a conservation easement.

Existing regulatory mechanisms that apply to National Forest System lands appear adequate to conserve the species on those lands, especially the protection given to the wetland habitats of *Ptilagrostis porteri* in the National Forest Management Act, Presidential executive order, regional Watershed Conservation Practices Handbook (with special protection for fens), forest plans, grazing management plans, and road reconstruction plans. Enforcement of these protections also appears to be adequate on National Forest System lands. A similar situation for protection of wetlands appears to apply to the site on U.S. Air Force property.

The adequacy of existing regulatory mechanisms for the conservation of *Ptilagrostis porteri* on private and State of Colorado lands is questionable, given the current uncertainty at this time about the application of Clean Water Act to the protection of wetlands. However, it is likely that the resolution of this uncertainty will still afford some protection of wetlands – and especially fens, which have scientific and regulatory agreement about their unique and irreplaceable character (Hartman 1999).

Aside from the protection of *Ptilagrostis porteri* wetland habitats as discussed above, its populations are not currently protected on private, State of Colorado, or U.S. Air Force lands, except in the few private-land sites where land has been purchased or easements obtained specifically to protect *P. porteri*.

On private and state lands, many thousands of *Ptilagrostis porteri* plants and much habitat have been lost in the past as a result of peat mining and hydrological alterations (Sanderson 2004). Either regulations or enforcement of those regulations were wanting. It is uncertain whether the current regulatory mechanisms are sufficient to conserve *P. porteri* on private and state lands, but enforcement of those regulatory mechanisms is probably not adequate.

Biology and Ecology

Classification and description

Ptilagrostis porteri (Rydberg) W.A. Weber is in the family Poaceae (also called Gramineae, the Grass Family). There are 15 to 20 taxa in the genus *Ptilagrostis*, with ten in China (Peterson et al. 2005), six to eight in the nations of the former Soviet Union (Tsvelev 1984, Czerepanov 1995, Watson and Dallwitz 2005), two to three in the Himalayas (Freitag 1985), and two in North America (Barkworth 1983, Peterson et al. 2005). *Ptilagrostis porteri* is the only species of the genus in Colorado or the Rocky Mountains.

In a revision of North American *Ptilagrostis* in 1983, Mary Barkworth decided that this taxon was properly a subspecies of *P. mongholica* (Barkworth 1983). Barkworth was apparently unaware of the contracted-panicle form of *P. porteri*, because she described the species as if *P. porteri* were entirely with open panicles (**Figure 3**). This led her to attach *porteri* to the open-panicle species *P. mongholica* of eastern Siberia, Mongolia, and northeastern China. Some older treatments report it as *P. mongholica* ssp. *porteri* following Barkworth (1983). However, William A. Weber, who is familiar with both species, says that they are "amply distinct both morphologically and ecologically" (Weber 1983, 2003). *Ptilagrostis mongholica* is a species of rocky sites, mountain grasslands, and alpine meadows (Tsvelev 1984, Neuffer et al. 2003), whereas *P. porteri* is restricted to montane fens and willow carrs.

There are other *Ptilagrostis* species in central and eastern Asia that are closely related to *P. porteri*, and this close relationship has long fascinated phytogeographers (Weber 1965, Major 1975a, 1975b, 1977, Axelrod and Raven 1985, Weber 2003). Recent studies would place the contracted-panicle form of *P.*

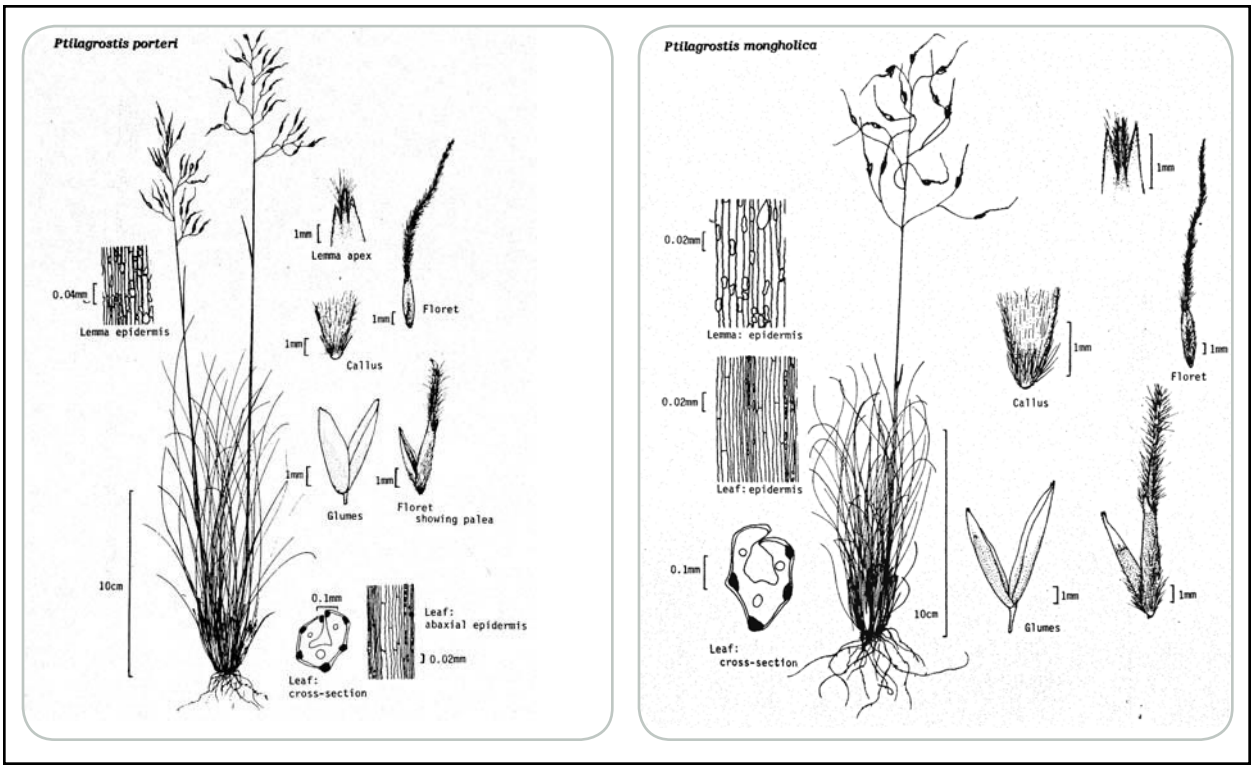

Figure 3. The open-panicle form of *Pilagrostis porteri*, left, contrasted with *P. mongholica*, right (Barkworth 1983). Used with permission.

porteri closest to *P. concinna* (Hooker *fils*) Roshevits of Pamir, Tienshan, and the Himalayas; or to its close relative, *P. schischkinii* (Tsvelev) Czerepanov of Mongolia, the Altai, and eastern Siberia (Fedchenko 1918). The open-panicle form of *P. porteri* was initially thought to be closer to *P. alpina* (Schmidt) Siplivinski of Okhotsk, northeastern China, and northern Japan (Yurtsev 1970), but recent treatments place it closer to *P. minutiflora* (Titov) Czerepanov of northeastern Asia (Barkworth 1983, Tsvelev 1984, Freitag 1985, Weber 2003, Peterson et al. 2005).

The other North American member of this genus, *Ptilagrostis kingii* (Bolander) Barkworth, differs in several characters from *P. porteri*, including length of the awn and length of the plumose hairs on the awn. While *P. kingii* sometimes occurs in similar habitats as *P. porteri* (Sawyer and Keeler-Wolf 2000), habitats for *P. kingii* in California apparently do not include fens (Ratliff 1982). See "Habitats of related species" below.

Ptilagrostis porteri is often known as Porter's feathergrass (Colorado Natural Heritage Program 2005a), but it also goes by Porter's false needlegrass (USDA Natural Resources Conservation Service 2005) or Porter's needlegrass.

Ptilagrostis porteri is a "perennial bunchgrass with stems 20-50 cm tall; the leaves are mostly basal, 2-12 cm long, fine and very narrow; the terminal panicle is about 6-10 cm long; spikelets are single-flowered, resembling the needlegrasses, [but with] a feathery (long-hairy) awn 1.2-2.5 cm long" (Johnston et al. 1981, see also Barkworth 1983).

Technical description of Ptilagrostis porteri (Rydberg) W.A. Weber

Culms 20 to 50 cm tall. Leaf blades 2 to 20 cm long, 0.3 to 0.5 mm wide, involute, subfiliform, sulcate, scaberulous; ligule 1.8 to 3 mm long, obscure, truncate to acute. Panicle mostly 5 to 12 cm long, open with flexuous panicle branches or contracted with the panicle branches ascending to erect; panicle branches glabrous, filiform, few-flowered. Spikelets 4.5 to 6 mm long. Glumes hyaline, 4.5 to 6 mm long. Anthers 1.2 to 2.0 mm long, glabrous. Lemma 2.5 to 3.8 mm long, oblong-elliptic, softly pilose on the lower half, scaberulous above, lobed at summit; awn persistent, 12 to 23 mm long, plumose the whole length with hairs 1 to 2 mm long, with a single 40 to 45° bend one-third from the base, the first segment weakly twisted. Chromosomes probably 2n = 22 (Hitchcock and Chase

1950, Harrington 1954, Johnston et al. 1981, Barkworth 1983, Sanderson and March 1996, Watson and Dallwitz 2005, Peterson et al. 2005).

Some populations of *Ptilagrostis porteri* have open panicles, but other populations of *P. porteri* have contracted panicles, as demonstrated in **Figure 4** and **Figure 5**. In some populations the two forms are mixed (Johnston and Hendzel 1982, von Ahlefeldt 1999). Some populations (for example, Beaver Creek) are predominantly contracted-panicle plants, with a few (5 to 10 percent) with open panicles. Other populations (e.g., Long Draw) have predominantly open panicles. So far, no populations have been found that have close to an equal proportion of open and contracted panicles. The presence of both open and contracted panicles in the same populations of *P. porteri* (**Figure 4** and **Figure 5**) is a subject for discussion since this character is often used to distinguish species in *Ptilagrostis* and other grass genera (Hitchcock and Chase 1950, Tsvelev 1984, Peterson et al. 2005).

Ptilagrostis porteri can be very difficult to locate when flowering culms are absent, as the plants have shorter leaves and culms than most of the grasses and sedges with which it grows, and some of its associates have narrow leaves as well. Vegetatively, it could be confused with a fescue, especially *Festuca idahoensis* or *F. arizonica* (Weber and Wittmann 2001b), both of which can occur on nearby upland slopes. While these fescues generally have longer, stiffer leaves and usually occur in drier habitats, in the drought of the last few years, some of the hummocks that provide habitat for *P. porteri* have dried somewhat and we see a few *F. arizonica* or *F. idahoensis* plants on the hummocks, usually on the drier edge of the wetland. *Ptilagrostis porteri* superficially resembles species of *Stipa* and *Achnatherum* (a genus recently segregated from *Stipa*). However, like other members of its genus, *P. porteri* has plumose awns, whereas most *Stipa* and *Achnatherum* do not have plumose awns (Fedchenko 1918, Johnston and Hendzel 1982, Tsvelev 1984, von Ahlefeldt 1999, Weber and Wittmann 2001b). *Ptilagrostis* in North America can also be distinguished from *Stipa* and other genera by its hairlike leaf blades, flat palea apex, and wet habitat (Barkworth 1990, Watson and Dallwitz 2005).

In flower in its native habitat, *Ptilagrostis porteri* cannot be confused with anything else, notwithstanding that it can be difficult to spot because of the abundance of vegetation with which it grows (Sanderson and March 1996).

Figure 4. Contrasting the open panicle form (left) with the closed panicle form (right) of *Ptilagrostis porteri*. Both forms are sometimes found in the same population. Photos by the author, August 13, 1981.

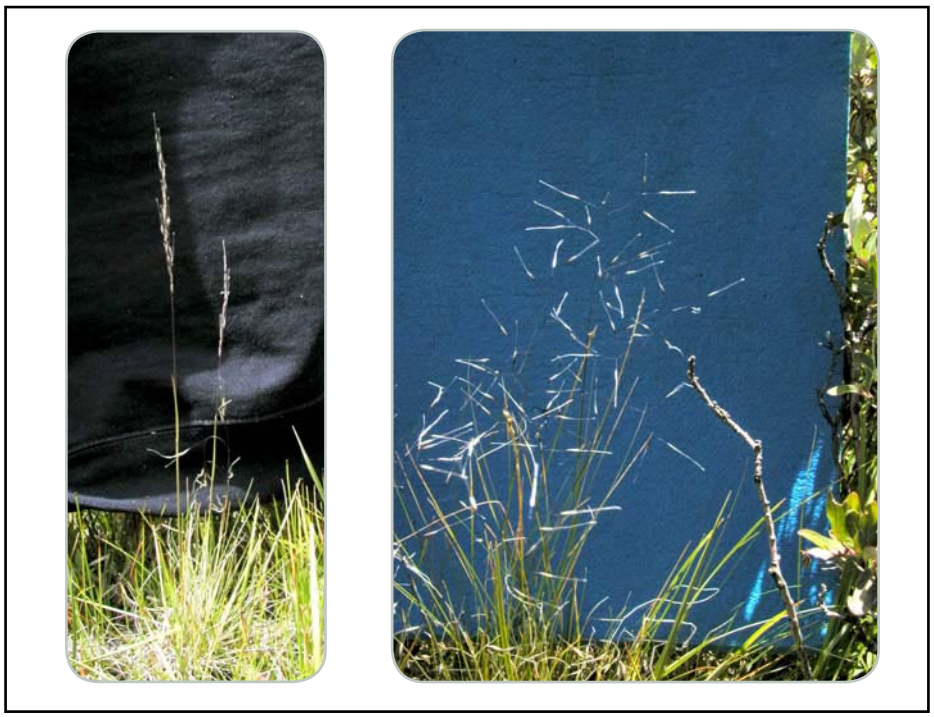

Figure 5. Comparing the closed-panicle (left) and open-panicle forms (right) of *Ptilagrostis porteri*. Both photos by the author from the same population, August 2004.

To locate *Ptilagrostis porteri* in a new or unfamiliar site, having the culms back-lit is a considerable help (**Figure 6** and **Figure 7**). Having walked across a potential site one way, a surveyor should walk back the other way, and when counting plants in a population, one should carefully sharpen your search image and maintain concentration, or large segments of the population may be missed. Undoubtedly, these factors have been responsible for much of the variation in population sizes reported in the data. Most reported population numbers are probably underestimates because the observer likely missed some flowering plants that were especially obscure in their surroundings, and likely missed vegetative plants as well.

Figure 6. *Ptilagrostis porteri* in typical habitat, *Salix planifolia* (planeleaf willow) carrs. The panicles of *P. porteri* are visible as white spikes against the darker willows in the middle ground, only visible in this picture because they are back-lit by the sun. Photo by the author, October 4, 1982.

Figure 7. A closer view of *Ptilagrostis porteri*, again back-lit by the sun. Photo by the author, October 4, 1982.

History of Ptilagrostis porteri in the Rocky Mountains

Ptilagrostis porteri was first collected in 1862 by Charles C. Parry, and by Elihu Hall and J. P. Harbour, somewhere in central Colorado. It was collected again by George Vasey in 1868 as part of Powell's Expedition, and by John Wolf (1820-1897, sometimes spelled *Wolfe*) in 1873 as part of Wheeler's Expedition (Harvard University Herbaria 2005). These collections were all identified by George Thurber, an associate of Asa Gray, as *Stipa mongolica* (Porter and Coulter 1874; **Appendix B**). In 1905, Per Axel Rydberg recognized that it was a new species, and so he named it *S. porteri* in honor of the first person to describe it, Thomas C. Porter (Rydberg 1905). William A. Weber transferred the species to the Asiatic genus *Ptilagrostis* (Weber 1966).

The site(s) from which the 1862 Parry collections and 1862 Hall and Harbour collections was taken is unknown. After the Wolf collection at Twin Lakes in 1873, *Ptilagrostis porteri* was apparently not collected again until Morris Schubert discovered the Lost Park Campground population in 1955, and Ralph Gierisch of the USFS discovered the Geneva Park populations in the late 1950s. E. W. Stevens collected *P. porteri* in Buckskin Creek above Alma in 1959; this population has not been re-located. William A. Weber of the University of Colorado studied the Long Gulch and Lost Park populations beginning in 1966. Robert Price discovered the small Summit County (Monte Cristo Creek) population while researching *Draba* populations in 1979.

In 1981, Barry Johnston of the USFS, Scott Peterson of the Colorado Natural Heritage Program, and William Harmon of the University of Northern Colorado began a study of the populations of *Ptilagrostis porteri*, which was continued by Barry Johnston and Leonard Hendzel of the USFS from 1982 through 1984. They further investigated most of the then-known populations and discovered several new sites, including two sites in Beaver Creek above Fairplay and the largest known *P. porteri* population in East Lost Park, which was discovered in 1983 and inventoried in 1984 (Johnston 2004).

Until 1989, all of the known sites for *Ptilagrostis porteri* were in the mountains around South Park, and almost all occurrences of this species were in willow carrs. Then in 1989 and 1990, David Cooper of Colorado State University conducted a wetland inventory of South Park and discovered a number of sites for *P. porteri* in the floor and margins of this large high-elevation mountain park (Cooper 1991). Some of these sites were associated with an ecological type new to Colorado, the extreme rich fen (Cooper 1996,

Sanderson and March 1996, Vitt 2000). Cooper's studies in South Park were continued and expanded by John Sanderson of the Colorado Natural Heritage Program and later Cooper's student (Sanderson and March 1996), and by Susan Spackman and her associates at the Colorado Natural Heritage Program (Spackman et al. 2001). While a few of the occurrences of *P. porteri* in the bottom of South Park investigated by Cooper, Sanderson, and Spackman were associated with willows, most were in fen complexes (Sanderson and March 1996, Spackman et al. 2001).

In 1991, Pat Murphy discovered the populations at Farish Recreation Area, a part of the U.S. Air Force Academy, in northwestern El Paso County.

In the middle 1990s, the USFS began monitoring select populations of *Ptilagrostis porteri* on National Forest System lands, and this resulted in the discovery of two new sites on the South Park District (Holt and Howard 1998, Olson et al. 2003, Howard 2002, Bohon 2005, Lamb 2005). In 2004 and 2005, Dave Bathke discovered and described a new site in upper Geneva Creek, on the South Platte Ranger District (Bathke 2005).

Distribution and abundance

Ptilagrostis porteri is known only from Park, Summit, El Paso, and possibly Lake, counties in central Colorado (**Figure 2**). Almost all of the sites are in northern and west-central Park County. There is one small site in adjacent Summit County. One occurrence is on U.S. Air Force Academy property in northwestern El Paso County. This site is somewhat disjunct from the main range of the species, separated by land where the species has not been documented but where few searches have been conducted (**Figure 2**). The Lake County site, also disjunct from the species' main range, is represented by an old 1873 collection from Twin Lakes. However, the population there has not been rediscovered despite several limited searches in recent years; perhaps the species has been eliminated from Lake County. It is worth noting that in 1873, Lake County included present-day Chaffee, Gunnison, and Pitkin counties (Stanwyck 2003). Perhaps the specimen was collected somewhere other than the present Lake County, but Twin Lakes was a well-known location in 1873 as it is now.

There are 29 known sites for *Ptilagrostis porteri* (**Table 1**). Of these, 26 have extant *P. porteri* populations according to recent studies. Three sites are of unknown status, represented by herbarium specimens without recent population rediscovery or study. One of the herbarium sites (Twin Lakes) may have been extirpated; ownership of this site is unknown because we do not know how far Dr. Wolf was from Twin Lakes when he collected the plants there in 1873. Of the 28 sites for which we know the land ownership, 15 are completely on National Forest System lands, five are partly on National Forest and partly on private lands, one is partly on National Forest and partly on U. S. Air Force Academy lands, and seven are on private and/or State of Colorado lands (**Table 1** and **Table 2**). Most of the populations on National Forest System lands are documented with herbarium specimens, and many of the populations on private lands have documenting herbarium specimens as well (**Table 1**).

The vast majority (over 95 percent) of the plants of *Ptilagrostis porteri* that have been seen are in one large occurrence, in East Lost Park (**Table 3**; **Appendix A**). The number of plants in this population was systematically estimated at 397,800 individuals by the author and Leonard Hendzel in October 1984, using eight belt transects across this 355 acre site. Two of these belt transects were re-read in August 2004 by the author, and both had an average of 40 percent more plants than 20 years earlier, indicating that the population is now likely over 400,000 individuals (Johnston 2004).

Table 2. Sizes of *Ptilagrostis porteri* sites and populations sorted by ownership.

		Elevation (ft.)			Area (acres)			Population count		
Ownership	**Number of site**	**Min.**	**Ave.**	**Max.**	**Min.**	**Ave.**	**Max.**	**Min.**	**Ave.**	**Max.**
Unknown	1									
USDA Forest Service (USFS)	15	9,600	10,332	12,000	2	38	355	20	31,310	397,000
Part USFS and part private	6	9,100	10,500	11,900	2	29	86	24	184	650
Private*	7	9,180	9,611	10,300	46	165	353	6	1,109	5,000
TOTAL	29									

*Part State of Colorado in one case.

Table 3. Most recent reliable population estimates of *Ptilagrostis porteri* at known sites. There are no numbers 19 or 23. See **Appendix A** for more details.

Site	Name	Acres	Individuals	Density (individuals per acre)
1	Geneva Park 1	58	820	14.1
2	Geneva Park 2 (Geneva Creek)	2	100	50.0
3	Long Gulch – A & B	14	535	38.2
5	Buckskin Creek	Unknown	Unknown	Unknown
6	Monte Cristo Creek	7	20	2.9
7	Lost Park Campground	15	1,500	100.0
8	Lost Park – B (South Fork Lost Creek)	7	2,110	301.4
9	East Lost Park	355	397,000[†]	1,241.8
10	Beaver Creek 1 (lower)	2	90	45.0
11	Beaver Creek 2 (middle)	3	650	216.7
12	Palmer Peak	Unknown	Unknown	Unknown
13	Hollthusen Gulch	86	100	1.2
14	Crooked Creek Spring	2	100	50.0
15	Sacramento Creek 1	72	200	2.8
16	Little Sacramento Creek	2	3,000	1,500.0
17	Little Sacramento Creek 2	8	1,000	125.0
18	Warm Springs	46	6	0.1
20	Teller Mountain (Upper Hall Valley)	8	30	3.8
21	Abyss Trailhead	10	500	50.0
22	Farish Recreation Area	2	24	12.0
24	High Creek Fen	235	6	0.0
25	South Fork South Platte	77	250	0.0
26	(North) Tarryall Creek	123	1,000	8.1
27	Fremont's Fen (Michigan Creek Fen)	353	5,000	14.2
28	South Jefferson (Creek)	112	1,000	8.9
29	Wahl Ranch	208	500	2.4
30	Old House (Creek)	3		100.0
31	Geneva Creek W5	8	50	6.6
	AVERAGES	70	15,996	145.0
	TOTALS	1,818	415,891	

[†]Population measured using a systematic sampling method.

There are many more recorded individuals on National Forest System lands than on private lands. Population sizes are unknown at only two USFS sites (numbers 5 and 12 in **Table 1**). Except for the very large East Lost Park population, populations on National Forest System lands range from 20 to 3,000 individuals and average 910 individuals per population (**Table 2**). Looking at populations on all ownerships and excluding the East Lost Park population, populations range in size from six to 5,000 individuals and average 753 individuals per population.

There is much potential habitat within the known range of this species that has not been searched, on both public and private land. It is a reasonable presumption that with adequate surveys, this species will be found to occur elsewhere.

Population trend

Population sizes of *Ptilagrostis porteri* vary from very few (two to six) to 397,000 (**Table 3**, **Figure 8**; **Appendix A**). Methods for estimating and counting

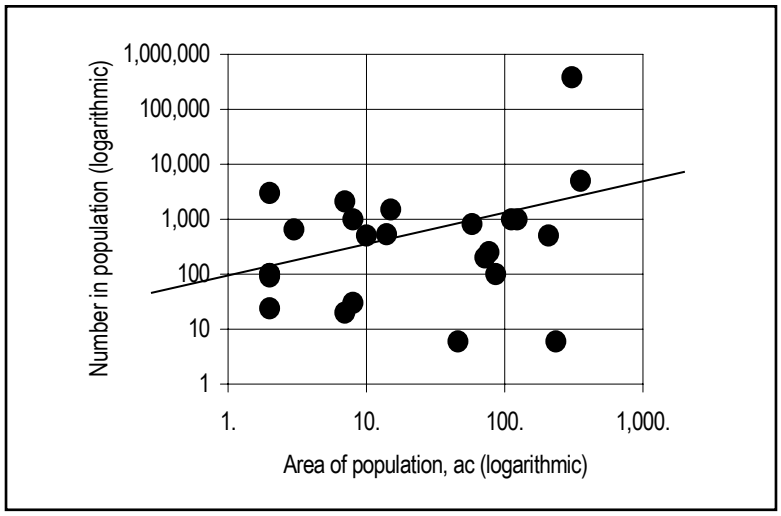

Figure 8. Population size as a function of population area for *Ptilagrostis porteri*. Data from **Table 1** and **Table 2**.

P. porteri populations have varied widely between observers (**Appendix A**), and estimated numbers are very different among different observers, even in the same week of the same year. Thus, most of the variation in population sizes at an individual site from year to year is likely to be due to differences between observers, and it is difficult to establish population trends with much certainty. An exception here is the East Lost Park population, the largest population, where a systematic method was used (Johnston 2004, Elzinga et al. 1998). The size of this population was estimated using standard methods in 1984. Eight strip transects 6 feet wide were paced in a straight line across the habitat at regular intervals, and plants were counted in each strip; the average number of plants per acre was calculated from the counts by strip, and then this was multiplied by the number of acres in the habitat. A partial re-reading of the transects in 2004 by the author indicated there had been no decline and a possible slight increase over those twenty years (Johnston 2004).

Populations of *Ptilagrostis porteri* at three Pike National Forest sites have been monitored since 1997 by personnel from the South Park Ranger District (**Table 4**). The trend appears to be stable even though numbers have varied from year to year. This variation may be explained in several ways:

- vegetative plants of *P. porteri* are difficult to distinguish from vegetative plants of other species
- there was no systematic system for counting vegetative *P. porteri* plants before 2003
- the methods used to count individuals in the plots varied somewhat from year to year
- the years from 1999 to 2003 were drought years in this area, with water tables much lower than normal

Table 4. Results from monitoring *Ptilagrostis porteri* populations at three sites on the South Park Ranger District of Pike National Forest (Howard 2002, Lamb et al. 2003, Olson et al. 2003).

		Plot Size	Total Number of Plants in Plot							Recent Population	Recent Population
Site	Name	(acres)	1997	1998	1999	2000	2001	2002	2003	Estimate	Estimate
3	Long Gulch – A & B	2.47	152	36‡	535		279	229	261	535	1999
7	Lost Park Campground	0.16		460			304*	354	673[a]	>1,500	1982
11	Beaver Creek 2 (middle)	0.12				±250	185*	147	329[b]	650	1983

‡Tried a new method; number clearly inaccurate (too low).

*Low estimate because too late in season to see many plants.

[a]Flowering 156, Non-flowering 517.

[b]Flowering 134, Non-flowering 195.

- ❖ the number of flowering culms apparently varies from year to year in response to unknown factors

- ❖ there was likely some variation among observers (Olson 2005).

In summary, the populations on National Forest System lands appear to be stable to slightly increasing, based on monitoring at four sites.

Populations on private lands apparently have not been monitored, formally or informally. Many private lands in the bottom of South Park have been subject to peat mining activities. In addition, many of these lands have altered hydrology – ditching or other drainage practices – designed to deliver more water to the large cities downstream. In areas where these practices have occurred, botanists have consistently found no *Ptilagrostis porteri* plants. Since both of these practices have occurred in what appears to have been *P. porteri* habitat, it is reasonable to assume that these practices have resulted in the decline or elimination of *P. porteri* populations, but this has apparently not been directly observed (Sanderson 2004).

Habitat

All *Ptilagrostis porteri* sites are poorly-drained wetlands, with wetland hydrology. Most sites are complexes of several different wetland patch types, some patches with organic or mostly-organic soil and some with mineral or mostly-mineral soil (**Figure 6**, **Figure 9**, **Figure 10**). If the predominant patch type (the matrix) is dominated by willows (*Salix* spp.; usually with mineral or mostly-mineral soil), then the site is often called a *willow carr* or *willow carr complex*, even though there may be organic-soil fens or other wetlands interspersed within the matrix (von Ahlefeldt 1999). A *willow carr* site "is typically found along the margins of peat aprons within the fen expanse and bordering upland rises" (Johnson and Steingraeber 2003). If the predominant patch type is a fen with organic or mostly-organic soil, the site may be called a *fen complex*, or a *mire* in the terminology of Johnson and Steingraeber (2003), even though there may be patches of mineral soil interspersed within the matrix. These "sites generally form an ecotone between the more hydric, peat-dominated areas and the mineral soil meadows, possessing either soil condition" (Johnson and Steingraeber 2003).

Ptilagrostis porteri plants often occur on the tops and sides of hummocks, where the soil surface is slightly less wet than in the areas between the hummocks, as in **Figure 11**. The areas between the hummocks are called *swales* by some scientists (Sanderson and March 1996, Spackman et al. 2001), and *hollows* by others (Cooper and MacDonald 2000). The hummocks tend to have *Dasiphora floribunda* and willows on them, usually short willows such as *Salix planifolia*, *S. brachycarpa*, or *S. candida*; sometimes also *Betula glandulosa* is also present (Johnston et al. 1981, Johnston and Hendzel 1982, Sanderson and March 1996, Cooper 1996, von Ahlefeldt 1999, Spackman et al. 2001, Bathke 2005). There are two different classes of *P. porteri* sites that arise from differences in the other plants that occur on the hummocks and the plant communities in the area between hummocks.

1. Sites in mountain areas, sometimes with gradient over 2 percent. Most of the *Ptilagrostis porteri* sites on National Forest System lands fall into this category. Dominating the hummocks is usually *Salix planifolia* or *Dasiphora floribunda*, often with *Betula glandulosa*. Between the hummocks, *Deschampsia cespitosa* is co-dominant with either *Carex aquatilis* or *C. utriculata* (Johnston et al. 1981, Johnston and Hendzel 1982, Johnston 2001, Bathke 2005, Colorado Natural Heritage Program 2005). The predominant patch type (the matrix) in these sites is willow carr. Some sites have small fens (1 to 5 m diameter) interspersed between the hummocks, but there are other sites where the area between the hummocks is less wet for some reason; *P. porteri* population size and health do not appear to differ between these sites. In these situations, *P. porteri* occurs most often on moderately-wet microsites, usually on the tops or upper sides of hummocks (Johnston et al. 1981, Johnston and Hendzel 1982, Center for Native Ecosystems et al. 2002). There does not appear to be a preferred aspect on the hummocks. These sites tend to be less often calcareous than those in South Park (class 2 below). pH at East Lost Park is 6.3- to .9, slightly acid to neutral, with a small amount of Calcium (Cooper 1991).

   The two associations represented in **Figure 11**, *Carex aquatilis* (*–C. utriculata*)*–Deschampsia cespitosa* and *Salix planifolia–Dasiphora floribunda*, are often found in different sites, continuously saturated fen and seasonally saturated willow carr, respectively; but these

Figure 9. Typical habitat for *Ptilagrostis porteri*. In the matrix of short-willow carr are patches of sedge-dominated fen. *Ptilagrostis porteri* plants are usually on the slightly-higher (a few cm) ground of the willows, or on the edges of the fen patches. Photo by the author, August 12, 2004.

Figure 10. Typical habitat for *Ptilagrostis porteri* (left), and a closer look (right). Habitat is apparently willow carr, rather than fen. The panicles of *P. porteri* are almost invisible, even against darker vegetation. Photos by the author, August 13, 1981.

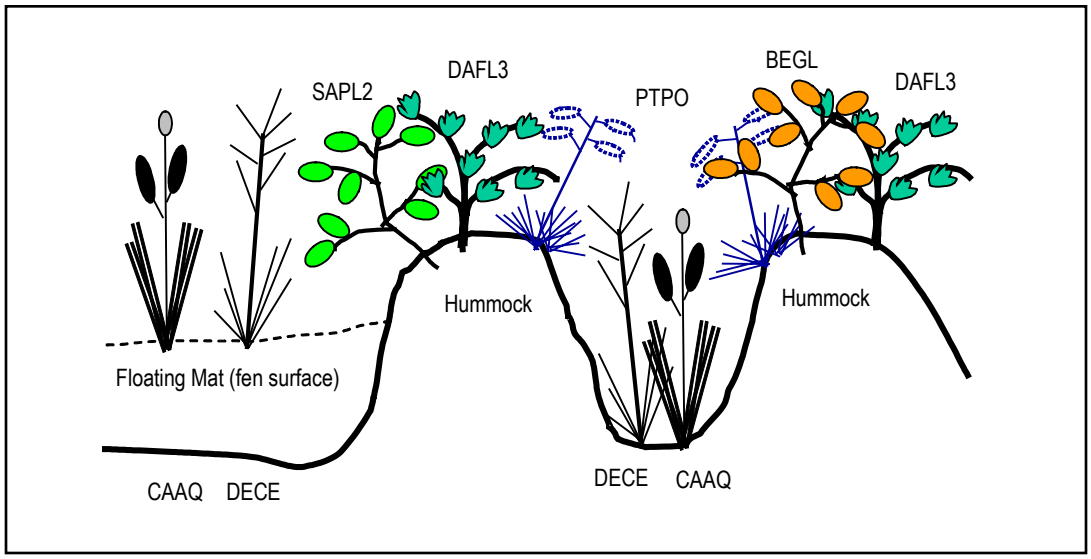

Figure 11. Microsite of *Ptilagrostis porteri*. Plant species codes are shown in **Table 5** and **Appendix F**.

different sites can be small, 1 to a few meters diameter. Sometimes, as at the Beaver Creek sites, most of the site is hummocked willow carr (right side of **Figure 11**), with small scattered patches saturated floating mat fen occasionally occurring 3 to 10 m wide (left side of **Figure 11**); *Ptilagrostis porteri* here occurs on the tops and sides of the hummocks, not in the fens. At other sites, for example Lost Park Campground or East Lost Park, the hummocks are still present, but they are not as visible because floating sedge mats have filled in the spaces between the hummocks. In either situation, *P. porteri* is never found on the continuously-saturated floating mat fen, but only on the seasonally-saturated, somewhat drier (less wet) hummock tops.

2. Sites in the bottom of South Park, gradient often less than 2 percent. Most of these *Ptilagrostis porteri* sites are on private land. As before, *P. porteri* occurs here on hummocks or drier margins of wetlands. The hummocks in these sites are dominated by *Salix candida*, *S. brachycarpa*, and *Dasiphora floribunda*. The associates on the hummocks are some of the same species as in the mountain class (*Carex aquatilis*, *Deschampsia cespitosa*, *Juncus arcticus*) but also include some unusual characteristic species (*C. scirpoidea*, *Kobresia simpliuscula*, *K. myosuroides*, *Primula incana*). Between the hummocks can be found species such as *Thalictrum alpinum*, *Trichophorum pumilum*, *C. microglochin*, and more *K. simpliuscula* or *K. myosuroides* (Cooper 1996, Johnson and Steingraeber 2003).

   The plant communities in some of these fens are unusual, even on a world scale. *Trichophorum pumilum–Kobresia simpliuscula* is very rare (Cooper 1996), as is *K. myosuroides–Thalictrum alpinum* as subalpine fen vegetation (Cooper and Sanderson 1997). *Kobresia myosuroides* and *T. alpinum* were thought to be restricted to the alpine zone before discovery of the extreme rich fens in South Park.

   The predominant patch type (the matrix) in these sites is fen, where peat has accumulated over a period of thousands of years (Cooper and MacDonald 2000). These sites usually have a higher proportion of fen to willow carr than the mountain sites. These sites are fen complexes with a minority of willow carrs or other mineral-soil wetlands (Johnson and Steingraeber 2003).

   These sites tend to be calcareous. Water pH is 6.4 to 7.8, neutral to moderately alkaline with much calcium (Cooper 1991, 1996, Johnson and Steingraeber 2003). These extreme rich, calcareous fens are not common in Colorado, being associated with valleys below deposits of limestone or dolomite, such deposits themselves being uncommon (Johnson and Steingraeber 2003). Some of the extreme rich fens in South Park do not have any *Ptilagrostis porteri*, and the site thought to be the best example of this fen type, High Creek Fen, has only a few plants of *P. porteri* (Spackman et al. 2001, Johnson and Steingraeber 2003, Colorado Natural Heritage Program 2005b). This indicates that an extreme rich fen itself may be outside the normal habitat range for *P. porteri*, but *P. porteri* instead occupies the fen margins or on hummocks within it.

   These sites have been subject to more peat mining than the mountain sites, probably because more of them are on private land.

There has been some discussion about the composition and origin of the hummocks that often form habitat for *Ptilagrostis porteri*. Ant mounds have been studied on hummocks in a fen complex in Montana, and these studies suggest "that the hummocks are abandoned ant mounds" (Lesica and Kannowski 1998). The hummocks examined are dominated by species such as *Dasiphora floribunda*, *Betula glandulosa*, and short willows, just as in the *P. porteri* hummocks in Colorado.

In some of the ecosystems in South Park, *Carex aquatilis* and *Deschampsia cespitosa* have helped to produce the hummock form (Johnson and Steingraeber 2003). The shrubs and grasses that live on the hummocks (including *Ptilagrostis porteri*) contribute to the hummocks' formation and maintenance because they trap much of the sediment that comes from above in seasons of high water, usually late winter and early spring. Judy von Ahlefeldt (1989) describes a situation at Fremont's Fen (Michigan Creek Fen) where *P. porteri* appears to have been instrumental in forming the hummocks on which it grows within the calcareous (pH

8) fen complex. There is also apparently some influence from frost heave action; ant mounds have not been seen at any *P. porteri* site (personal observation).

The hummocks have thin peat deposits (Cooper 1996) and much organic matter on them, but they also have rocky mineral soil in their cores, so it is uncertain to what extent *Ptilagrostis porteri* depends on peat mosses: it may not be dependent on mosses at all.

Mosses are also associated with the willow carr ecosystem in which *Ptilagrostis porteri* grows and the fen ecosystems adjacent to *P. porteri* habitats. Some of the fen microhabitats near *P. porteri* populations have very deep deposits of peat. Von Ahlefeldt (1989) reports that the peat deposits under the fen microhabitats in East Lost Park are up to 10 feet thick, indicating a possible age of 10,000 to 20,000 years (Cooper and MacDonald 2000).

Plants associated with *Ptilagrostis porteri* are listed in **Table 5**. The most common associate of *P. porteri* is *Dasiphora floribunda* (shrubby cinquefoil). Since *D. floribunda* often occurs in somewhat drier situations, this indicates that *P. porteri* is fundamentally a willow carr species.

Ptilagrostis porteri does not prefer shade. While it often occurs somewhat shaded by short *Salix* or *Dasiphora*, it seldom occurs in tall willow (more than 1 m tall) thickets (Sanderson and March 1996, von Ahlefeldt 1999). At some sites, *P. porteri* is associated with populations of other sensitive species, notably *Trichophorum pumilum*, *Salix candida*, *Carex livida*, *Eriophorum gracile*, and *Kobresia simpliuscula*. *Cylactis* (*Rubus*) *arctica* ssp. *acaulis* is associated with *P. porteri* at Geneva Park (Olson 2005).

Elevations of *Ptilagrostis porteri* sites range from 9,100 to 12,000 ft. (**Table 2**, **Figure 12**). Occurrences with the largest number of individuals (at least 1,000) are between 9,500 and 11,000 ft. in elevation (**Figure 12**); occurrences with more than 100 individuals range from 9,400 to 11,000 ft. in elevation. Occurrences covering the largest area (more than 100 acres) are between 9,200 and 9,800 ft. in elevation (**Figure 12**). There are no large occurrences (in area or numbers) at elevations below 9,200 ft. or above 11,200 ft.

Most *Ptilagrostis porteri* sites occur in bottom landscape positions with relatively low slope angle or stream gradient. All sites are clearly aggradational, that is, accumulating sediment and storing water by means of the dense plant material trapping sediment and water. Broadleaf willows and wetland sedges are widely known for their sediment-trapping and water-holding abilities. At most sites, some of the water comes from side drainages or springs just upslope.

Wetland hydrology is apparently necessary for the maintenance of *Ptilagrostis porteri* populations (Johnston et al. 1981, Johnston and Hendzel 1982, Sanderson and March 1996). Wetland hydrology is characterized by the following:

- a high water table during most if not all of the growing season
- water chemistry (pH, nutrients) that stays within narrow ranges of quality
- inflow to the wetland that follows a natural seasonal cycle, whether from stream flow, groundwater, or both.

The water-table height, chemistry, and quantity of groundwater is an essential component of the hydrology supporting *Ptilagrostis porteri* sites. Water tables are relatively high, but below the surface, for most of the growing season. Seasonal water tables for *P. porteri* sites vary from 3.1 to –10.4 cm (average –5.1 cm) in the short-willow carr ecosystem, and from –5.2 to –63.0 cm (average –37.6 cm) in the dry mire (Johnson and Steingraeber 2003). All of these sites receive most of their water in stream flow or ground water flow from higher in the drainage basin.

The high correlation of most sites with geological source material of limestone or limy shales (**Appendix D**, **Appendix E**) indicates that *Ptilagrostis porteri* may depend on water and soils that are somewhat alkaline (Sanderson and March 1996, von Ahlefeldt 1999, Johnson and Steingraeber 2003).

Precipitation at known sites ranges from 12 to 32 inches per year, with no apparent correlation between precipitation and population size (**Figure 13**).

Soils of *Ptilagrostis porteri* occurrences have predominantly been mapped as Cryaquolls, Cryoborolls, and Histosols (Moore 1992, Irvine 2004; **Appendix C**), which shows that the majority of sites is not the fen Histosol habitat, but rather the Cryaquoll–Cryoboroll willow carr habitat. For most sites, geology of limestone, limy shales, or limy sandstones is either present on the site or in the watershed just upstream of the site (**Appendix D**). Several sites have been documented as having calcareous substrates or somewhat basic pH.

Table 5. Plants associated with *Ptilagrostis porteri* (Johnston and Hendzel 1982, Sanderson and March 1996, von Ahlefeldt 1999, Colorado Natural Heritage Program 2005).

Common Associates:			
Scientific Name[1]	**Common Name(s)**	**Code**[2]	**Number of Sites Found**
Shrubs			
Betula glandulosa	bog birch	BEGL	12
Dasiphora floribunda	shrubby cinquefoil	DAFL3	18
Salix brachycarpa	barrenground willow, short-fruited willow	SABR	12
Salix candida	hoary willow, sageleaf willow	SACA4	8
Salix planifolia	planeleaf willow	SAPL2	16
Forbs			
Thalictrum alpinum	alpine meadow-rue	THAL	11
Graminoids			
Carex aquatilis	water sedge	CAAQ	9
Deschampsia cespitosa	tufted hairgrass	DECE	12
Kobresia myosuroides	Bellard's kobresia	KOMY	11
Moderately common associates:			
Scientific Name[1]	**Common Name(s)**	**Code**[2]	**Number of Sites Found**
Forbs			
Clementsia rhodantha	rose-crown, redpod stonecrop	CLRH2	5
Graminoids			
Agrostis spp.	bentgrass	AGROS2	5
Calamagrostis canadensis	bluejoint reedgrass	CACA4	5
Carex utriculata	beaked sedge	CAUT	5
Trichophorum pumilum	little bulrush, Rolland's bulrush	TRPU18	6
Uncommon associates:			
Scientific Name[1]	**Common Name(s)**	**Code**[2]	**Number of Sites Found**
Shrubs			
Salix geyeriana	Geyer willow, silver willow	SAGE2	2
Salix glauca	grayleaf willow, glaucous willow	SAGL	1
Salix monticola	serviceberry willow, park willow	SAMO2	3
Salix myrtillifolia	blueberry willow	SAMY	2
Forbs			
Armeria scabra	sea pink	ARSC	1
Cylactis arctica ssp. *acaulis*	dwarf raspberry, arctic raspberry	CYARA	1
Gentianodes algida	alpine gentian, whitish gentian	GEAL6	3
Geum macrophyllum	large-leaved avens	GEMA4	1
Lomatogonium rotatum	marsh felwort	LORO	1
Packera pauciflora	alpine groundsel	PAPA19	3
Parnassia parviflora	small-flowered grass-of-Parnassus, small-flower parnassia	PAPA9	1
Pedicularis groenlandica	elephant-head, elephanthead lousewort	PEGR2	1
Primula egaliksensis	Greenland primrose	PREG	3
Psychrophila leptosepala	marsh marigold	PSLE	1

Table 5 (concluded).

Scientific Name[1]	Common Name(s)	Code[2]	Number of Sites Found
Saussurea weberi	Weber's saw-wort	SAWE	3
Sisyrinchium pallidum	pale blue-eyed-grass	SIPA11	3
Graminoids			
Alopecurus aequalis	shortawn foxtail	ALAE	1
Carex aurea	golden sedge	CAAU3	1
Carex canescens	pale sedge, gray sedge, silvery sedge	CACA11	1
Carex capillaris	hair sedge	CACA12	1
Carex livida	livid sedge	CALI	3
Carex nebrascensis	Nebraska sedge	CANE	2
Carex pellita	woolly sedge	CAPE42	1
Carex rupestris	curly sedge	CARU3	2
Carex scirpoidea	northern singlespike sedge, western singlespike sedge	CASC10	3
Carex scopulorum	cliff sedge, mountain sedge	CASC12	1
Carex simulata	short-beaked sedge	CASI2	3
Carex spp.	sedge	CAREX	2
Eleocharis quinqueflora	few-flowered spike-rush, few-flowered spike-sedge	ELQU2	1
Eriophorum gracile	slender cottongrass	ERGR8	2
Festuca arizonica	Arizona fescue	FEAR2	1
Festuca brachyphylla	alpine fescue	FEBR	1
Festuca idahoensis	Idaho fescue	FEID	1
Juncus spp.	rush	JUNCU	3
Kobresia simpliuscula	Siberian bog sedge	KOSI	2
Luzula spicata	spike woodrush	LUSP4	1
Phleum commutatum	alpine timothy	PHCO9	2
Poa spp.	bluegrass	POA	1
Trisetum spicatum	spike trisetum	TRSP2	1

[1] Scientific names follow Weber and Wittmann (2001).

[2] Codes follow USDA Natural Resources Conservation Service (2005).

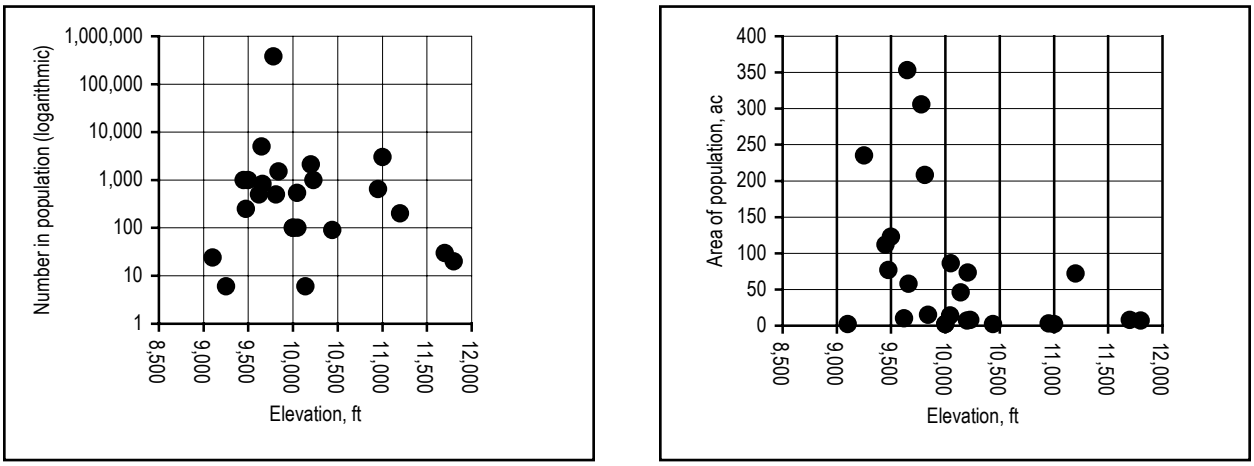

Figure 12. Population size (left) and area (right) as functions of elevation for *Ptilagrostis porteri*. Data from **Table 1** and **Table 2**.

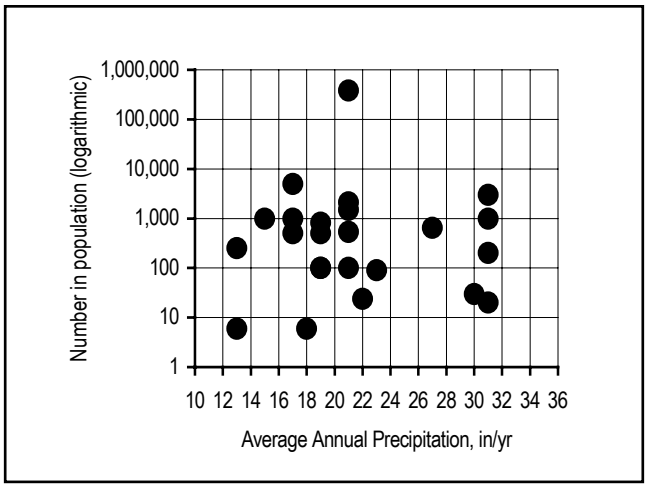

Figure 13. Precipitation versus size of population for *Ptilagrostis porteri* sites. Population sizes from **Table 2**, average annual precipitation from USDA Natural Resources Conservation Service 1998.

The contribution of these wetland sites to watershed function has been well known for some time (von Ahlefeldt 1989). In a healthy wetland site, beneficial watershed functions include trapping of sediment and providing for bank stability, which prevent excessive channel erosion or scour caused by a range of flood frequencies.

Habitats of related species

Ptilagrostis kingii occurs in seeps, wet meadows, dry meadows, and subalpine to alpine streambanks in the high mountains of central California, although habitats for this species apparently do not include fens (Ratliff 1982). *Ptilagrostis kingii* is reported to indicate middle to late seral conditions and is sensitive to heavy grazing; it is moderately shade-tolerant (Menke et al. 1997, Pacific Analytics 2001). Associated species are usually different than for *P. porteri*, but *P. kingii* can sometimes occur with *Dasiphora floribunda*, *Deschampsia cespitosa*, *Carex utriculata*, *Eleocharis* spp., or *C. scopulorum* (Sawyer and Keeler-Wolf 2000).

Among the species of *Ptilagrostis* in central and eastern Asia, *P. mongholica* inhabits rocky sites, mountain grasslands, and alpine meadows (Tsvelev 1984, Neuffer et al. 2003, Damiran 2005). It sometimes occurs in alpine meadows in Mongolia with species such as *Kobresia myosuroides*, *Aster alpinus*, *Bistorta vivipara*, and *Potentilla nivea*, and in *Festuca* mountain grasslands with species such as *Koeleria macrantha*, *Poa* spp., and *Artemisia* spp. (Erdenebaatar 2003). *Ptilagrostis minutiflora* from Okhotia and northeastern Asia inhabits "marshy meadows" (Tsvelev 1984), which may be similar to habitats for *P. porteri* in Colorado (Weber 2003). *Ptilagrostis concinna* of Pamir, Tienshan, and the Himalayas, inhabits alpine meadows and alpine mats at 3,200 to 4,600 m (10,550 to 15,100 ft.) with *Kobresia* spp., *Braya* spp., *Potentilla nivea*, *Saussurea* spp., *Thalictrum alpinum*, and *Festuca ovina* (Freitag 1985, Dickoré 2001, Xu et al. 2004a, 2004b, Yi et al. 2005), but it sometimes occurs in wet areas "with pool and hummock complex" in south-central China (Donoghue et al. no date). *Ptilagrostis schischkinii* of Mongolia, the Altai, and eastern Siberia, occurs on swales and stony slopes (Tsvelev 1984), which appears different from habitat for *P. porteri*.

Reproductive biology and autecology

Little is known about the reproduction, pollination, or genetics of *Ptilagrostis porteri*. The plants are perennial and herbaceous. They flower in early to late August, and their fruit matures between mid-August and early September (Johnston and Hendzel 1982). Fruit dispersal is by wind or by animal fur. Since the plumose awns are persistent on the fruit, the wind could possibly carry the fruit some distance. The plumose awns also would make the fruit adhere to animal fur. However, neither of these dispersal methods has been observed.

Growth and propagation requirements of *Ptilagrostis porteri* are not known, but they are known for the California species, *P. kingii* (Dyer 2001). The seeds of *P. kingii* are small, about 425,000 per pound (USDA Natural Resources Conservation Service 2005).

Demography

Three to four size classes of *Ptilagrostis porteri* have been documented at the larger occurrences. These include vegetative tuft, single tuft with one or two flowering stems, single tuft with more than two flowering stems, and multiple tufts with flowering stems. Different size classes suggest that populations are reproducing.

Other than those data, little is known about plant age or other demographic details of *Ptilagrostis porteri*. No demographic data have been collected that could be used in population or viability analyses. Seedlings have not been observed, and seeds have not been tested for viability. It is not known whether smaller, non-flowering plants are young plants or plants that simply did not flower that year for unknown reasons. Observations by the author over several years suggest that whether a given plant flowers in a given year depends on micro-environmental factors, but the nature of these factors is unknown.

As discussed above, much of the variation in population numbers from year to year is probably due to variation in observers. Nonetheless, it is evident that there are very small to small populations, medium-sized populations, large populations, and very large populations (**Table 3**, **Figure 8** and **Figure 12**). At most sites, population size appears to depend primarily on the extent and quality of habitat, rather than the effectiveness of dispersal or reproduction. The largest populations are in the largest extent of quality habitat, and the smallest populations are in the smallest extent of quality habitat.

Figure 14 is an outline of the hypothetical life cycle of *Ptilagrostis porteri*.

Community ecology

On National Forest System lands, most sites with *Ptilagrostis porteri* would be mapped as willow carrs, usually in the *Salix planifolia*/*Carex aquatilis* or *Salix brachycarpa*/*Carex aquatilis* plant association (Johnston 1987, Carsey et al. 2003a, 2003b). Most sites are very well vegetated, with three to four well-developed layers of vascular plants and mosses. Total live cover at sub-alpine sites is 200 to 300 percent. Between hummocks, there may be some saturated soil that does not appear to

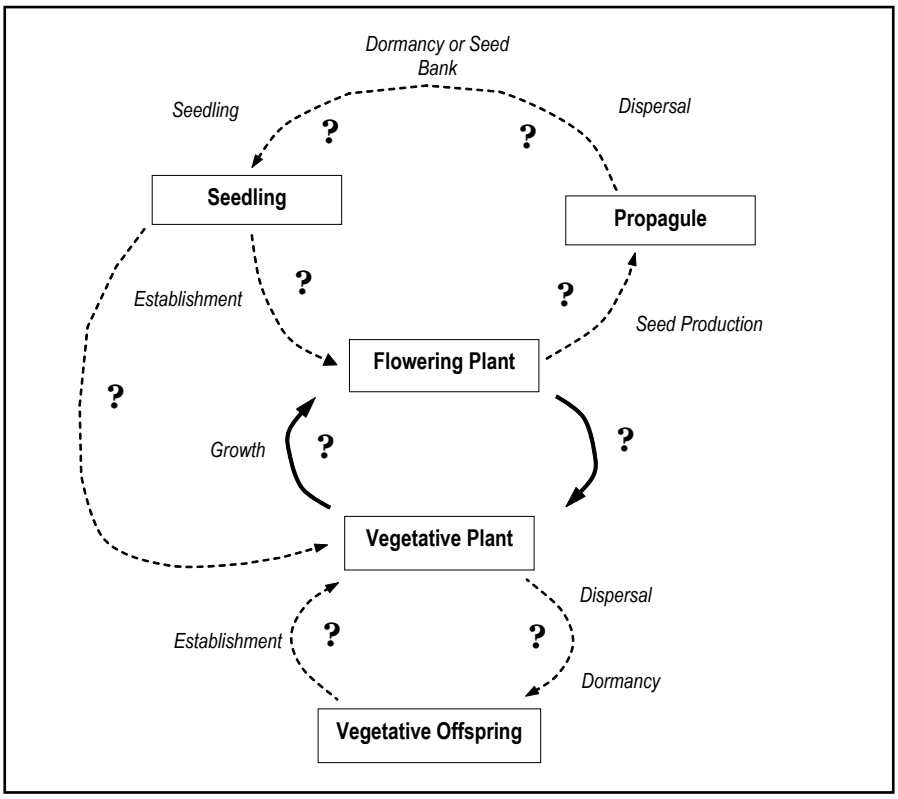

Figure 14. Hypothetical life cycle diagram of *Ptilagrostis porteri*. There is not sufficient information about this species to create a more specific diagram. Dotted lines indicate uncertain phases of the life cycle. Rates of growth, dispersal, and seed production are unknown (shown by "?"). After Grime 2002 and Beatty and others 2004.

be vegetated, at least at Geneva Park (Olson 2005), but in general there is usually no bare ground or cover of coarse fragments in *P. porteri* habitats.

Plant associations

Alpine *Ptilagrostis porteri* sites (those above timberline) have not been studied as much as sub-alpine sites, so we know much less about them. The plant associations to which these alpine sites belong is uncertain; perhaps it is *Carex scopulorum* / *Deschampsia cespitosa* (Johnston 1987). Total live cover at these sites is 150 to 200 percent. Some of the associated species in the alpine differ from those at lower-elevation sites (e.g., *Carex scopulorum* rather than *C. aquatilis*), but there is only one alpine site for which we have any floristic or habitat data. In general, alpine sites for any given species are smaller than those below timberline, and this likely is true for *P. porteri* (Eddleman 1962).

Herbivory

The plants of *Ptilagrostis porteri* are apparently not palatable to livestock (cattle and domestic sheep), or at most slightly palatable. Cattle have been observed to selectively graze sedges and other grasses before *P. porteri*, even in drought years; some botanists have hypothesized that this may give a competitive advantage to *P. porteri* (Holt and Howard 1998, Madsen 2004). Palatability is also apparently low when compared to wild herbivores. There have been a few reports of *P. porteri* plants lightly clipped by herbivores, but more often *P. porteri* is left alone even when herbivores are obviously present and nearby plants of other species have been grazed (Madsen 2004). Several associates of *P. porteri* that are more palatable and are preferred by herbivores, especially *Deschampsia cespitosa*, *Carex aquatilis*, and *C. utriculata* among herbaceous plants and the shrubs *Salix planifolia*, *Betula glandulosa*, and *S. brachycarpa* (Madsen 2004, personal observation).

Aspects of competition and disease with regard to *Ptilagrostis porteri* have not been studied.

CONSERVATION

Threats

There are no immediate threats to the viability of *Ptilagrostis porteri* on National Forest System lands. The primary potential threats on National Forest System lands include: grazing by ungulates, placer and peat mining, hydrologic alterations, and roads and trails. None of these potential threats are documented as currently having an impact to *P. porteri* or its habitat on National Forest System lands, with the exception of small-scale placer mining at one site.

Grazing

Grazing at the current low to moderate levels such as we see on these National Forest System lands does not appear to be a threat to *Ptilagrostis porteri*. Some of the largest populations are in active grazing allotments, where available monitoring and observational data indicate no decline in numbers of *P. porteri* or degradation of habitat.

Nine National Forest System *Ptilagrostis porteri* sites are within two large allotments that contain several large pastures that are lightly grazed by cattle in rotation (**Table 6**). The wetlands where *P. porteri* grows are seldom entered by cattle since they usually do not like to get their feet wet and can get more nutritious forage in adjacent uplands. However, utilization directly in the East Lost Park wetland has been observed at the end of the summer most likely due to changes in forage preference (drying of upland grasses) and receding of wet margins that outline the wetland (Coles personal communication 2006). There are currently no domestic sheep grazing allotments in these parts of the Pike, San Isabel, and White River national forests.

The allotment management plans for the two cattle grazing allotments in which *Ptilagrostis porteri* occurs were both written before the Rocky Mountain Region's sensitive species policy was inaugurated in 1992, but both of these plans do not allow cattle to graze riparian areas for more than a few days. In one of these allotments, the cattle spent too much time in riparian areas several years ago (though no impact to *P. porteri* was observed), and for this reason (among others), the USFS suspended one-fourth of the numbers for two years. The other allotment has seen a voluntary one-third reduction in numbers in the past few years. The trend in livestock numbers on these allotments has been downward for the last three to four decades. Both of these allotment management plans were rewritten in 2005 and the decision to implement them was done in September, 2005. Under the new allotment plans, stringent standards are placed on utilization by cattle in riparian areas and wetlands. If the standards are exceeded, livestock are immediately removed from the pasture.

The *Ptilagrostis porteri* sites on National Forest System lands have seen many significant reductions in livestock pressure since the System was established

Table 6. Grazing status of *Ptilagrostis porteri* sites on National Forest System lands.

Sites	Names	National Forest	Ranger District	Status	Active Allotment Name
1, 2, 21, 31	Geneva Park 1 and 2, Abyss Trailhead, Geneva Creek W5	Pike	South Platte	Grazed by cattle	Geneva Park
3, 7, 8, 9, 30	Long Gulch, Lost Park, East Lost Park, Old House	Pike	South Park	Grazed by cattle	Lost Park
5	Buckskin Creek	Pike	South Park	Not grazed	
6	Monte Cristo Creek	Arapaho*	Dillon	Not grazed	
10, 11	Beaver Creek	Pike	South Park	Not grazed	
12	Palmer Peak	Pike	South Park	Not grazed	
13	Hollthusen Gulch	Pike	South Park	Not grazed	
14	Crooked Creek Spring	Pike	South Park	Not grazed	
15, 16, 17	Sacramento Creek	Pike	South Park	Not grazed	
18	Warm Springs	Pike	South Park	Not grazed	
20	Teller Mountain (Upper Hall Valley)	Pike	South Platte	Not grazed	
22	Farish Recreation Area	Pike	Pikes Peak	Not grazed	

*Administered by the White River National Forest.

almost 100 years ago (von Ahlefeldt 1989). As a result, vegetation condition continues to improve, including the condition of riparian areas and wetlands.

On private lands, grazing has been much more intense than on National Forest System lands. While livestock grazing may have caused damage to *Ptilagrostis porteri* habitats or populations, this has not been directly observed. Some scientists believe that grazing is not now a significant threat to this species on private lands (Sanderson 2004) because of a sharp decline recently in the number of working ranches and the number of cattle in South Park. It has often been observed that where a large number of animals are grazing and where the grazing level is consequently intense, livestock are more likely to move into wetlands since the forage in uplands has likely been removed. Livestock in such situations are less particular about which species they graze. In past decades when the grazing pressure on private lands was more intense, this likely led to declines in *P. porteri* habitats and populations.

No indirect effects by cattle grazing on *Ptilagrostis porteri* or its habitats have been observed or measured on National Forest System lands. One possible indirect effect is trampling, which in intensely-grazed meadows in other areas has been observed to lead to soil compaction and a drop in the water table, with possible consequent de-watering of the hummocks which form the microhabitat for *P. porteri*. Another possible indirect effect could result from heavy or widespread grazing in the watersheds above, which could lead to increased bare ground and increased sedimentation at *P. porteri* sites. Another possible indirect effect could be water pollution by trampling and muddying, or chemical pollution from livestock excrement.

Elk and deer probably graze many of the *Ptilagrostis porteri* sites within Region 2, but it is unknown where, when, or how intensely. It is possible that the very light clipping on some of the shrubs that is occasionally seen in these sites is due to browsing by elk or deer. Deer, and especially elk, are capable of causing great damage to riparian areas and wetlands in their winter ranges through mortality of browsed shrubs, increases in bare soil, and trampling (Johnston et al. 2001), but such has not been observed in the watersheds above *P. porteri* sites.

Elk herds are noticeable in the valley bottom of South Park in the winter, but it is unknown whether they congregate in or near *Ptilagrostis porteri* sites and what effect they might have. No direct or indirect effects by elk or deer have been observed or measured at any *P. porteri* site.

The Beaver Creek sites (10 and 11 in **Table 1**) are near elk winter range, but it is unknown what effects elk use has on the vegetation in this area; no damage from these animals has been reported. As more homes are built in the critical winter range in

the South Platte drainage to the west of Beaver Creek, the potential for elk use of the Beaver Creek sites for winter range increases.

One possible indirect effect could result from deer or elk excessively browsing willows in these habitats, which might cause site degradation and population decline of *Ptilagrostis porteri*. Otherwise, indirect effects would be similar to those mentioned above for livestock.

Mining

Peat mining has been and continues to be a threat to *Ptilagrostis porteri* on private lands. For the past few decades, there had been much peat mining on private lands in South Park. However, this has tapered off in recent years due to the efforts of Park County and cooperating agencies to better protect wetlands and watersheds. The effects of present or past peat mining have not been observed at any *P. porteri* site on National Forest System lands, but it is not known whether peat mining has occurred on other National Forest System sites in or near the area of *P. porteri* distribution (black outline in **Figure 2**).

Several scientists have documented the decline of *Ptilagrostis porteri* habitats and populations due to peat mining, which removes the substrate in which *P. porteri* grows "and typically leaves no more than a few centimeters of organic substrate on top of Pleistocene outwash sands and gravel" (Cooper and MacDonald 2000). Another result of peat mining is de-watering of the site and drawdown of the water table. Also, the plant community of a mined peatland bears little resemblance to that of an unmined peatland as dryland native plants and exotics increase in abundance while hydrophilic wetland plants decrease (Cooper and MacDonald 2000). Even 40 years after peat mining, the water table of the site is still low compared with pre-mining levels, and there has been little to no re-colonization by native wetland plants. Cooper and MacDonald (2000) transplanted native wetland plants into peat mined areas in South Park and found that plant survival was greatly reduced with a drawdown of the water table to only –20 cm. The plant species studied were *Carex aquatilis*, *Kobresia simpliuscula*, *Juncus arcticus*, *Salix candida*, *S. brachycarpa*, and *S. monticola*; all of these are known to be associates of *P. porteri*. While some of the areas they studied were adjacent to *P. porteri* sites, no *P. porteri* was found in the peat mined areas. Apparently, populations of *P. porteri* are likely to have been partially or completely eliminated by peat mining in South Park (Sanderson and March 1996, Cooper and MacDonald 2000, Mayo 2005).

In the past, several streams and rivers in South Park have been intensely placer mined, notably Beaver Creek near Fairplay, where the piles of large gravel from the placer operations are still visible today, mostly below the Pike National Forest. For the most part, placer mining has subsided considerably, but the large-scale placer mining that once took place here had a great effect on the hydrology, ground water, and vegetation of these sites. It is possible that the large-scale historic placer mining in this area eliminated populations of *Ptilagrostis porteri*, but that would be difficult to confirm.

A small-scale placer mining club has been conducting small-scale placer mining on six unpatented mining claims along Beaver Creek since 1993, which are in the Middle Beaver Creek occurrence. Most of the activity consists of recreational panning and sluicing, but there is a small amount of high banking and use of small dredges. New disturbances are limited in size and number, and they are filled in and reclaimed. Sluice boxes and small dredges are used to excavate gold-bearing gravels that club members then work with their equipment. Reclamation is done with hand tools (Dobrowolski 2006). The mining club was notified on various occasions to avoid *Ptilagrostis* (or the monitoring plot) and have tried to be cooperative. The mining club's website (Gold Prospectors of Colorado 2004) indicates that there is a "marked plant" in the Beaver Creek area that they need to avoid (the plants are not marked, but the monitoring plot corners are staked). No sign of placer mining activity has been observed in the marked plot. Nonetheless, it is possible that the low-scale placer mining activities at the Middle Beaver Creek site have detrimentally affected *P. porteri* or its habitats. The current placer mining activities take place in what appears to have been suitable *P. porteri* habitat, and not all the plants of *P. porteri* occur within the marked plot. In addition, much of the population of *P. porteri* occurs downstream from the portion of Beaver Creek being placer mined, so there may be indirect effects resulting from the change in water quantity, its timing, or water chemistry. Apparently small amounts (a few cubic yards) of sediment are released each year and have passed downstream close to *P. porteri* occurrences; it is unknown whether this is detrimental to the *P. porteri* populations or habitats. There are no mining activities at any other *P. porteri* site on National Forest System lands.

There are old mines and mining structures in the watersheds above several *Ptilagrostis porteri* sites, but as far as we know there are no mines in these watersheds that have been active for several decades at least. There have been no observations of any indirect effects from any of these old mines. If there were any active mines, they could indirectly affect *P. porteri* or its habitat through extraordinary sediment production, water pollution, or changes in water chemistry, especially the addition of heavy metals.

Changes in hydrology

There has been much activity involving water and water rights on private lands in South Park. Many private landowners have sold their water rights to Front Range cities, and in some places ditches have been dug to move the water quickly downstream. One result of such practices is the de-watering of wetland ecosystems, which drops the water table and modifies the hydrological regime on which wetland plants like *Ptilagrostis porteri* depend.

In the 1990's, the City of Aurora (in the eastern part of the Denver Metropolitan Area) proposed to pump water from the aquifer under the northern part of South Park; this proposal was defeated in a referendum in 2003. Several studies showed that this depletion of the aquifer would also result in de-watering of wetlands and a decline of *Ptilagrostis porteri* habitats and populations.

Peat mining and placer mining can cause de-watering of wetlands and drawdown of the water tables, as discussed in the previous section. These effects are most severe when the mining has occurred on *Ptilagrostis porteri* sites, but there have likely also been indirect effects when the mining took place in the watershed above *P. porteri* sites. In many of the old mines in the historic past, water was diverted and streams de-watered for extended periods, and protective banks and vegetation were removed. These activities have permanently changed the hydrology of the watersheds downstream.

Currently, no ground-water changing activities, such as ditching to increase flow, placer mining, or peat mining, are occurring on National Forest System lands, nor are there any proposed. However, there are other activities on national forests that if they occur in watersheds that support *Ptilagrostis porteri*, could potentially cause indirect changes to water tables, water chemistry, or water quantities sufficient to cause deleterious changes to *P. porteri* populations or habitats. Several of these have been discussed in other sections, such as heavy grazing in the watersheds above *P. porteri* sites, mining in the watershed, heavy road or trail use in these watersheds, and large timber harvests in these watersheds.

Roads, trails, and recreation

The Federal Highway Administration has plans to rebuild the road (Forest Highway 80, National Forest Road 118) near the Geneva Park (numbers 1 and 2 in **Table 1**) and Abyss Trailhead (number 21) sites, on the Pike and adjacent Arapaho national forests. An Environmental Impact Statement was prepared, and the Record of Decision was signed in 1999. As of 2005, the road improvement work had not reached Geneva Park, but this phase of reconstruction may begin in 2006 or later. As part of this project, the wetlands where *Ptilagrostis porteri* grows would be temporarily fenced and construction activities will be limited to the area outside *P. porteri* habitat. Special provisions to protect *P. porteri* are part of the construction contract, including penalties for working across the fenced boundary. Most of the road in Geneva Park is lower in the watershed than the *P. porteri* sites, so there will likely be little impact to hydrology, but there may be some slight impact from dust or air pollution.

Although several roads pass close to *Ptilagrostis porteri* occurrences on National Forest System lands, there is no observable direct effect of road use on *P. porteri* populations or habitats. In several sites, road use does result in some dust depositing on vegetation close by the road, but that does not appear to be detrimental, as plants in that zone appear as healthy as others and no less dense than in other parts of the occurrence (personal observation).

Road construction through *Ptilagrostis porteri* habitats or near them appears to be a potential threat to the wetland hydrology on which populations of this species depend. At one *P. porteri* site (Long Gulch), the improved road apparently crosses the habitat. The road was constructed over 80 years ago. The current road surface is gravel and on an embankment built up over the years to put the road nearly 1 m above the soil surface of the willow carr. Construction of the original road long ago probably split the habitat and population in two; this split likely altered the wetland hydrology of this site. The two subpopulations now appear to be healthy, and observation and monitoring over almost 40 years have shown no declines.

Ptilagrostis porteri does not occur in heavily populated areas, and off road vehicle use is rare in its wetland habitat. Signs of off-road vehicles have been observed in one *P. porteri* site (Pollock 2001, Center for Native Ecosystems et al. 2002) even though this activity is against USFS regulations and such use is subject to law enforcement action. Effects of this activity on *P. porteri* or its habitats have not been documented. There are several sites that are vulnerable to illegal, off-road vehicle use, including Long Gulch and Lower Beaver Creek, but except for the occurrence cited above, this has apparently not happened. However, motor vehicle use is increasing in many areas throughout the mountainous part of Colorado, so illegal motor vehicle use may become a greater threat to *P. porteri* in the future. Several sites, however, have natural barriers (e.g., cliffs, rocks) that would prevent vehicle access to *P. porteri* populations.

At several sites, recreational trails pass close to or through *Ptilagrostis porteri* occurrences. The heavily-used trail along Lost Creek just below the Lost Park Campground goes right through the wetland where *P. porteri* occurs, and some damage to the wetland can be seen as a result of normal travel on this unimproved section of trail. However, soon after that same trail comes into East Lost Park, it passes through a corner of a large *P. porteri* occurrence (number 9 in **Table 1**), and here the plants have been observed growing in the trail, apparently undamaged (personal observation). Trail use has been increasing steadily over the last decade, and as it continues to increase, it may pose threats in the future.

Other potential threats

Timber harvest, including logging, is not currently a threat to any *Ptilagrostis porteri* occurrence on National Forest System land because there are no timber harvest activities or access roads nearby. Indirect threats could follow from large-area timber harvest in the watersheds above *P. porteri* because timber harvest could cause abnormally large sediment events and consequent changes in the hydrological regime of *P. porteri* sites. However, no large-area timber harvest is planned in the watersheds above *P. porteri* populations, and several of these watersheds consist of large tracts of designated wilderness areas, within which timber harvest is not allowed.

No diseases or pests are known that might affect *Ptilagrostis porteri*, and no diseases or pests have been observed on the plants of this species. All plants observed have apparently been healthy; however, the factors determining plant size and flowering are unknown. As far as known, there are no diseases or pests on the related species *P. kingii* or *P. concinna* (Dyer 2001, Dickoré 2001, Xu et al. 2004a, 2004 b, Yi et al. 2005).

Ptilagrostis porteri sites are wet and cold enough to exclude exotic plant species; usually none are seen in *P. porteri* habitats. Sometimes a few stems of the riparian invaders *Poa pratensis*, *Taraxacum officinale*, or *Elytrigia repens* may be seen on the dry edges of the site (personal observation).

There are no known commercial, recreational, or educational uses for *Ptilagrostis porteri*; few people visiting the areas near its occurrences are aware of its presence. There are few scientific studies of its populations, and none to date have used destructive sampling. There are relatively few herbarium specimens (fewer than 50), so scientific collecting is not a concern at this time.

Models predict that climate warming will occur across the western United States, and leading to a large reduction in mountain snowpack and "a substantial shift in stream-flow seasonality, so that by 2050, the spring stream-flow maximum will come about one month earlier in the year" (Barnett et al. 2005; also see Stewart et al. 2004, Mote et al. 2005). There may not be enough water later in the season to support late-season grasses such as *Ptilagrostis porteri*, and it may decline.

Conservation Status of Ptilagrostis porteri in Region 2

At the conclusion of her study on significant populations of *Ptilagrostis porteri*, both on private and National Forest System lands, Judy von Ahlefeldt (1989) said that:

> "*Ptilagrostis porteri* appears to be fairly secure, occurring on a wider range of habitat types than previously known and with vigorous populations in many places. Moderate grazing does not seem to be a serious threat, since the grass does not appear to be palatable to cattle, and because its location on hummock tops and sides is not trampled very much by cattle. Some locations are too wet, too hummocky, or too dense with willows, for cattle to visit. Peat mining or any future alteration of wetlands or watershed characteristics through severe mining or timbering could

cause population decline. Most populations are in areas where hikers are not likely to contact the populations."

The author believes that Von Ahlefeldt's conclusions remain true today. Populations on National Forest System lands appear stable or slightly increasing in the long term, despite fluctuations in the populations from year to year (**Appendix A**), which are probably in response to water table fluctuations, which in turn depend on precipitation and its seasonal distribution.

An envirogram graphically represents the components that influence the condition of a species and reflects its chance of reproduction and survival. Envirograms have been used especially to describe the conditions of animals (Andrewartha and Birch 1984), but they may also be applied to describe the condition of plant species. Those components that directly impact *Ptilagrostis porteri* make up the centrum, and the indirectly acting components comprise the web. Unfortunately, much of the information to make a comprehensive envirogram for *P. porteri* is unavailable. The envirogram in **Figure 15** is constructed to outline some of the components known to directly impact the species and also includes some more speculative factors.

Degradation and detrimental changes in habitat of *Ptilagrostis porteri* on National Forest System lands probably occurred in the late 19th and early 20th centuries due to placer mining, other mining activities, and heavy grazing. Evidence of *P. porteri* habitat degradation in the last three or four decades on National Forest System lands has been limited to small-scale placer mining at one site and foot trails at two sites.

On private lands, however, even though there has been no measurement of population trends, much *Ptilagrostis porteri* habitat has apparently been lost through peat mining, hydrological changes, and livestock grazing. Perhaps *P. porteri* populations and habitats on private lands have stabilized, but there is no indication that population or habitat trends are improving there (Sanderson 2004).

Detrimental changes in the hydrology of *Ptilagrostis porteri* habitat could occur indirectly from activities on the sites or in the watersheds above, such as large-scale timber harvest, heavy grazing, road construction and maintenance, development, climate change, or large wildfires. Except for the road reconstruction through Geneva Park, none of these activities are planned on National Forest System lands. Detrimental changes in the hydrology of *P. porteri* habitat are predicted to occur indirectly as a result of climate warming (Barnett et al. 2005).

The only National Forest population currently at risk appears to be at Middle Beaver Creek population, where small-scale placer mining is permitted.

Management of Ptilagrostis porteri in Region 2

Implications and potential conservation elements

Ptilagrostis porteri habitats and populations on National Forest System lands were probably impacted by the much more intense grazing that occurred in the 1920's and 1930's, but the exact levels and impacts are not known (von Ahlefeldt 1989). At the present time, however, they appear stable in quantity and quality.

Despite several intensive searches of the area, the Twin Lakes occurrence has not been rediscovered. A great deal of water-management activity has occurred in the area of Twin Lakes since Wolf collected it there in 1873, as summarized in the following quote:

> "Since the turn of the [20th] century, a series of hydraulic engineering works had converted Twin Lakes into a pair of connected reservoirs. First, the natural outlet of the lower lake was dammed, and a deeper, gated outlet was constructed about 1 km to the north. … Next, the stream connecting the lake was dredged into a channel that allowed the two bodies of water to fluctuate essentially as one. Finally, a tunnel was constructed under the Continental Divide to divert water from the western slope into Lake Creek. …
>
> The net result of these hydraulic changes was increased erosion in the inflow area of the upper lake. What had originally been a marshy meadow was now an eroded floodplain, and the resulting woody debris was deposited in the bottom of Upper Twin Lakes" (International Lake Environment Committee 2006, emphasis added).

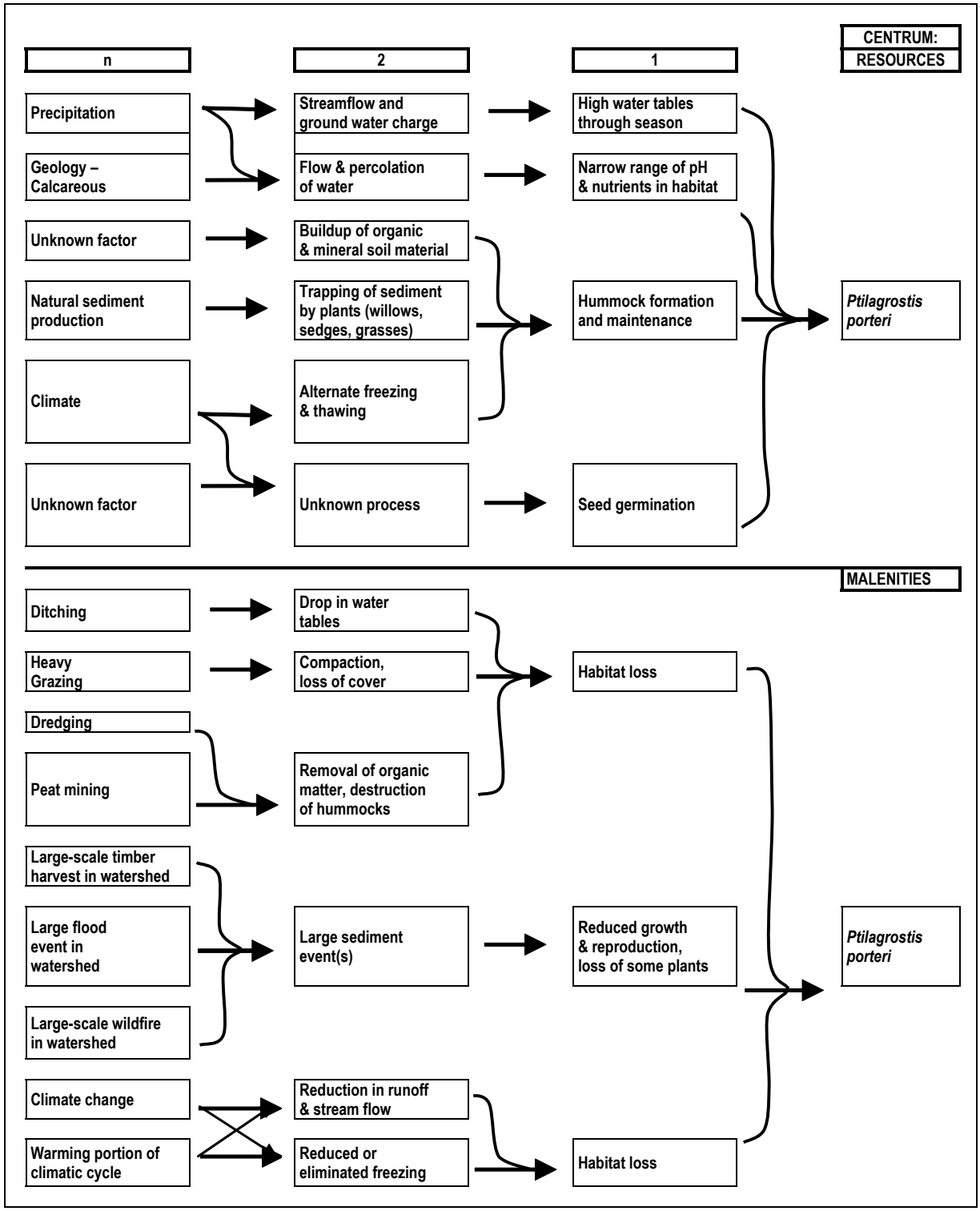

Figure 15. Envirogram of the resources and malenities of *Ptilagrostis porteri*.

This suggests a likelihood that *Ptilagrostis porteri* has been extirpated from the Twin Lakes area.

Populations of *Ptilagrostis porteri* on private lands have not been monitored, yet apparently peat mining, grazing, and placer mining have all had detrimental effects in the past. Peat mining and placer mining have decreased somewhat on private lands, and grazing continues at a somewhat lower level. Hydrological alterations often lead to de-watering or otherwise detrimentally changing sites and have resulted in the decline or elimination of *P. porteri* populations and habitats (Sanderson and March 1996, Sanderson 2000). However, this has apparently not been directly observed (Sanderson 2004).

The Forest Plan for the Pike and San Isabel National Forests is scheduled to be revised beginning in 2006, and by USFS policy, the conservation of *Ptilagrostis porteri* and other sensitive species could be a stated goal of the Forest Plan and any project-level plans, such as grazing allotment management plans. Proper grazing management, through the use of appropriate grazing systems and seasons and levels of use, in *P. porteri* sites and their watersheds will prevent the degradation of riparian areas and wetlands (Platts 1981, 1991). Proper management of wetlands and riparian areas is critical to the conservation of *P. porteri*. These sites should be managed to maintain their vegetative cover, native wetland species, and wetland hydrology, including groundwater, water table heights and fluctuations, and water chemistry and quality.

Since more than 90 percent of all known *Ptilagrostis porteri* individuals are concentrated in one large site (East Lost Park), conservation of this species, and several other significant rare plants species, is closely tied to protection of this site. Populations within the Lost Creek Wilderness are probably not sufficiently protected against recreational overuse or unauthorized excessive livestock use. Perhaps (following the Pike National Forest Plan and in agreement with the Colorado Natural Areas Program), a management strategy could be prepared for this site, as well as other *P. porteri* sites could be similarly protected. In order to determine how best to conserve *P. porteri* and its habitats, an interagency conservation strategy is warranted.

Tools and practices

Inventory of *Ptilagrostis porteri* on National Forest System sites would provide accurate demographic data, complete habitat descriptions, and accurate and complete floristic and plant community data. All of this information could be collected in conjunction with an ongoing wetlands inventory, in coordination with the BLM, the State of Colorado, and relevant counties.

The population monitoring efforts by the South Park and South Platte Ranger Districts are commendable as they provide valuable data pertinent to the management and conservation of *Ptilagrostis porteri*. Stabilization and standardization of the monitoring methods would help in data interpretation. Sufficient data to plan conservation efforts of *P. porteri* would include the monitoring of habitat elements, such as plant communities, hydrology, and water chemistry and quality. Monitoring should be extended to other known sites. Monitoring methods could be based on the current methods or drawn from Elzinga et al. (1998) or other sources. All populations should be carefully mapped. For smaller populations (less than perhaps 500), the entire population should be counted by size class, but for larger populations, a systematic sampling method should be used as was used for the East Lost Park population. For all populations, there should be one to several permanent 2 to 5 m^2 grids set up, and all individuals should be mapped to validate the grosser counts of individuals (Elzinga et al. 1998).

As far as the author knows, no agency or individual has attempted any management practices specifically to conserve *Ptilagrostis porteri* or restore or improve its habitat. There are no species conservation plans for this species. As detailed above, there are several management activities that are compatible with its conservation of this species, and several management activities that are detrimental. In order to conserve *P. porteri* and its habitats on public and private lands, cooperation needs to be increased between the USFS, State of Colorado and other federal agencies, landowners, and local governments with interests in this species and its habitats. This could be in conjunction with the Colorado Division of Wildlife's riparian mapping program, the South Park Wetlands Focus Area Committee, or others.

Trail use on National Forest System lands has been increasing steadily over the last decade, and as trail use increases, the slight impacts we see now on *Ptilagrostis porteri* populations and habitats may accelerate. Opportunities may exist to relocate trails away from *P. porteri* populations and habitats or to lessen impacts on them, such as constructing riprap or log bridge structures.

Information Needs

To develop a conservation plan for *Ptilagrostis porteri*, its distribution needs to be better understood, and we need more detailed information concerning its life cycle, reproduction, dispersal, establishment, and demography. The associated plant communities on these sites should be better described and monitored in order to determine indicators of habitat quality and to detect possible threats from insects, diseases, and exotic and invasive species. We also need to better understand the role of bunchgrasses and other species in the functioning of wetlands.

The distribution of *Ptilagrostis porteri* is moderately well known, but much area still needs to be searched. Focus should be put on discovery and intensive inventory of high-quality sites. Areas especially in need of searches include:

- Tarryall Creek and its tributaries below the confluence of Michigan Creek and Jefferson Creek, down to Lake George
- Lost Creek and Goose Creek down to Goose Creek Campground
- Sheep Creek, Twelvemile Creek, and Cave Creek above confluence with the South Platte River
- creeks north, west, and south of Twin Lakes.

Modeling of potential habitat might be useful. In addition there are a number of sites known from site records or herbarium specimens only, and a number of sites where basic demographic and habitat data are missing. For most populations, there are no accurate population counts (or estimates), and trends of population and habitat have never been measured. This is especially true on private lands. Populations of *Ptilagrostis porteri* should be monitored to ensure that they remain in stable equilibrium with their habitat. On National Forest System lands, recreational use, grazing, roads, trails, and placer mining need to be monitored to ensure that they do not cause detrimental impacts to *P. porteri* occurrences or habitat.

The role of disturbance, both natural and human-caused, in the ecology of *Ptilagrostis porteri* and its habitats, is largely unknown and unstudied. Questions to be addressed might include:

- How are hummocks formed?
- What are the successional pathways of hummocks?
- Is it a willow carr species, a calcareous fen species, or both?

Methods that might be used for restoration of *Ptilagrostis porteri* populations are largely unknown and unstudied. Restoration of wetland habitats has received more attention recently (e.g., Cooper and MacDonald 2000, Bedford and Godwin 2003, Gorham and Rochefort 2003). As far as the author knows, seeds or other material from *P. porteri* have not been stored.

DEFINITIONS

Awn – "A narrow, bristlelike appendage, usually at the tip" (Harris and Harris 2001).

Biological Evaluation – "A documented Forest Service review of Forest Service actions in sufficient detail to: 1) comply with the requirements of the Endangered Species Act; 2) ensure that actions do not contribute to loss of viability of native or desired non-native plant or animal species, or cause a trend towards listing under the E[ndangered] S[pecies] A[ct]; and 3) provide a standard by which to ensure that endangered, threatened, proposed, and sensitive species and critical habitats receive full consideration in Forest Service decision-making" (USDA Forest Service 2005, Section 2670.5).

Carr – "Shrublands with greater than 25% shrub cover on minerotrophic peatlands" (von Ahlefeldt 1999); often dominated by willows, birches, or shrubby cinquefoil.

Culm – "A hollow or pithy stalk or stem, as in the grasses, sedges, and rushes" (Harris and Harris 2001).

Endemic – Restricted to a relatively small geographical area.

Exsiccatae – A collection of dried plants, usually sent or shipped as a unit.

Fen – "Minerotrophic peatlands dominated by sedge, grass, or reed" (von Ahlefeldt 1989); a kind of wetland characterized by accumulation of peat, "a peatland that is fed by groundwater" (Brinson 1993); "wetlands distinguished by their strong connection to ground water, wetlands whose vegetation, water chemistry, and soil development are determined, in large part, by the flows of ground water to [them]" (Bedford and Godwin 2003); In contrast, "Bogs are restricted to humid regions and do not occur in the southern Rocky Mountains" (Cooper 1991).

Filiform – "Thread-like; filamentous" (Harris and Harris 2001).

Glume – "One of the paired bracts at the base of a grass spikelet" (Harris and Harris 2001).

Hummock – "A low mound or ridge of earth" (American Heritage Dictionary 2000).

Inflorescence – "The flowering part of a plant; a flower cluster; the arrangement of the flowers on the flowering axis" (Harris and Harris 2001).

Involute – "With the margins rolled" (Harris and Harris 2001).

Isotype – An herbarium specimen, a duplicate specimen of the type specimen, usually collected from the same population as the type specimen.

Lemma – "The lower of the two bracts (lemma and palea) which subtend a grass floret, often partially surrounding the palea" (Harris and Harris 2001).

Ligule – "The membranous appendage arising from the inner surface of the leaf at the junction with the leaf sheath in many grasses and some sedges" (Harris and Harris 2001).

Membranous – "Thin, soft, flexible, and more or less translucent, like a membrane" (Harris and Harris 2001).

Minerotrophic – Describing wetlands whose water sources are in contact with mineral soils.

Palea (or palet) – A chaffy scale or bract; the uppermost of two bracts (lemma and palea) which subtend a grass floret, often partially surrounded by the lemma" (Harris and Harris 2001).

Panicle – "A branched, racemose inflorescence with flowers maturing from the bottom upwards" (Harris and Harris 2001).

Pedicel – "The stalk of a single flower in an inflorescence, or of a grass spikelet" (Harris and Harris 2001).

Pilose – "Bearing long, soft, straight hairs" (Harris and Harris 2001).

Plumose – "Feathery or feather-like; having fine hairs on one side, like the plume of a feather" (Dayton 1950).

Raceme – "An unbranched, elongated inflorescence with pedicellate flowers maturing from the bottom upwards" (Harris and Harris 2001).

Scaberulous (or scaberulose) – "Slightly rough to the touch, due to the structure of the epidermal cells, or to the presence of short stiff hairs" (Harris and Harris 2001).

Sensitive species – "Those plant and animal species identified by a Regional Forester for which population viability is a concern, as evidenced by: a. Significant current or predicted downward trends in population numbers or density [or] b. Significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution" (USDA Forest Service 1995).

Spikelet – "A small spike or secondary spike; the ultimate flower cluster of grasses and sedges, consisting of one to many flowers subtended by two bracts (glumes)" (Harris and Harris 2001).

Sulcate – "With longitudinal grooves or furrows" (Harris and Harris 2001).

Vegetative – "Of or pertaining to the non-floral parts of the plant" (Harris and Harris 2001).

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APPENDIX A

Population Estimates of Ptilagrostis porteri Occurrences

Site	Name	Estimated area of occurrence (acres)	Number in Population												Number in Plot[3]			Latest reliable population estimate/count	Density (individuals per acre)
			1978	1980-1981	1982	1983-1984	1989-1990	1993–1995	1996-1998	1999	2000	2000‡	2001[2]	2005	2001	2002	2003		
1	Geneva Park 1	58	75	over 1000	over 1500	814					300	300	B					820	14.1
2	Geneva Park 2	2 [322*]									50-100	100	C					100	50
3	Long Gulch – A & B	14	300		±300		25-30		152	535	15	139	C		279	229	261	535	38.2
4	Twin Lakes	[8750*]										§							
5	Buckskin Creek	[500*]																	
6	Monte Cristo Creek	7			12				15		±20							20	2.9
7	Lost Park Campground	15			over 1500		1		over 505	62		1500	A		304	354	673	1,500	100
8	Lost Park – B	[288*]			2110													2,110	301.4
9	East Lost Park	355 [1368[1]]				397, 700†					"thou-sands"	1239						397,000	1118.3
10	Beaver Creek 1 (lower)	2				90					75-100	30	B					90	45
11	Beaver Creek 2 (middle)	3				654					200-250	650	B		185	147	329	650	216.7
12	Palmer Peak	[2000]										§							
13	Hollthusen Gulch	86										100	C					100	1.2
14	Crooked Creek Spring	2						±24			±10	100	C					100	50
15	Sacramento Creek 1	72					±200					200	C					200	2.8
16	Little Sacramento Creek	2									±3000		B					3,000	1500
17	Little Sacramento Creek 2	8									±000		A					1,000	125
18	Warm Springs	46									6							6	0.1
20	Teller Mountain	8	30										E					30	3.8
21	Abyss Trailhead	10						100-300			±500							500	50

Appendix A (concluded).

Site	Name	Estimated area of occurrence (acres)	Number in Population												Number in Plot[3]			Latest reliable population estimate/count	Density (individuals per acre)
			1978	1980-1981	1982	1983-1984	1989-1990	1993–1995	1996-1998	1999	2000	2000[‡]	2001[2]	2005	2001	2002	2003		
24	High Creek Fen	235									6		C2					6	0
25	South Fork South Platte	77								over 250	2		D, E					250	3.2
26	(North) Tarryall Creek	61 + 62										1000	E					1,000	8.1
27	Fremont's Fen	353										Over 5000	B					5,000	14.2
28	South Jefferson	112										1000	C					1,000	8.9
29	Wahl Ranch	208						"100+ hummocks"				500	A					500	2.4
30	Old House	3												[±]300				300	100
31	Geneva Creek W5	8												[±]50				50	6.6
	AVERAGE																	15,996	145.2
	TOTAL																	415,891	

[*]Unknown; number given is total search area.

[†]Population estimated using a systematic sampling method.

[±]Estimated number.

[‡]J. Sanderson estimates in letter (Sanderson 2000).

[§]Occurrence still not re-discovered.

[1]Total potential conservation area.

[2]"Element Occurrence Ranking" of Spackman et al. 2001:

A = Relatively large, pristine, defensible, and viable.

B = Small but in good condition, or large but removed from its natural condition and/or not viable and defensible.

C = Small, in poor condition, and possibly of questionable viability.

D = Does not merit conservation efforts because it is too degraded or not viable.

H = Historically known, but not verified for an extended period of time.

X = Extirpated.

E = Not enough information to rank.

F = Not relocated, failed to find.

The number following the letter indicates the number of occurrences in the area; no number means 1.

[3]These plots are smaller than the whole population

APPENDIX B

Notes on Isotype Specimen at New York Botanical Garden

This is an isotype specimen that was found in the type case at the New York Botanical Garden Herbarium (NY). Two portions of the label have been pasted on; they apparently come from a semi-published *exsiccatae* description. From the footnote, Asa Gray (*A. G.*) was the general author of the *exsiccatae* description. In this case the identification of this specimen was farmed out to George Thurber, an agrostologist with the U.S. Department of Agriculture.

Labels on the specimen sheet:

1. "College of Pharmacy Herbarium, Deposited 1948 in the New York Botanical Garden" [This was John Torrey's herbarium].

2. "Annotation label. PTILAGROSTIS PORTERI (Rydb.) W. A. Weber, 1978 det. B. C. Johnston."

3.

> Rocky Mountain Flora, Lat. 39°-41°.
>
> 646. Stipa
>
> MONGOLICA, Turcz. (*Ptilagrostis Mongolica*, Griseb. in Ledeb., Fl. Ross.) I have no specimen by which to confirm this determination, but it accords so well with the description, except as to size, as to leave little doubt.* This makes the third species with a plumose awn found in our territory.
>
> E. HALL & J. P. HARBOUR, Colls. 1862.
>
> *A comparison with an authentic but imperfect Mongolian specimen confirms Prof. Thurber's determination. – *A. G.*

Then in 1874, Thomas C. Porter and Coulter wrote the first *Synopsis of the Flora of Colorado*, in which they first described this specimen:

> "STIPA MONGOLICA, Turcz. (*Ptilagrostis Mongolica*, Griseb. in *Ledeb. Fl. Ross*.) – Slender, 1° high, with filiform leaves and a loose few-flowered panicle; the membranous glumes obtuse, about 2" long, sub-equal, purplish, and the scarcely shorter hairy palet ending in a bent plumose awn, 6" in length. – Hall & Harbour, 648" (Porter and Coulter 1874, pp. 145-146).

George Thurber apparently wrote this description because of similarities in typesetting to the label cited above, and on the same page as it appears is a new genus by Thurber. "A. G." is Asa Gray. Some common abbreviations of the day: ° = foot and " = line = 1/12 of an inch. "648" was a typographical error (should have been "646") in Porter and Coulter; Hall and Harbour 648 is not a grass.

In 1905, Per Axel Rydberg gave a new name to the published description of Porter and Coulter; he called this species *Stipa porteri* Rydberg, obviously in honor of Thomas C. Porter, the first author of *Synopsis of the Flora of Colorado*. Therefore, the description of *Stipa mongolica* in Porter and Coulter, repeated above, now has become the type description of Rydberg's new name, and the specimen Hall and Harbour 646 now has become the type specimen of *Stipa porteri* Rydberg.

In Thurber's description, the name of the Mongolian species is spelled *mongolica*, but in fact it was originally published as *Stipa mongholica* Turczaninov in 1836. By 19th-century rules, they were allowed to "correct" names, as Grisebach did in Flora Rossica in 1853. But by today's rules, we must use the form of the name as originally published.

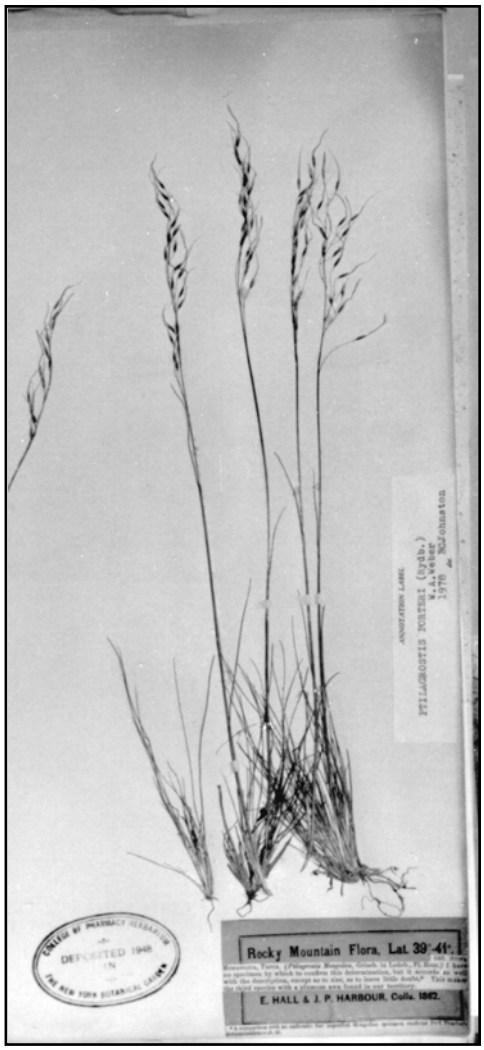
In 1966, William A. Weber compared specimens of *porteri* with specimens collected in Siberia, and decided that *porteri* belonged in the genus *Ptilagrostis*, as was hinted at by Grisebach and Thurber. So Weber transferred the species, as *P. orteris* (Rydberg) W. A. Weber.

In 1983, Mary Barkworth decided that the Colorado plants best represented a subspecies of *Ptilagrostis mongholica*, so she transferred them to subspecific status, as *P. mongholica* (Turczaninov ex Trinius) Grisebach in Ledebour subsp. *porteri* (Rydberg) Barkworth. She chose the type specimen as Hall and Harbour 646 in the herbarium at Philadelphia (PH), which makes the specimen in the picture here an Isotype.

Nomenclature (International Plant Names Index 2004) *Stipa porteri* Rydberg, Bulletin of the Torrey Botanical Club 32: 599. 1905. Nomen novum for *S. mongolica* Porter & Coulter *non* Turczaninov. Type Chosen by: Barkworth, Systematic Botany 8: 417. 1983. Collectors: E. Hall, J. P. Harbour. Collector Number: 646. Type Status: lectotype. Herbarium: PH [Academy of Natural Sciences of Philadelphia].

Ptilagrostis porteri (Rydberg) W. A. Weber, University of Colorado Studies, Series in Biology 23: 2. 1966.

Ptilagrostis mongholica subsp. *porteri* (Rydb.) Barkworth, Systematic Botany 8: 417. 1983.



Sources:

Barkworth, Mary E. 1983. *Ptilagrostis* in North America and its relationship to other Stipeae (Gramineae). Systematic Botany 8 (4):395-419.

International Plant Names Index. 2006. International Plant Names Index. http://www.ipni.org.

Porter, Thomas C.; and John M. Coulter. 1874. Synopsis of the flora of Colorado. Survey of the Territories, Miscellaneous Publication No. 4, 180 pp. Washington, D.C.: U. S. Geological Survey.

Weber, William A. 1966. Additions to the flora of Colorado – IV. University of Colorado Studies, Series in Biology, No. 23, 24 pp.

APPENDIX C

Soils Mapped at Ptilagrostis porteri Sites on National Forest System Lands

Site	Name	SMU	Soil Map Unit
1	Geneva Park 1	110F	Cryoborolls - Cryaquolls association, 0 to 15 percent slopes
2	Geneva Park 2 (Geneva Creek)	100F	Cryofluvents - Cryaquolls - Histosols complex, 0 to 15 percent slopes
3	Long Gulch – A & B	110F	Cryoborolls - Cryaquolls association, 0 to 15 percent slopes
4	Twin Lakes	*	
5	Buckskin Creek	*	
6	Monte Cristo Creek	*	
7	Lost Park Campground	190F	Histosols - Gateview (Pachic Cryoborolls) family association, 0 to 15 percent slopes
8	Lost Park – B	190F	Histosols - Gateview (Pachic Cryoborolls) family association, 0 to 15 percent slopes
9	East Lost Park	110F	Cryoborolls - Cryaquolls association, 0 to 15 percent slopes
10	Beaver Creek 1	110F	Cryoborolls - Cryaquolls association, 0 to 15 percent slopes
11	Beaver Creek 2	100F	Cryofluvents - Cryaquolls - Histosols complex, 0 to 15 percent slopes
12	Palmer Peak	*	
13	Hollthusen Gulch	110F	Cryoborolls - Cryaquolls association, 0 to 15 percent slopes
14	Crooked Creek Spring	110F	Cryoborolls - Cryaquolls association, 0 to 15 percent slopes
15	Sacramento Creek 1	100F	Cryofluvents - Cryaquolls - Histosols complex, 0 to 15 percent slopes
16	Little Sacramento Creek	(620G)	(Frisco family, 5 to 40 percent slopes)
17	Little Sacramento Creek 2	100F	Cryofluvents - Cryaquolls - Histosols complex, 0 to 15 percent slopes
18	Warm Springs	110F	Cryoborolls - Cryaquolls association, 0 to 15 percent slopes
20	Teller Mountain	908C	Moran (Typic Cryumbrepts) family - Rock outcrop - Cryaquolls complex, 0 to 40 percent slopes
21	Abyss Trailhead	110F	Cryoborolls - Cryaquolls association, 0 to 15 percent slopes
22	Farish Recreation Area	2	Aquolls, 1 to 10 percent slopes
30	Old House (Creek)	110F	Cryoborolls - Cryaquolls association, 0 to 15 percent slopes
31	Geneva Creek W5	100F	Cryofluvents - Cryaquolls - Histosols complex, 0 to 15 percent slopes

*Unknown, because exact locations of these sites are unknown.

Summary of Soils Mapped for National Forest Sites

Soil Component	Number of Sites
Cryaquolls	15
Cryoborolls	11
Histosols	7
Cryofluvents	5
Aquolls	1
Moran (Cryumbrepts)	1
Rock outcrop	1

Sources:

Irvine, J.R. 2004. Soil and Ecological Land Unit Survey: Northern San Isabel and Western Pike National Forests, Colorado. Review draft.

Moore, R. 1992. Soil survey of Pike National Forest, eastern part, Colorado: Parts of Douglas, El Paso, Jefferson, and Teller Counties. [Place of publication not stated]: USDA Forest Service and Soil Conservation Service, in Cooperation with Colorado Agricultural Experiment Station. 106 pp. + 2 maps at 1: 362,057 and 24 maps at 1: 24,000.

APPENDIX D

Bedrock Geology and Source Geology for Ptilagrostis porteri Sites

A. Precambrian granite and gneisses, no limestone implicated

Site	Bedrock Map Code	Source/Derivation	Bedrock at Site	Source Map Unit
1, 2, 21, 31	1 Qg	1a Xb	1 Quaternary Gravels and Alluviums	1a Precambrian Biotitic Gneiss, Schist, and Migmatite
		1b Xg		1b Precambrian Granitic Rocks Of 1,700-M.Y. Age Group
		1c Xfh		1c Precambrian Gneisses
3, 6, 7, 8, 30	1 Xb		1 Precambrian Biotitic Gneiss, Schist, and Migmatite	
9, 22	1 Yp		1 Rocks Of Pikes Peak Batholith	
20	1 Xfh		1 Precambrian Felsic and Hornblendic Gneisses	

B. Limestones, limy shales, or limy sandstones present

Site	Bedrock Map Code	Source/Derivation	Bedrock at Site	Source Map Unit
5	1 Xb	1a TKi	1 Precambrian Biotitic Gneiss, Schist, and Migmatite	1a Tertiary Laramide Intrusive Rocks
		1b Pm		1b Minturn Sandstone-Shale-Limestone
10, 17	1 Pm		1 Minturn Sandstone-Shale-Limestone	
11	1 TKi	1a Pm	1 Tertiary Laramide Intrusive Rocks	1a Minturn Sandstone-Shale-Limestone
12	1 TKi		1 Tertiary Laramide Intrusive Rocks	
	2 PPm		2 Maroon Sandstone-Siltstone-Limestone	
13	1 Qg	1a TKi	1 Quaternary Gravels and Alluviums	1a Tertiary Laramide Intrusive Rocks
		1b Kc		1b Cretaceous Shales
		1c KJde		1c Dakota-Morrison-Entrada Sandstones
14	1 Qa	1a Pm	1 Modern Alluvium	1a Minturn Sandstone-Shale-Limestone
	2 Pm	1b PPm	2 Minturn Sandstone-Shale-Limestone	1b Maroon Sandstone-Siltstone-Limestone
	3 PPm		3 Maroon Sandstone-Siltstone-Limestone	
15, 16	1 Mp		1 Mississippian-Devonian-Ordovician-Cambrian Limestones-Dolomites	
	2 Pm		2 Minturn Sandstone-Shale-Limestone	
18, 24	Qg	1a Pmb	1 Quaternary Gravels and Alluviums	1a Minturn and Belden Sandstone-Shale-Limestone
		1b Mp		1b Mississippian-Devonian-Ordovician-Cambrian Limestones-Dolomites
		1c Pm		1c Minturn Sandstone-Shale-Limestone

Appendix D (concluded).

Site	Bedrock Map Code	Source/Derivation	Bedrock at Site	Source Map Unit
19	1 Qg	1a Kg	1 Quaternary Gravels and Alluviums	1a Cretaceous Shales
	2 Klf	1b TKi	2 Cretaceous Laramie Formation and Fox Hills Sandstone	1b Tertiary Laramide Intrusive Rocks
	3 Tsp		3 South Park sandstone and shale	
23	1 Qg	1a Tsp	1 Quaternary Gravels and Alluviums	1a South Park sandstone and shale
	2 Tsp	1b Tki	2 South Park sandstone and shale	1b Tertiary Laramide Intrusive Rocks
25	1 Qg	1a Pmbe	1 Quaternary Gravels and Alluviums	1a Facies of Minturn-Belden Gypsum-Siltstone-Shale
		1b Pmb		1b Minturn and Belden Sandstone-Shale-Limestone
26	1 Qg	1a Klf	1 Quaternary Gravels and Alluviums	1a Cretaceous Laramie Formation and Fox Hills Sandstone
	2 Tsp	1b Kp	2 South Park sandstone and shale	1b Pierre Shale
	3 Klf		3 Cretaceous Laramie Formation and Fox Hills Sandstone	
27	1 Qg	1a TKi	1 Quaternary Gravels and Alluviums	1a Tertiary Laramide Intrusive Rocks
	2 Klf		2 Cretaceous Laramie Formation and Fox Hills Sandstone	
28	1 Klf		1 Cretaceous Laramie Formation and Fox Hills Sandstone	
29	1 Qg	1a Kc	1 Quaternary Gravels and Alluviums	1a Carlile Shale
		1b TKi		1b Tertiary Laramide Intrusive Rocks

Source:

Green, G.N. 1995. The digital geologic map of Colorado in ARC/INFO format. Open-File Report OF-92-0507, 9 pp. Denver, CO: U. S. Geological Survey. http://pubs.usgs.gov/of/1992/ofr-92-0507/READ.2ND, Last Modified April 12, 1995. ARC files in http://pubs.usgs.gov/of/1992/ofr-92-0507.

APPENDIX E

*Elements of Habitat for Ptilagrostis porteri Occurrences**

Site	Name	Geology	Habitat	Associates
1	Geneva Park 1	Granite-Gneiss	Willow carr, hummocks	*Salix planifolia*, *S. geyeriana*, *Dasiphora floribunda*, *Clementsia rhodantha*, *Juncus* spp., *Deschampsia cespitosa*, *Alopecurus*, *Phleum commutatum*, *Calamagrostis canadensis*, *Agrostis* spp., *Betula glandulosa*, *Danthonia intermedia*, *Festuca arizonica*
2	Geneva Park 2 (Geneva Creek)	Granite-Gneiss	Willow carr, hummocks	*Salix planifolia*, *Dasiphora floribunda*, *Thalictrum alpinum*, *Deschampsia cespitosa*
3	Long Gulch – A & B	Granite-Gneiss	Willow carr, beaver dams	*Salix brachycarpa*, *S. monticola*, *S. planifolia*, *Dasiphora floribunda*, *Clementsia rhodantha*, *Carex aurea*, *Phleum commutatum*, *Deschampsia cespitosa*, *Thalictrum alpinum*, *Betula glandulosa*
5	Twin Lakes	Limestone-Shale-Sandstone	"Subalpine meadow"	*Poa* spp., *Carex* spp., *Salix* spp.
6	Monte Cristo Creek	Granite-Gneiss	Small patch alpine wetland	*Carex rupestris*, *Deschampsia cespitosa*, *Kobresia myosuroides*, *Festuca brachyphylla*, *Trisetum spicatum*, *Luzula spicata*, *Dasiphora floribunda*, *Salix planifolia*, *Betula glandulosa*, *Saussurea weberi*, *Gentianodes algida*
7	Lost Park Campground	Granite-Gneiss	Willow carr, included small fens	*Salix geyeriana*, *S. planifolia*, *Deschampsia cespitosa*, *Dasiphora floribunda*, *Carex aquatilis*, *Clementsia rhodantha*, *Festuca idahoensis*, *Betula glandulosa*
9	East Lost Park	Granite-Gneiss	Interspersed willow carrs-fens-cinquefoil, hummocks with swales filled in	*Dasiphora floribunda*, *Salix brachycarpa*, *S. planifolia*, *Deschampsia cespitosa*, *Betula glandulosa*, *Calamagrostis canadensis*
10	Beaver Creek 1 (lower)	Limestone-Shale-Sandstone	Willow carr, beaver dams, included small fens, some hummocks	*Betula glandulosa*, *Salix monticola*, *S. planifolia*, *S. brachycarpa*, *Carex aquatilis*, *Deschampsia cespitosa*, *C. utriculata*, *Dasiphora floribunda*, *Calamagrostis canadensis*, *Carex nebrascensis*, *C. rupestris*
11	Beaver Creek 2 (middle)	Limestone-Shale-Sandstone	Willow carr, beaver dams, included small fens, some hummocks	*Salix planifolia*, *S. glauca*, *Deschampsia cespitosa*, *Carex aquatilis*, *Dasiphora floribunda*, *Betula glandulosa*, *C. nebrascensis*, *Kobresia myosuroides*
12	Palmer Peak	Limestone-Shale-Sandstone	"Above timberline, 11,800 ft"	*Salix brachycarpa*
13	Hollthusen Gulch	Limestone-Shale-Sandstone	Tall willow carr matrix with rich fens and extreme rich fens as patches	*Salix planifolia*, *Carex aquatilis*, *Kobresia myosuroides*, *Thalictrum alpinum*, *Trichophorum pumilum*
14	Crooked Creek Spring	Limestone-Shale-Sandstone	Tall willow carr at edges, hummocks and swales, some extreme rich fens	*Kobresia myosuroides*, *Salix candida*, *Dasiphora floribunda*, *S. planifolia*, *S. brachycarpa*, *Carex aquatilis*, *C. utriculata*, *Gentianodes algida*
15	Sacramento Creek 1	Limestone-Shale-Sandstone	Hummocky peat fen	*Salix* spp., *Dasiphora floribunda*
16	Little Sacramento Creek	Limestone-Shale-Sandstone	Willow carr, hummocks	*Salix brachycarpa*, *S. planifolia*, *Dasiphora floribunda*, *Saussurea weberi*, *Betula glandulosa*, *Psychrophila leptosepala*
17	Little Sacramento Creek 2	Limestone-Shale-Sandstone	Willow carr with fens, hummocks	*Salix planifolia*, *S. brachycarpa*, *Betula glandulosa*, *Carex* spp., *Juncus* spp., *Deschampsia cespitosa*, *Dasiphora floribunda*, *Gentianodes algida*
18	Warm Springs	Limestone-Shale-Sandstone	Peaty willow carr, hummocks	*Salix brachycarpa*, *S. candida*, *Kobresia myosuroides*, *Juncus arcticus*, *Carex simulata*, *C. aquatilis*, *Eleocharis quinquenervis*, *Trichophorum pumilum*

Appendix F (concluded).

Site	Name	Geology	Habitat	Associates
20	Teller Mountain (Upper Hall Valley)	Granite-Gneiss	High subalpine willow carr	*Armeria maritima*, *Saussurea weberi*
21	Abyss Trailhead	Granite-Gneiss	Fen, willow carr, hummocks	*Salix planifolia*, *Dasiphora floribunda*, *Thalictrum alpinum*, *Carex aquatilis*, *Betula glandulosa*, *S. brachycarpa*, *C. capillaris*
22	Farish Recreation Area	Granite-Gneiss	Willow carr, sedge peatland, hummocky	*Salix planifolia*, *S. monticola*, *S. brachycarpa*, *Dasiphora floribunda*, *Carex utriculata*, *C. aquatilis*, *C. simulata*, *C. pellita*, *Deschampsia cespitosa*, *Calamagrostis canadensis*, *Alopecurus aequalis*, *Geum macrophyllum*, *Clementsia rhodantha*, *Lomatogonium rotatum*
24	High Creek Fen	Limestone-Shale-Sandstone	Extreme rich calcareous fens ("best example"), part with peat hummocks	*Salix candida*, *Kobresia simpliuscula*, *Trichophorum pumilum*, *S. brachycarpa*, *Dasiphora floribunda*, *Carex scopulorum*, *Parnassia parviflora*
25	South Fork South Platte	Limestone-Shale-Sandstone	Extreme rich fen	*Dasiphora floribunda*, *Deschampsia cespitosa*, *Salix candida*, *S. brachycarpa*, *Betula glandulosa*, *Carex simulata*, *D. cespitosa*
26	(North) Tarryall Creek	Limestone-Shale-Sandstone	Rich fen, peat hummocks	*Thalictrum alpinum*, *Kobresia myosuroides*, *Dasiphora floribunda*
27	Fremont's Fen (Michigan Creek Fen)	Limestone-Shale-Sandstone	Many large hummocks, large population(s) of *Ptilagrostis*; past peat mining around edges	*Kobresia myosuroides*, *Thalictrum alpinum*, *Trichophorum pumilum*
28	South Jefferson (Creek)	Limestone-Shale-Sandstone	Hummocky fen	*Kobresia myosuroides*, *Thalictrum alpinum*
29	Wahl Ranch (Jefferson and Guernsey Creeks)	Limestone-Shale-Sandstone	Rich fens and extreme rich fen	*Sisyrinchium pallidum*, *Kobresia myosuroides*, *Trichophorum pumilum*, *Thalictrum alpinum*, *Salix candida*
31	Geneva Creek W5	Granite-Gneiss	Fens with hummocks in willow carr	*Salix planifolia*, *Betula glandulosa*, *Dasiphora floribunda*, *Thalictrum alpinum*, *Pedicularis groenlandica*, *Carex aquatilis*, *C. canescens*, *Sphagnum* sp., *Calamagrostis canadensis*, *Clementsia rhodantha*, *Kobresia* sp.

*Only sites with vegetation and habitat descriptions shown in this table.

Sources:

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von Ahlefeldt, J. 1999. High elevation riparian area evaluation for known and potential Porter's needlegrass, *Ptilagrostis porteri* habitat: History, remote sensing relationships and management. Pike and San Isabel National Forests, Pueblo, CO. 75 pp.

APPENDIX F

North American Plant Species Mentioned in Document

Scientific Name*	Code†	Common Name	Alternative Name
Shrubs			
Betula glandulosa	BEGL	bog birch	*Betula nana*
Dasiphora floribunda	DAFL3	shrubby cinquefoil	*Pentaphylloides floribunda*
Salix spp.	SALIX	willow	
Salix brachycarpa	SABR	barrenground willow, short-fruited willow	
Salix candida	SACA4	hoary willow, sageleaf willow	
Salix geyeriana	SAGE2	Geyer willow, silver willow	
Salix glauca	SAGL	grayleaf willow, glaucous willow	
Salix monticola	SAMO2	serviceberry willow, park willow, mountain willow	
Salix planifolia	SAPL2	planeleaf willow	
Graminoids			
Agrostis spp.	AGROS2	bentgrass	
Alopecurus aequalis	ALAE	shortawn foxtail	
Calamagrostis canadensis	CACA4	bluejoint reedgrass	
Carex spp.	CAREX	sedge	
Carex aquatilis	CAAQ	water sedge	
Carex aurea	CAAU3	golden sedge	
Carex capillaris	CACA12	hair sedge	
Carex livida	CALI	livid sedge	
Carex nebrascensis	CANE	Nebraska sedge	
Carex pellita	CAPE42	woolly sedge	*Carex lanuginosa*
Carex rupestris	CARU3	curly sedge	
Carex scopulorum	CASC12	cliff sedge, mountain sedge	
Carex simulata	CASI2	short-beaked sedge	
Carex utriculata	CAUT	beaked sedge	
Danthonia intermedia	DAIN	timber oatgrass, timber danthonia	
Deschampsia cespitosa	DECE	tufted hairgrass	*Deschampsia caespitosa*
Eleocharis quinquenervis	ELQU2	few-flowered spike-rush, few-flowered spike-sedge	
Elytrigia repens	ELRE2	quackgrass	
Festuca arizonica	FEAR2	Arizona fescue	
Festuca brachyphylla	FEBR	alpine fescue	
Festuca idahoensis	FEID	Idaho fescue	
Juncus spp.	JUNCU	rush	
Juncus arcticus	JUAR2	Arctic rush	*Juncus balticus*
Kobresia myosuroides	KOMY	Bellard's kobresia	
Kobresia simpliuscula	KOSI2	simple bog sedge	
Luzula spicata	LUSP4	spike woodrush	
Phleum commutatum	PHCO9	alpine timothy	*Phleum alpinum*

Appendix F (concluded).

Scientific Name*	Code†	Common Name	Alternative Name
Poa spp.	POA	bluegrass	
Poa pratensis	POPR	Kentucky bluegrass	
Ptilagrostis kingii	PTKI	Sierra false needlegrass	*Oryzopsis kingii*
Ptilagrostis porteri	PTPO	Porter's feathergrass, Porter's false needlegrass	*Ptilagrostis mongholica* ssp. *porteri*
Trichophorum pumilum	TRPU18	little bulrush, Rolland's bulrush	*Scirpus rollandii*
Trisetum spicatum	TRSP2	spike trisetum	
Forbs			
Armeria maritima	ARMA6	sea pink	*Armeria scabra*
Clementsia rhodantha	CLRH2	rose-crown, redpod stonecrop	*Sedum rhodanthum*
Gentianodes algida	GEAL6	alpine gentian, whitish gentian	*Gentiana algida*
Geum macrophyllum	GEMA4	large-leaved avens	
Lomatogonium rotatum	LORO	marsh felwort	
Parnassia parviflora	PAPA9	small-flowered grass-of-Parnassus	
Pedicularis groenlandica	PEGR2	elephant-head, elephanthead lousewort	
Primula incana	PRIN	silvery primrose	
Psychrophila leptosepala	PSLE	marsh marigold	*Caltha leptosepala*
Saussurea weberi	SAWE	Weber's saw-wort	
Sisyrinchium pallidum	SIPA11	pale blue-eyed-grass	
Taraxacum officinale	TAOF	dandelion	
Thalictrum alpinum	THAL	alpine meadow-rue	

*Scientific names follow Weber and Wittmann 2001b

†Codes follow USDA Natural Resources Conservation Service 2005.