# Status of *Antennaria arcuata* (Meadow pussytoes) in Sublette County, Wyoming

Prepared for the Bureau of Land Management - Pinedale and Rock Springs Field Offices

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## ABSTRACT

Surveys were conducted for *Antennaria arcuata* (Meadow pussytoes) in Sublette County, southwestern Wyoming. Potential habitat was surveyed throughout the Upper Green River Basin and the nearest potential habitat at the head of the Sweetwater River watershed. This report presents the results of the first systematic surveys in the Upper Green River Basin, documenting nine populations on all three sides of the basin, and building on all prior work. *Antennaria arcuata* was previously characterized as having a two-part distribution in Fremont and Sublette counties whereas results of the current survey suggest a more contiguous distribution pattern and expand information on habitat requirements. Incidental to surveying *Antennaria arcuata*, five other wetland species of concern were documented that are not otherwise known from BLM lands in Wyoming. One is a recently-recognized addition to the state flora. They do not occupy the same wetland vegetation zone but their confluent habitat provides context for understanding the habitat of *Antennaria arcuata*. Results for each of the five species are presented in a report chapter on additional survey results.



## ACKNOWLEDGEMENTS

Michael Kirkpatrick (WYNDD) helped conduct *Antennaria arcuata* field surveys and provided review of the report. Victoria Pennington (WYNDD) contributed many of the preparations needed for 2012 field surveys of *A. arcuata* using Geographic Information System software and layers for photointerpretation and assembling maps, digitized survey routes after the field season, provided help in preparing tables and climate data that appear in this report, and provided review.

Consultation with Dr. Robert Dorn is acknowledged with thanks. The Rocky Mountain Herbarium facility (University of Wyoming) and personnel are integral to this and all species studies. Review of all *Utricularia* specimens by Garrett Crow (University of New Hampshire) is greatly appreciated. Finally, the interest and insights of Karen Clause, Natural Resource Conservation Service of southwestern Wyoming, are acknowledged with thanks.

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Cover page: Meadow pussytoes (*Antennaria arcuata*), by B. Heidel

# Table of Contents



APPENDICES

TABLES



FIGURES

## INTRODUCTION

*Antennaria arcuata* (meadow pussytoes) is a rare species characterized as a Great Basin regional endemic having small, disjunct populations (Bayer 1992). Its distribution centers include Blaine County, Idaho; Elko County, Nevada; and Fremont County, Wyoming (Bayer 1992, Bayer 2006, USDA PLANTS Database 2012). After a Wyoming status report was written (Fertig 1996), it was also documented at three places in the Upper Green River Basin in Sublette County, Wyoming by Steve Laster (Bureau of Land Management; BLM). The purpose of this project was to conduct systematic surveys for *A. arcuata* in Sublette County, separate from prior fieldwork in Fremont County.

## STUDY AREA

Field surveys for *Antennaria arcuata*, a BLM sensitive species (USDI BLM 2001, 2010), were conducted in Sublette County, Wyoming by Wyoming Natural Diversity Database (WYNDD). There were two main reasons for framing this as the study area. It represented the area having three records of *Antennaria arcuata* with limited population information. The three populations were originally documented by Steve Laster, BLM. The three populations were on opposite sides of the basin, a distance that suggested a potential breadth of distribution. Likewise, a potential distribution model (Fertig and Thurston 2003) indicated that the county had large areas of unsurveyed potential habitat (Figure 1). The 2012 surveys addressed the full range of potential habitat in Sublette County. The study area is also referred to as the Upper Green River Basin throughout this document, though survey scope was expanded to include the corner of the Sweetwater watershed that enters Sublette County.

## METHODS

At the start of this project, all available literature on *Antennaria arcuata* was reviewed, known distribution in Sublette County was studied, and potential distribution was superimposed as modeled by Fertig and Thurston (2003). Three prior systematic surveys for *A. arcuata* were conducted in Fremont County (Whiskey Basin Consultants 1982, Marriott 1986, Fertig 1996). An ArcMap project platform was set up using known and potential distribution, bedrock geology mapping (based on Love and Christiansen 1985), digital ortho-photographs (NAIP 2006), and U.S. Geological Survey mapping.

Two approaches were taken in targeting areas for survey: modeling and photointerpretation. Highest probability areas found on public land were targeted (Figure 1), in keeping with a potential distribution model (Fertig and Thurston 2003). The environmental factors that sorted out in the potential distribution model were July temperature, bedrock geology, elevation and relief. The areas flagged in the potential distribution model tended to be

continuous bands or large polygons bordering the basin, requiring photointerpretation to locate riparian meadow habitat within them.

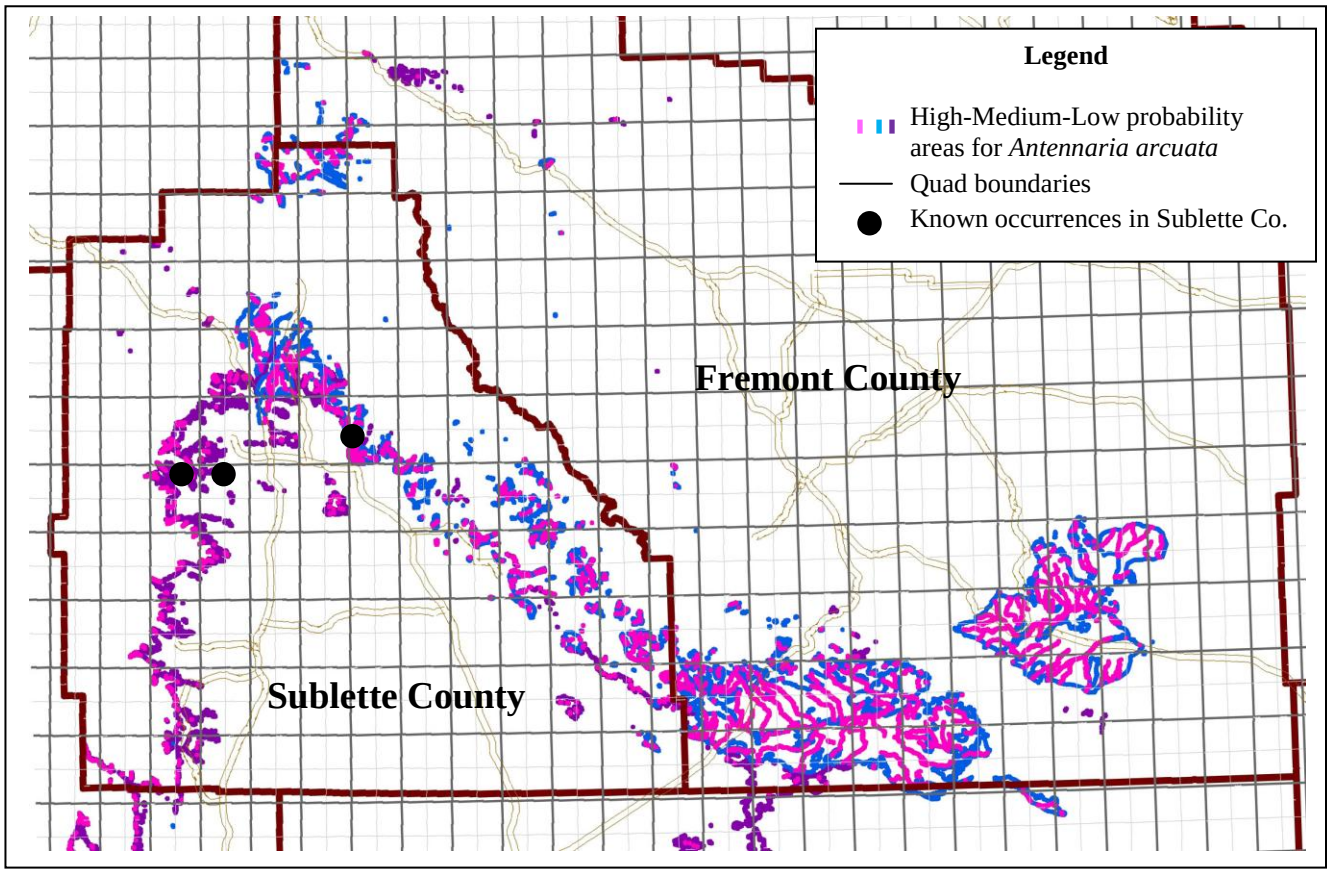



Figure 1. Potential distribution model of *Antennaria arcuata* in Sublette County, WY; based on output from Fertig and Thurston (2003)

Photointerpretation was conducted across the Upper Green River Basin of Sublette County, independent of and in tandem with potential distribution model work. Only one of the three known populations had precise location information, so it was evaluated to see if diagnostic signatures could be discerned for species' habitat on aerials. None could be discerned initially, therefore, it was not possible to narrow down the pool of riparian meadow sites. Large wet meadow sites were an automatic priority where present on public lands. As the study progressed, habitat signatures were recognized and targets reconsidered.

In preparation for fieldwork, digital ortho quarter-quads (doqqs) were printed with section lines, known distribution, and potential distribution superimposed onto 8 ½" x 11" pages of paper, representing about the same scale as 1:24,000 U.S.G.S. topographic maps. The aerials and U.S.G.S. maps were both used for reference in setting field survey priorities and navigation

in the field. About 40 U.S.G.S. topographic map areas intersected with potential habitat, representing about 100 doqq printouts (Figure 1).

Surveys for *Antennaria arcuata* were conducted by 1-2 people, working between 6 July – 23 August 2012, working in tandem on different sides of the same valley, different valley segments or different valleys. When *A. arcuata* was found, determinations were made of its extent, and characterizations were made of its environmental setting, habitat conditions, and plant associates. A single Geographic Positioning System (GPS) point was taken for subpopulations of 10 m radius or less. Otherwise multiple GPS points were taken. Stem counts were not made because the species reproduces vegetatively by stolons, although rough estimates were made to compare relative population sizes. Frequency was noted (uncommon, common, abundant/dominant). Sensitive plant survey forms were filled out, and later entered in the WYNDD database. Survey routes are represented in Appendix A. Voucher specimens were collected for every new population and for old populations that were precisely-located and mapped for the first time. All specimens were deposited at Rocky Mountain Herbarium, and duplicates to New York Botanic Garden.

## RESULTS - SPECIES INFORMATION

### Classification

Scientific name: *Antennaria arcuata* Cronq.

History of the species: The species was first described by Arthur Cronquist based on a 1946 collection by J.H. Christ (16065) from hayfields near Carey in Blaine County, Idaho. A specimen from the Atlantic City – Sweetwater River area was collected by Johnson (s.n.) in 1905, Fremont County, Wyoming; but not identified as *A. arcuata* until Cronquist annotated it in 1952 (Cronquist 1955). It was discovered in Elko County, Nevada in the late 1970's. The first surveys for it in Wyoming were conducted in the late 1970's.

Synonyms: None

Common name: Meadow pussytoes (also called Box pussytoes or Arching pussytoes)

Family: Asteraceae

Size of genus: The *Antennaria* genus is comprised of 45 species (34 in North America; Bayer 2006). The genus is widespread across temperate and arctic/alpine regions of North America, Eurasia and South America, also present in Mexico.

Phylogenetic relationships: *Antennaria arcuata* is a sexual diploid and the only member of the Arcuatae clade within the *Antennaria* genus based on phylogenetic analysis using ITS regions of rDNA (Bayer et al. 1996, Bayer 2006). Before that time, it was placed in the Argenteae clade with two other sexual diploid taxa (Bayer 1992). Its phylogenetic relationships and origins have not been determined.

**Present legal or other formal status**

U.S. Fish & Wildlife Service: None. In 1975, *Antennaria arcuata* was included in the first list of species considered for designation under the Endangered Species Act, and proposed as Endangered the following year (USDI Fish & Wildlife Service 1975). It became a Category 2 candidate for listing under the Act beginning in 1980 (U.S. Fish and Wildlife Service 1980, 1985, 1990, 1993). The recognition of Category 2 species was replaced with a new Species at Risk category in 1996. However, the list is not maintained and species in this category are not considered formal candidates for listing.

Agency status: Designated sensitive by Wyoming Bureau of Land Management (BLM 2001, 2010). It is also designated sensitive by Nevada Bureau of Land Management and U.S. Forest Service – Region 4.

Global Heritage rank: G3; previously G2. The rank prior to this study indicated that the species was imperiled throughout its range. The global rank was last reviewed in 1997. Updating of the global rank to G3 (vulnerable) was conducted by WYNDD as part of this study, in collaboration with NatureServe.

State Legal status: None

State Heritage rank: S3; previously S2. It has been recognized as a rare species in Wyoming ever since the earliest state lists (Clark and Dorn 1979). The previous state rank (S2) was last reviewed in 2012 before the field season (Heidel 2012). Updating of the state rank to S3 (vulnerable) was conducted by WYNDD as part of this study.

**Description**

General non-technical description: Meadow pussytoes is a white-woolly perennial herb that spreads by conspicuously arching woolly stolons up to 10 cm long. Flowering stems are 5-40 cm tall with relatively few oblanceolate leaves that are equally grayish-white hairy above and below. Flower heads are numerous, clustered at the tip of the stem, and have membranous, white-tipped bracts and white disk flowers (ray flowers are absent). Individual plants are unisexual. Pistillate plants have involucres 4-6 mm long, and staminate plants have involucres 5-7 mm long (Cronquist 1950; Dorn and Dorn 1980, Dorn 2001; Marriott 1986; Fertig et al. 1994; Fertig 1996; Figures 2-5 and report cover).

Technical description: Plants perennial, 5-15 (40) cm tall with woolly stems. Stolons 4-10 cm and arched. Basal leaves 1-3-nerved, narrowly to broadly spatulate, or narrowly rhombic-obovate, 20-45 x 3-15 mm, tips mucronate, faces densely white-woolly. Cauline leaves linear, (2-)5-40 mm, not flagged. Heads (4-)7-25, in racemiform to paniculiform or corymbiform arrays. Involucres staminate 3-5 mm; pistillate 4.5-6(-7) mm. Phyllaries distally whitish (mostly staminate) or graying stramineous to light brown. Corollas staminate 2.5-4 mm; pistillate 3.5-5 mm. Cypselae 1-1.8 mm and glabrous, pappi staminate 3-4.5 mm; pistillate 4-6 mm. 2*n*=28. (Bayer 2006). Note: The relative length of pistillate and staminate involucres was first described by Dorn and Dorn (1980) and differs from Bayer (2006).

Local field characters: Recognized by its long, arching, sparsely-leafy, densely white-woolly stolons that develop by flowering time.

Similar species: *Antennaria microphylla, A. parvifolia*, and *A. rosea* have short, non-woolly stolons and densely crowded basal rosettes. *A. flagellaris* has slender, glabrous stolons and inflorescences composed of a single flower head. Other *Antennaria* species in Wyoming lack stolons, have glabrous upper leaf surfaces, or dark-tipped involucral bracts. *Gnaphalium chilense* is an annual or biennial herb with bisexual flower heads and yellowish, membranous involucral bracts (Dorn 2001, Fertig et al. 1994, Fertig 1996).

Phenology: Flowering late June-July; in fruit July-August.

**Geographical distribution**

Range: Regional endemic found in disjunct areas in south-central Idaho, northeastern Nevada, and central to southwest Wyoming (Figure 6). In Wyoming, it was known from the Sweetwater River Valley with a concentration of populations in the South Pass area of the southern Wind River Range in the vicinity of Atlantic City, but extending as far east as Jeffrey City. Prior to this study it was known as far west as Oregon Buttes in the Sweetwater watershed, and from three locations in the Upper Green River Basin. As a result of this study, it has been found much more widely at Basin margins and its Sweetwater watershed distribution was extended westward, all in Sublette County (Figures 7, 8).

Extant sites: *Antennaria arcuata* is known from 30 occurrences in Wyoming in a discontinuous distribution (Figures 8-9; Table 1). Nine occurrences are in Sublette County and the rest are in Fremont County. All Fremont County occurrences lie within the Sweetwater River watershed and border named rivers or streams. Eight of the nine Sublette County occurrences are in the Upper Green River watershed whereas the ninth is in headwaters of the Sweetwater River. Almost all are on draws with ephemeral flow or on unnamed tributaries. The locations of *Antennaria arcuata* sites in 2012 Sublette County surveys are grouped separately from Fremont County sites in Table 1.

Figure 2. *Antennaria arcuata* illustration. By W. Fertig. From: Fertig et al. 1994.

Figure 3. *Antennaria arcuata* in flower (pistillate flowers). Note: All photos are by B. Heidel unless otherwise stated.

Figure 4. *Antennaria arcuata* woolly stolons, on display by Steve Laster.

Figure 5. *Antennaria arcuata* in flower (staminate flowers).

Figure 6 (right). Distribution of *Antennaria arcuata* rangewide

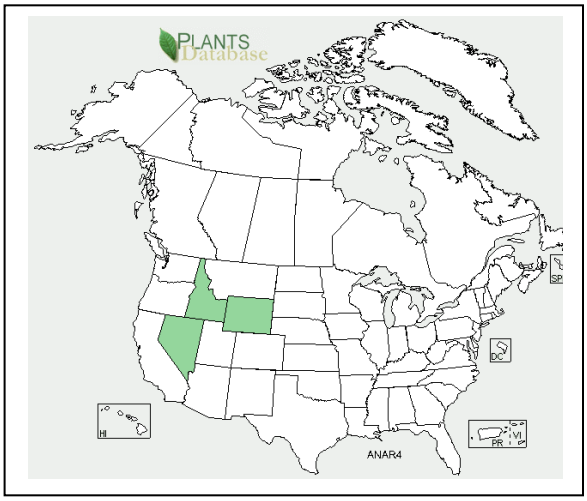
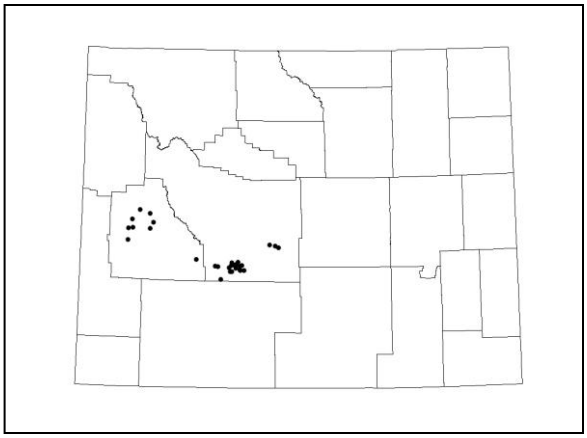



Figure 7 (right). Distribution of *Antennaria arcuata* in Wyoming



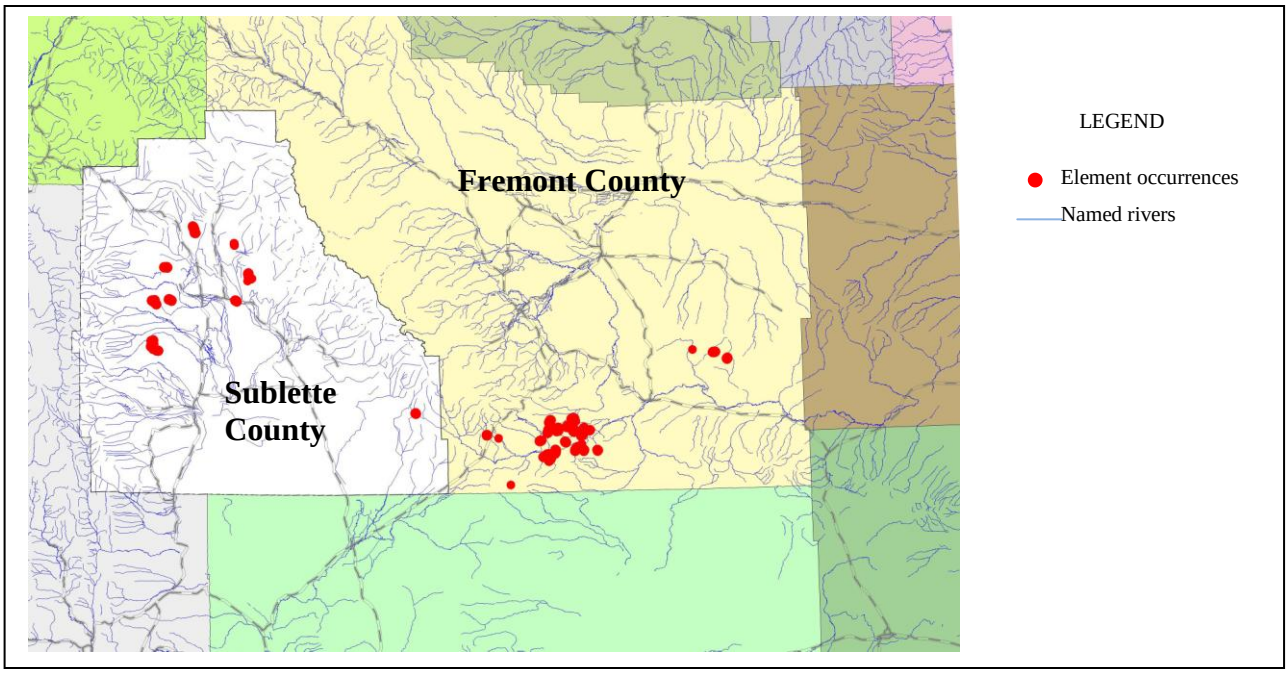



Figure 8. Distribution of *Antennaria arcuata* after surveys in Sublette County, Wyoming

Table 1. Location of *Antennaria arcuata* populations in Wyoming

| EO# | Directions | County | Legal Description | Elev. ft (m) | USGS 7.5' Quad | Public Land |
|---|---|---|---|---|---|---|
| **SUBLETTE COUNTY (BLM PINEDALE AND ROCK SPRINGS FIELD OFFICES)** | | | | | | |
| 024 | Ca 1-2 miles southwest and west of Soda Lake along two tributaries of Hay Gulch, ca 2.1-2.75 miles west of Fremont Lake and 5 air miles north of Pinedale. | Sublette | T34N R109W Sec. 3, 4, 9; T35N R109W Sec. 33 | 7420-7540 (2262-2298) | Cora, Fremont Lake South | BLM Pinedale FO |
| 026 | Brodie Draw and unnamed tributary, west of Aspen Ridge, ca. 10.2 air miles west-southwest of Daniel Junction. | Sublette | T33N R112W Sec. 6; T34N R112W Sec. 31; T34N R113W Sec. 36 | 7500-7560 (2286-2304) | Halfway, Merna | BLM Pinedale FO; State of Wyoming |
| 027 | Ryegrass Draw, ca 7 air miles west of Daniel. | Sublette | T34N R112W Sec. 34 | 7300-7400 (2225-2256) | Onion Springs, Webb Draw | BLM Pinedale FO |
| 028 | Duck Creek, ca. 3.5 miles west of Pinedale, on north side of U.S. Highway 191 and north side of creek. | Sublette | T34N R110W Sec. 36 | 7210 (2198) | Mount Airy | State of Wyoming |
| 029 | Unnamed tributary of Webb Draw, on the southwest flank of Beaver Ridge, ca. 7.5 air miles northwest of Daniel Junction. | Sublette | T35N R112W Sec. 28 | 7340-7420 (2237-2261) | Webb Draw | BLM Pinedale FO |
| 030 | Unnamed tributary of Green River, ca. 13-14.5 air miles north of Daniel Junction, ca. 4.5-6 air miles north of Warren Bridge. | Sublette | T36N R111W Sec. 9, 16 | 7580-7680 (2310-2341) | Warren Bridge | BLM Pinedale FO, State of Wyoming |
| 031 | Upper ends of North and South Antelope Draws and unnamed draw to immediate south, ca 13.5 air miles northwest of Marbleton. | Sublette | T32N R113W Sec. 22, 27, 34, 35, 36 | 7560-7790 (2304-2374) | Halfway, Meadow Canyon | BLM Pinedale FO |
| 032 | Wind River Range, west slope, Jensen Meadows, tributary of Lander Creek on east side of Continental Divide, ca. | Sublette | T29N R103W Sec. 6 | 8000 (2438) | Jensen Meadows | State of Wyoming, BLM Rock Springs FO |
| 033 | Unnamed tributary of Willow Creek, ca 2.5 air miles south of New Fork Lakes, ca. 12.5 air miles north-northwest of Pinedale. | Sublette | T36N R110W Sec. 36 | 7480 (2280) | New Fork Lakes | State of Wyoming |
| **FREMONT COUNTY (BLM LANDER AND ROCK SPRINGS FIELD OFFICES)** | | | | | | |
| 001 | Vicinity of Burr Mine [Burr Gulch], ca 1 mile north of the Sweetwater River. | Fremont | T28N R98W Sec. 8 | 7300 (2225) | Radium Springs | BLM Lander FO |
| 003 | Granite Creek drainage, ca 0.1 miles north of Chicken Springs and ca 1.3 air miles south of the Sweetwater River. Also on Granite Creek ca 1 mile upstream of the Sweetwater River on south bank. | Fremont | T28N R98W Sec. 11, 15, 22 | 7300 (2225) | Lewiston Lakes; Radium Springs | BLM Lander FO |

| | | | | | | |
|---|---|---|---|---|---|---|
| 004 | Mormon Creek, in vicinity of Mormon Springs, ca 2 air miles south of the Sweetwater River. | Fremont | T28N R98W Sec. 13, 24 | 7200 (2195) | Lewiston Lakes | BLM Lander FO; State of Wyoming |
| 005 | Tributary to east of Willow Creek, ca 3 air miles north of the Sweetwater River, ca 5-6 miles southeast of Atlantic City. | Fremont | T28N R99W Sec. 4, 5, 8 | 7300-7350 (2225-2240) | Atlantic City | BLM Lander FO |
| 006 | Long Slough, ca 1 air mile south of the Sweetwater River on the west side of BLM Road 2317. | Fremont | T28N R99W Sec. 22, 27, 28 | 7200 (2195) | Atlantic City; Radium Springs | BLM Lander FO, BLM Rock Springs FO |
| 007 | Harris Slough, just south of the Sweetwater River, ca 1 mi le west of Buffalo Gulch. Also on tributary of Harris Slough, ca 2 air miles south of the Sweetwater River, ca 4 miles west of the Antelope Hills. | Fremont | T28N R99W Sec. 13, 23, 24, 26, 27, 34 | 7200-7300 (2195-2225) | Circle Bar Lake; Radium Springs | BLM Lander FO; Sweetwater Preserve |
| 009 | McLean Meadows and adjacent small tributary drainages of the Sweetwater River on its north bank, just east of the confluence of Strawberry Creek, 0.5-1 air miles west of the Lewiston Lakes. | Fremont | T28N R98W Sec. 2; T29N R97W Sec. 30, 31; T29N R98W Sec. 36 | 7200-7340 (2195-2240) | Lewiston Lakes | BLM Lander FO |
| 010 | Level Meadows Creek,drainage east of Atlantic City, ca 5 miles north of the Sweetwater River. | Fremont | T29N R98W Sec. 14 | 7300 (2225) | Radium Springs | BLM Lander FO |
| 011 | Upper Deep Creek, on north side of Atlantic City-Hudson Road, ca 10.5 air miles east-southeast of Atlantic City. | Fremont | T29N R98W Sec. 22, 27, 28 | 7500-7560 (2285-2300) | Radium Springs | BLM Lander FO |
| 012 | Diamond Creek from the south side of the Atlantic City-Sweetwater Station Road south ca mile to its confluence with Deep Creek near the Gilespie Cabin Historic Site and Radium Springs, ca 2.25-3.25 miles north of the Sweetwater River. | Fremont | T29N R98W Sec. 26, 35 | 7400 (2255) | Radium Springs | BLM Lander FO |
| 013 | Northeast fork of Upper Strawberry Creek, and ca 0.2 miles north of the Atlantic City· Hudson Road. | Fremont | T29N R98W Sec. 29, 30 | 7500-7540 (2285-2300) | Radium Springs | BLM Lander FO |
| 015 | Headwaters of Strawberry Creek at the Crow's Nest, 6-6.5 miles north of the Sweetwater River. | Fremont | T29N R99W Sec. 13 | 7600-7640 (2315-2330) | Radium Springs | BLM Lander FO |
| 016 | Along tributary northeast of Rock Creek, ca 0.5 air miles north of the Handcart Site on the Oregon Trail. | Fremont | T29N R99W Sec. 25, 26, 35 | 7400 (2255) | Radium Springs | BLM Lander FO |
| 017 | Pine Creek, ca 2.7 air miles | Fremont | T28N R101W | 7700 | South Pass | BLM Rock |

| | | | | | | |
|---|---|---|---|---|---|---|
| | south-southwest of South Pass City. | | Sec. 1 | (2345) | City | Springs FO |
| 018 | Fish Creek at crossing with WY Highway 28 at southwestern-most turnoff to South Pass City, ca 8.5 air mi west-southwest of Atlantic City. | Fremont | T29N R101W Sec. 34 | 7900 (2410) | Anderson Ridge; South Pass City | BLM Rock Springs FO |
| 019 | Tributary to west of Buffalo Creek, ca 12 air miles east-northeast of Jeffrey City. | Fremont | T31N R92W Sec. 8, 17 | 6840-6900 (2085-2105) | Muskrat Basin | BLM Lander FO |
| 020 | East Fork of East Long Creek, ca 14 air mi north-northwest of Jeffrey City. | Fremont | T31N R93W Sec. 1, 2 | 6900-7000 (2105-2135) | Tin Cup Mountain | BLM Lander FO |
| 021 | Upper end of Chimney Creek, ca 0.2 miles northeast of the uppermost of the Lewiston lakes, ca 1.4 air miles north of Sweetwater River Canyon. | Fremont | T29N R97W Sec. 29, 32 | 7250 (2210) | Lewiston Lakes | BLM Lander FO; Sweetwater Preserve |
| 022 | Ca 4 air miles west of Continental Peak and ca 5 air miles northeast of Oregon Buttes in Oregon Gulch drainage. | Fremont | T27N R100W Sec. 29 | 7572-7600 (2305-2315) | Dickie Springs | BLM Rock Springs FO |
| 023 | South Fork of Willow Creek in vicinity of spring, 2.5 air miles south of confluence of Willow Creek and Sweetwater River, ca 1 mile north of Strawberry Creek. | Fremont | T28N R97W Sec. 21 | 7370 (2245) | Lewiston Lakes | BLM Lander FO |
| 025 | Sweetwater River Plateau; on south side of 2-track about 1 mile east of road crossing Long Creek, about 2 air miles north of Long Creek mountain, ca 9 air miles east of WY Hwy 135. | Fremont | T31N R93W Sec. 6 | 6860 (2091) | Elkhorn Springs | BLM Lander FO |

*Antennaria arcuata* has a relatively long history of surveys in Wyoming. It was collected for the first time in the state in 1905 (*Johnson s.n.* RM) and annotated by Cronquist in 1952 (Cronquist 1955). Its recognition under the Endangered Species Act in 1975 drew attention of agencies. Wyoming surveys were conducted for the U.S. Forest Service by Barry Johnston in 1977-1978, and for the Bureau of Land Management between 1978-1982 by BLM staff (James Saulmon, BLM State Botanist) and consultants Robert Dorn and Robert Lichvar (Whiskey Basin Consultants 1982). In 1985, its distribution was extended further east in Fremont County as part of floristic surveys by June Haines (Haines 1988). The first Wyoming status report was produced by Hollis Marriott (Marriott 1986). Survey work was expanded and past population sites revisited to produce a second status report by Walter Fertig (Fertig 1996), with revisionary mapping of occurrences by drainage and separation distance standards so that the running tallies of populations and population/site names were revised at that time compared to earlier ones. In

1995, its distribution was extended further west in Fremont County as part of floristic surveys by Laura Welp (Welp et al. 1986, Welp 1987). The current report represents Sublette County surveys, while drawing from all prior work.

Historical sites: None.

Unverified/Undocumented reports: None.

Sites where present status not known: Two of the four original subpopulations in the Soda Lake area of Sublette County (#024) could not be relocated in 2012. One of those two is in a relatively dry setting affected by both grazing intensity and drought conditions of 2012. The other location either had a location error if on public land, or else fell on private land as recorded on the collection label.

One of the new Sublette County populations, on Duck Creek (#028), was surveyed on state lands but not on contiguous BLM lands because they had only small slivers of potential habitat set off by the meandering creek, and unclear boundaries between public and private land.

In addition, the Fremont County population on Pine Creek (#017) could not be relocated in 1995 and may be extirpated. The rest of sites in Fremont County have not been revisited since 1995 or 1996, except for visits by BLM Lander Field Office interns to Elkhorn Spring (#025) and McLean Meadows (#009) in 2012.

Areas surveyed but species not located: *Antennaria arcuata* is present in a small fraction of Upper Green River Basin drainages. Unsuccessful searches were conducted along over 50 valley segments and locations upstream and downstream from existing populations. It was sought on 21 U.S.G.S. topographic maps but not found. All surveys are shown in Appendix A.

Land ownership: All Sublette County occurrences are on lands administered by the BLM Pinedale Field Office, the BLM Rock Springs Field Office, or the Department of State Lands. There may be potential habitat on private lands, and some population boundaries are mapped right up to private land boundaries.

**Habitat**

*Antennaria arcuata* is a facultative wetland plant throughout its range (Lichvar 2012). It is found mainly in subirrigated, alkaline meadows of broad, open valleys on Quaternary deposits.

Associated vegetation: In the Sweetwater River valley, the alkaline meadow communities occupied by *Antennaria arcuata* are often found in a matrix of silver sagebrush (*Artemisia cana*) and shrubby cinquefoil (*Pentaphylloides floribunda*). In the Upper Green River Basin, they are

sometimes found with *Artemisia cana* var. *viscidula* and *Pentaphylloides floribunda*. They are absent from riparian zones with tall, dense graminoid or shrub cover and where soils are saturated.

Frequently associated species: *Antennaria arcuata* is associated with facultative and obligate wetland species (Lichvar 2012). Dominants in the Sweetwater watershed included tufted hairgrass (*Deschampsia cespitosa*), Baltic rush (*Juncus balticus*), Kentucky bluegrass (*Poa pratensis*, Nevada bluegrass (*P. nevadensis*; considered by some as a synonym of *P. secunda*), Junegrass (*Koeleria macrantha*), and clustered field sedge (*Carex praegracilis*) (Fertig 1996). Dominants in Sublette County included *Deschampsia cespitosa*, *Juncus balticus*, mat muhly (*Muhlenbergia richardsonis*), rush-like bluegrass (*Poa juncifolia*; considered by some as a synonym of *P. secunda*), *P. secunda*, *Carex praegracilis* and Nebraska sedge (*C. nebrascensis*). A robust list of associated species was reported by Bayer (1992) from six sites used in genetics research, including four in Fremont County, WY and one each in Idaho and in Nevada. The associated species found during surveys in Sublette County overlap with this larger list, include some species associates found in Idaho or Nevada not previously reported in Wyoming, and slightly expand the list (asterisked species in Table 2).

Table 2. Plants associated with *Antennaria arcuata*

| Family | Scientific Name[1] | Sublette Co., WY | Fremont Co., WY | Idaho | Nevada |
|---|---|---|---|---|---|
| Asteraceae | *Achillea millefolium L.* | x | x | x | x |
| Asteraceae | *Agoseris glauca* (Pursh) Raf. var. *glauca* | x | x | | |
| Asteraceae | *Agoseris glauca* (Pursh) Raf. var. *dasysepala* (Torr. & Gray) Jeps. | | x | | |
| Asteraceae | *Antennaria corymbosa*E. Nels. | | x | | |
| Asteraceae | *Antennaria microphylla* Rydb. | x | x | | |
| Asteraceae | *Artemisia cana* Pursh (apparently includes both *A. c.* var. *cana* and *A. c.* var. *viscidula*) | x | x | x | |
| Asteraceae | *Aster ascendens* Lindl. (syn. *Symphyotrichum ascendens*) | | x | x | |
| Asteraceae | *Aster falcatus* Lindl. (syn. *Symphyotrichum falcatum*) | | x | | |
| Asteraceae | **Aster hesperius* (syn. *Symphyotrichum hesperium*) | x | | | |
| Asteraceae | Aster *lonchophyllus* Hook. [probably *Erigeron lonchophyllus*] | | x | | |
| Asteraceae | **Cirsium arvense* (L.)Scop. | x | | | |
| Asteraceae | *Cirsium hookerianum* Nutt. [possibly *C. scariosum*] | | x | | |
| Asteraceae | **Cirsium scariosum* Nutt. | x | x | | |
| Asteraceae | *Crepis tectorum* L. | | x | | |
| Asteraceae | *Erigeron lonchophyllus* Hook. | x | x | | |
| Asteraceae | *Haplopappus lanceolatus* (Hook.) Torr. & Gray (syn. *Pyrrocoma lanceolata* (Hook.) Greene) | x | | x | |
| Asteraceae | *Haplopappus uniflorus* (Hook.) Torr. & Gray (syn. *Pyrrocoma uniflora* (Hook.) Greene) | x | x | x | |
| Asteraceae | *Senecio canus* Hook. | | | | x |
| Asteraceae | *Solidago nana* Nutt. | | x | | |
| Asteraceae | **Taraxacum officinale* L. | x | | | |

[1] Synonyms are in parentheses. Questions about prior determinations are in brackets. This list includes all taxa in Bayer (1992), Marriott (1986) and Fertig (1996). Any other associates species found in Sublette County but not previously reported as an associate is set off by an asterisk (*).

| | | | | | |
|---|---|---|---|---|---|
| Cyperaceae | *Carex aurea* Fern. | | x | | |
| Cyperaceae | *Carex nebrascensis* Dewey | x | x | | |
| Cyperaceae | *Carex praegracilis* Boott | x | x | | |
| Cyperaceae | *Carex simulata* Mack. | | x | x | |
| Cyperaceae | **Eleocharis quinqueflora* (Hartm.) Schw. | x | | | |
| Equisetaceae | *Equisetum laevigatum* A. Br. | | x | | |
| Fabaeeae | *Astragalus agrestis* Dougl. ex G. Don | | x | | |
| Fabaeeae | *Astragalus bodinii* Sheld. | | x | | |
| Fabaeeae | *Astragalus gracilis* Nutt. | | x | | |
| Fabaeeae | *Astragalus vexilliflexus* Sheld. | | x | | |
| Fabaeeae | *Trifolium longipes* Nutt. var. *reflexum* A. Nels. | | x | | |
| Gentianaceae | *Gentiana affinis* Griseb. var. *affinis* | x | x | | |
| Iridaceae | *Iris missouriensis* Nutt. | | x | | x |
| Juncaceae | *Juncus balticus* Willd. var. *montanus* Engelm. | x | | | |
| Juncaceae | *Juncus longistylis* Torrey | | x | | |
| Liliaceae | *Zigadenus elegans* Pursh | | x | | |
| Liliaceae | *Zigadenus venenosus* Wats. var. *gramineus* (Rydb.) Walsh | | x | | |
| Malvaceae | *Sida!cea oregana* (Nutt. ex Torr. & Gray) Gray | | | x | |
| Poaceae | *Agropyron dasystachyum* (Hook.) Scribn. var. *riparium* (Scribn. & Smith) Bowden (*Elymus lanceolatus* (Scribn. & Sm.) Gould var. *lanceolatus*) | x | x | | x |
| Poaceae | **Agrostis stolonifera* L. | x | | | |
| Poaceae | *Bromus ciliatus* L. | | x | | |
| Poaceae | *Bromus japonicus* Thunb. | | | | x |
| Poaceae | *Calamagrostis montanensis* (Scribn.) Scribn. in Vasey | | x | | |
| Poaceae | *Danthonia californica* Bolander | | | x | |
| Poaceae | *Deschampsia cespitosa* (L.) Beauv. | x | x | | |
| Poaceae | *Hordeum brachyanthenum* Nevski | x | x | | x |
| Poaceae | *Hordeum jubatum* L. | | | | x |
| Poaceae | *Koeleria cristata* Pers. | | x | | |
| Poaceae | *Muhlenbergia cuspidata* (Torr.) Rydb. [Possibly *M. richardsonis*] | | x | x | X |
| Poaceae | *Muhlenbergia filiformis* (Thurb. ex Wats.) Rydb. | | x | | |
| Poaceae | **Muhlenbergia richardsonis* (Trin.) Rydb. | x | | | |
| Poaceae | *Oryzopsis pungens* (Torr. ex Spreng.) Hitchc. | | x | | |
| Poaceae | *Phleum alpinum* L. | | x | | |
| Poaceae | *Poa annua* L. | | | x | |
| Poaceae | *Poa arida* Vasey | | x | | |
| Poaceae | **Poa juncifolia* Scribn. | x | | | |
| Poaceae | *Poa nevadensis* Vasey ex Scribn. | | x | | |
| Poaceae | *Poa pratensis* L. | | x | | |
| Poaceae | *Poa sandbergii* Vasey (syn. *Poa secunda* Presl.) | x | x | x | X |
| Poaceae | *Trisetum wolfii* Vasey | | | x | |
| Polemoniaceae | *Phlox kelseyi* Britton | | x | | |
| Primulaceae | *Dodecatheon pulchellum* (Raf.) Merr. | | | | |
| Ranunculaceae | *Ranunculus acriformis* Gray var. *acriformis* | | x | | |
| Rosaceae | *Pentaphylloides floribunda* (Pursh) Love | | x | | |
| Rosaceae | *Potentilla anserina* L. | x | x | | |
| Rosaceae | *Potentilla gracilis* Dougl. ex Hook. var. *elmeri* (Rydb.) Jeps. | | x | x | |
| Rosaceae | *Potentilla gracilis* Dougl. ex Hook. var. *pulcherrima* (Lehm.) Fern. | | | | X |
| Rosaceae | *Potentilla ovina* Macoun var. *ovina* | x | x | | |
| Salicaceae | *Salix geyeriana* Anderss. | x | x | | |
| Saxifragaceae | *Parnassia palustris* L. var. *montanensis* (Fern. & Rydb. ex Rydb.) Hitchc. | x | x | | |
| Scrophulariaceae | *Castilleja cusickii* Greenm. | | | x | X |
| Scrophulariaceae | *Orthocarpus luteus* Nutt. | x | | x | |
| Scrophulariaceae | *Penstemon rydbergii* A. Nels. var. *oreocharis* (Greene) Holmgren | | | x | |

*Antennaria arcuata* is often found growing near littleleaf pussytoes (*A. microphylla*). Flowering stalks of the two species look similar. In Fremont County, *A. microphylla* is bimodal and replaces *A. arcuata* on drier hummocks and on wetter soils (Fertig 1996). Changes in soil moisture-retaining capacity, either through increased soil compaction or increased vegetation density, may shift the competitive balance in favor of *A. microphylla* at many sites. The microhabitat occupied by *A. arcuata* in Fremont County relative to *A. microphylla* is represented in Figure 9. In Sublette County, they are often in the same valley bottom but not consistently overlapping, and usually with *A. arcuata* positioned closer to the center of the valley bottom than *A. microphylla*. They could be found growing together on some of the same hummocks or terraces, in which case, *A. arcuata* tended to be on the edge of the hummock or terrace rather than the center where *A. microphylla* was concentrated.

Topography: *Antennaria arcuata* occupies bottomland settings, usually associated with drainages but also in drainage headwaters in glacial deposits where there may not be surface flow. Several Sublette County populations are found along drainages named as draws, with no perennial flow. At any given site, it is restricted to a particular microtopographic setting or range of settings, and corresponding vegetation zone(s). The microtopographic setting of Fremont County populations are in the spaces between hummocks or on their lower sides, occasionally on flat terrain or in shallow swales at the edge of drainage bottoms (Fertig 1996; Figure 9). By contrast, the settings of Sublette County populations are mainly on top or sides of hummocks, but some populations or subpopulations are also on flat stream borders that are subirrigated (Figures 10-15).

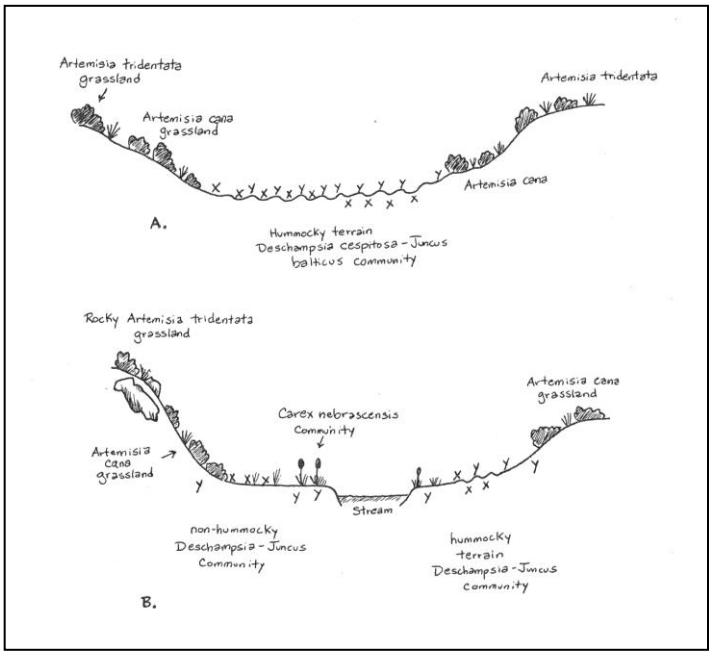



Figure 9. Topographic position of *Antennaria arcuata* in landscapes of the Sweetwater watershed, where X = *Antennaria arcuata*; Y = *Antennaria microphylla*. Illustrated by W. Fertig, from Fertig (1996).

Almost all Sublette County sites had hummocks present in the landscape (except the unnamed Willow Creek tributary, #033), and the hummocks were the most consistently occupied of microhabitats at most sites. Hummocks provide an array of moisture-availability and vegetation conditions over a small area. The organic soil content of hummocks and high vegetation cover on top enhance water retention and ameliorate soil temperature. In addition, plants have occasionally been found extending onto the channel bottom, at the base of small cutbanks of channel bottoms, and in shallow swales of beaded wetlands isolated from streams. All microtopographic settings have subirrigated conditions. Known occurrences in Wyoming range in elevation from 4950-8000 ft.

Soil relationships: Known populations of *Antennaria arcuata* in Fremont County, Wyoming are found mainly on soils derived from Quaternary sandy alluvial deposits (Love and Christiansen 1985) as reported by Fertig (1996). Known populations of *A. arcuata* in Sublette County, Wyoming are on a wider range of parent materials based on the same geology mapping (Table 3) including glacial deposits, fans, and alluvium. It appeared that all Sublette County sites have soils derived from Quaternary deposits whether or not the geology mapping shows the level of detail adequate to distinguish upland parent materials from bottomland parent materials.

Table 3. Geologic parent material at *Antennaria arcuata* sites of Sublette County

| **EO #** | **Site** | **Parent material**[2] | **Well-developed histosols present locally** |
|---|---|---|---|
| 024 | Soda Lake | Quaternary glacial deposits including till and outwash comprised of sand, gravel and boulders | |
| 026 | Brodie Draw | Quaternary gravel, pediment and fan deposits of mostly locally derived clasts | Yes |
| 027 | Ryegrass Draw | Quaternary gravel, pediment and fan deposits of mostly locally derived clasts | Yes |
| 028 | Duck Creek | Quaternary alluvium and colluvium comprised of clay, silt, sand and gravel in flood plains, fans, terraces and slopes | Yes |
| 029 | Webb Draw | Quaternary gravel, pediment and fan deposits of mostly locally derived clasts | |
| 030 | Green River tributary | Eocene Pass Peak Formation and equivalents including Lookout Mountain Conglomerate Member of Wasatch Formation | |
| 031 | Antelope Draws | Quaternary gravel, pediment and fan deposits of mostly locally derived clasts | |
| 032 | Jensen Meadows | Archean Wind River Range granodiorite to porphyritic and equigranular granite | |
| 033 | Willow Creek tributary | Quaternary glacial deposits including till and outwash comprised of sand, gravel and boulders | |

[2] Parent material information from Love and Christiansen (1985).

Figures 10-15. *Antennaria arcuata* habitat lies in broad valleys

Figure 10. One of the broadest valley settings is an unnamed tributary of the Green River (#30)

Figure 11. The head of the Sweetwater River has occupied habitat at the Continental Divide along Jensen Meadows in Sublette County (#032)

Figure 12. The broadest valley setting is in Green River bottomland along Duck Creek (#028)

Figure 13. Brodie Draw is typical Upper Green River habitat (#026)

Figure 14. Only a narrow zone of habitat is usually occupied within any given valley, rarely discernible from a distance, as at a Webb Draw tributary (#029)

Figure 15. Even narrow drainage habitats were found to be occupied, as long as they are in a broad valley and part of a longer or larger system, as on a Brodie Draw tributary (#026)

Figure 16. *Antennaria arcuata* hummocks are thought to retain moisture most of the growing season, as in the Soda Lake area (#024)

Figure 17. *Antennaria arcuata* hummocks tended to dry out under 2012 conditions at some places as at Brodie Draw (#026)

Figure 18. Valley bottom terraces also provided habitat, as on the unnamed tributary of the Green River (#030). Note glacial erratic (left).

Figure 19. Terrace habitat had high proportions of vegetative plants, as at the unnamed tributary of the Green River (#030).

Figure 20. Tall willows were rarely present except at an unnamed Willow Creek tributary (habitat was directly left of willows; note corral; #033)

Figure 21. Occasionally *Antennaria arcuata* was present in channel bottoms or sides, above or below hummocky segments, as at Ryegrass Draw (#027)

Bayer (1992) analyzed soils from six populations of *Antennaria arcuata* (four in Wyoming, and one in Idaho and in Nevada). Soils from these sites ranged from neutral to basic, with high concentrations of calcium, magnesium, and sodium, though sodium concentrations were below levels that classify them as sodic or its vegetation as halophytic. Most sites were also found to be high in organic content, ranging between 3-20%. Organic material has very low density so a 3% content by weight is actually a high organic content by volume. Two of the six samples (one in Idaho, one in Wyoming) exceed the 13% threshold at which soils are classified as histosols (organic soils). Low levels of selenium were found in assays of *A. arcuata* plants, suggesting that this compound is present in the soil. No work has been done analyzing soils of Sublette County populations but they generally appeared to have loamy rather than sandy textures.

At three of the Sublette County populations, there were zones bordering *Antennaria arcuata* habitat where marl accumulated. Marl is a calcium carbonate or lime-rich mud that precipitates out of water and accumulates in biological processes of freshwater and marine systems. In temperate latitudes and freshwater systems, the submerged nonvascular plant *Chara* spp. is the agent actively precipitating calcium-rich ions. Marl accumulation is restricted to alkaline fens as found in Wyoming, and the three particular Sublette County population sites had fen habitat near occupied *A. arcuata* habitat.

Regional climate: Climate data from three of the nearest meteorological stations are represented below (USDI NOAA 2006). They all represent high, intermontane settings and cold desert conditions. The known species' distribution through 2003 was negatively associated with mean July temperature (Fertig and Thurston 2003).

The meteorological station at Big Piney has data from 1948-2001, and is at an elevation of 2082 m (6830 ft). Mean annual temperature is 1.7º C (35.1º F) with mean January temperature at -12.1º C (10.3º F) and mean July temperature at 15.5º C (59.9º F). Mean annual precipitation is 18.95 cm (7.46 in), with peak precipitation in May at 2.67 cm (1.05 in). It lays claim to being Icebox of the Nation, based on 1930 weather monitoring data that pre-dates NOAA records.

The meteorological station at Farson has data from 1915-2006, and is at an elevation of 2009 m (6590 ft). Mean annual temperature is 3.06º C (37.5º F) with mean January temperature at -12.4º C (9.7º F) and mean July temperature at 17.7º C (63.9º F). Mean annual precipitation is 18.67 cm (7.35 in), with peak precipitation in May at 2.64 cm (1.04 in).

The meteorological station at Pinedale has data from 1948-2006, and is at an elevation of 2192 m (7190 ft). Mean annual temperature is 2.1º C (35.8º F) with mean January temperature at -10.8º C (12.6º F) and mean July temperature at 15.4º C (59.8º F). Mean annual precipitation is 27.61 cm (10.87 in), with peak precipitation in May at 4.19 cm (1.65 in).

Local microclimate: The microhabitats occupied by *Antennaria arcuata* remain moist at or below the surface late into summer (Fertig 1996), at least in at most years. In July 2012 when surveys began, the Upper Green River Basin was in extreme drought (National Drought Mitigation Center 2012) and subsurface moisture was reduced or wanting.

Almost all Sublette County sites had hummocks present in the landscape, and the hummocks were the most consistently occupied of microhabitats at most sites (Figures 16-21). Hummocks provide an array of moisture-availability and vegetation conditions over a small area. They may buffer the species from competition on one hand, or may exacerbate desiccation on the other. The high vegetation cover on top may enhance water retention and ameliorate soil temperature.

**Population biology and demography**

Phenology: *Antennaria arcuata* has been characterized as having a flowering/fruiting period from July through September (Dorn 1980, Marriott 1986, Fertig 1996). It was collected in flower at the Soda Lake population on 24 June 1997 by Steve Laster. In a warm, dry year such as 2012, it might be expected to start at least as early. The stolons start to elongate at about flowering time, and elongated stolons are needed for determination. After fruiting, the inflorescences may senesce and the flowering stalks fall over. The phenology might be described in more detail as flowering in (late June) July and fruiting from mid July – mid August (September).

Population size and condition: Surveys of *Antennaria arcuata* in 1995 reported an estimated 99,900-130,350 individuals in 20 populations covering ca 400-500 acres (Fertig 1996). He reported densities of 38-105 plants per square meter in demographic plots (belt transects subjectively placed in areas of high density) and individual plants appearing in small, dense, unisexual clusters.

Several new populations with plants numbering in the thousands have been discovered since the 1995 surveys upon which the most recent status report (Fertig 1996) was based. A new population of 1500-2000 plants was discovered by Walter Fertig in Fremont County in 1996. At least six of the Sublette County populations have numbers in the 1000's (Table 4). The largest was estimated at about 50,000 plants, among the highest numbers of any in the state. Sublette County population numbers expand total numbers by at least 50% so the totals have been revised to estimates of 150,000-200,000. Some of the highest densities in Sublette County approached or exceeded that in Fremont County demographic plots.

The information at hand suggests that all prior census information was based on tallying flowering stems (ramets) as separate individuals. It is possible that all or most plants in any given square meter represent only one (or few) genetically distinct individuals (genets). The photograph on the report cover shows six flowering stems, with patterns of stolon development

suggesting past or present connectivity (see also Figures 22-23). If basal rosettes and the flowering stems that spring from them are short-lived, then patterns of stolon development are obscured over time. This fundamental question of what constitutes an individual was a major reason for placing a priority on the extensive survey work of mapping rather than the intensive survey work of counting. The merits of census and the best methods warrant further consideration. One approach for Sublette County populations might be tallying every hummock that is occupied, assuming that each has at least one unique genet. In other settings where the habitat is on a smooth, more continuous surface or the species lies between hummocks as it does in Fremont County, there is no ready rule of thumb. Considering all the challenges of censusing, and without being able to distinguish genets from ramets, any population size figure can be high by an order of magnitude. It is important to note that the low genetic diversity of the species means that putative population size may not be as great a contribution to species' viability as it is for most other outcrossing species.

The challenge of census is further complicated by dry conditions. In the dry 2012 season, it was possible that flowering stem numbers were reduced compared to most years, and they crumpled in some settings (Figure 24). The ratio of flowering-to-nonflowering plants, where noted, was between 1:5 and 1:10. Nonflowering plants are inconspicuous so the actual ratio may be skewed even further.

Type of reproduction: *Antennaria arcuata* reproduces vegetatively by stolons or sexually as a dioecious, diploid species that produces seed. Many species of *Antennaria* also reproduce asexually by apomixis (the production of viable seed without fertilization or meiosis) but this trait is limited to polyploid members of the genus and there is no evidence suggesting that *A. arcuata* is apomictic (Bayer 1984). It does have levels of genetic variation that are very low in comparison to all other sexual species of *Antennaria* in North America (Bayer 1992). This characterization is based on mean number of alleles per locus, proportion of polymorphic loci, and observed heterozygosity. The author hypothesized that this reflects its disjunct and restricted distribution and its habitat specificity precluding migration at the end of most recent glaciation.

Vegetative reproduction of *Antennaria arcuata* is by means of stolons. It was noted by Bayer (1992) that rosettes at the base of stems tend to be short-lived, so that connections between plants are short-lived. This above-ground vegetative reproduction might be favored over seed set on substrate that may be anaerobic when moist (as is characteristic of organic soils), and in wetland vegetation that is relatively dense with limited exposed surface and high competition except at the edges of hummocks that generally have near-vertical margins that are not well-suited for either seedling establishment or rooting except over the course of growing seasons. Vegetative reproduction would be particularly favored in Sublette County where *A. arcuata* was most consistently found on hummock tops and sides as compared to Fremont County where it was most consistently found on intervening hummock swales (Fertig 1996). A preponderance of

vegetative reproduction over sexual reproduction may also contribute to the low genetic diversity of *A. arcuata* and mainly single-sex hummocks (Figure 25). It is postulated that most flowering stems on any given hummock reflect ramets rather than genets so that effective population sizes are much lower than any flowering stem count would indicate (Table 4; discussed above).

Figure 22. One individual or 50 individuals? Vegetative reproduction confounds population estimates at the Soda Lake area (#024).

Figure 23. The proportion of vegetative plants was especially high on flat terrace settings, as in parts of the Soda Lake area (#024)

Figure 24. Flowering stems of *A. arcuata* were prostrate possibly due to drought, on 6 Aug at Jensen Meadows (#032).

Figure 25. Pistillate plants were usually found apart from staminate plants rather than in the same clump, as seen at Brodie Draw (#026). By M. Kirkpatrick.

Table 4. Size and extent of *Antennaria arcuata* populations in Wyoming

| EO# | Population overview | Area (ac.) | Density and Trend | Documen-tation | Last Observed Date |
|---|---|---|---|---|---|
| **SUBLETTE COUNTY (BLM PINEDALE AND ROCK SPRINGS FIELD OFFICES)** | | | | | |
| 024 | 2012-07-07: 5 subpops. in ca 2 x 2 miles, with total numbers probably several 1000's, surveyed by B. Heidel and M. Kirkpatrick.<br>2009-06-24: 2 patches in 50 ft of | 14.7 | Of the four original subpopulations - one could not be found in 2012 in heavily grazed habitat also impacted by drought, another could not be found in a location that is either mis-mapped or else on | Survey | 7 July 2012 |

| | | | | | |
|---|---|---|---|---|---|
| | one other, surveyed by S. Laster.<br>2000-07-12: No data. Collection by C. Delmatier.<br>1998-06-29: Locally abundant, est. at several thousand plants, surveyed by W. Fertig and S. Laster.<br>1997-06-24: No data. Collection by S. Laster. | | private land. Two persist including the largest of original subpopulations, and a new one of similar large size was found. | | |
| 026 | 2012-07-09: 1 large pop. with total numbers in the 10,000's along 1.5+ miles of stream reach including tributary, surveyed by B. Heidel and M. Kirkpatrick.<br>2009-06-27: Scattered for perhaps 1 mile. Dominant in some patches up to 500 ft², surveyed by S. Laster.<br>2000-07: Observed two places by S. Laster. | 17.4 | Described originally as scattered for ca 1 mile and dominant in some patches up to 500 ft². Surveyed in 2012 and persisting in the previously-reported patterns, with expansion. | Survey | 27 June 2009 |
| 027 | 2012-07-07: Surveyed by B. Heidel and M. Kirkpatrick.<br>2009-06-27: Extensive. Surveyed by S. Laster.<br>2006-07-15: In flower. Estimated low 1000's of plants, surveyed by B. Heidel, S. Laster, and others. | 8.9 | Described originally as low 1,000's. Usually 1-5 plants on most hummocks among many hundreds of hummocks. Surveyed in 2012 and persisting in previously-reported patterns. | Survey | 7 July 2012 |
| 028 | 2012-08-07: Est. 200-1000 plants, surveyed by B. Heidel. | 13.4 | Mainly low density. New population. | Survey | 7 August 2012 |
| 029 | 2012-07-09: Three subpops. within 0.5 x 1 mile, and at different subpopulation size magnitudes (10's, 100's and 1000's), surveyed by B. Heidel and M. Kirkpatrick. | 4.9 | Low to high density. New population. | Survey | 9 July 2012 |
| 030 | 2012-07-09: Locally abundant, est 50,000 plants, semi-continuous for over 1.5 miles, surveyed by B. Heidel and M. Kirkpatrick | 36.3 | Mostly high density. New population. | Survey | 9 July 2012 |
| 031 | 2012-08-09: 6 subpops. in headwater segments of 3 drainages, spanning over 3 miles.<br>2012-07-13: (Sec. 27) Est. 500-1000 plants, Surveyed by M. Kirkpatrick.<br>(Other sections) Mostly a magnitude or more lower. Surveys by B. Heidel and M. Kirkpatrick. . | 13.0 | Low to high density. New population. | Survey | 9 August 2012 |
| 032 | 2012-08-06: Locally common. | 3.3 | Mostly high density. New | Survey | 6 August |

| | | | | | |
|---|---|---|---|---|---|
| | Est. 500-1000 plants, surveyed by B. Heidel. | | population. | | 2012 |
| 033 | 2012-08-21: Rare to locally common in 8 small areas spanning ca 0.6 miles, probably low 100's, surveyed by B. Heidel. | 1.8 | Low density at all but two points. New population. | Survey | 21 August 2012 |
| **FREMONT COUNTY (BLM LANDER AND ROCK SPRINGS FIELD OFFICES** | | | | | |
| 001 | 367 plants observed, 459 estimated. Surveyed by R. Lichvar. Site not resurveyed in 1995. | 12.8 | No trend data. | Survey | 12 August 1980 |
| 003 | Population estimated at 21,500-30,000 reproductive and vegetative individuals in one of two known colonies in 1995. The second, smaller colony was not relocated. | 25 + | Individual clones dense with plants arranged in a clumped, non-random pattern. The largest subpopulation appears to have nearly doubled in size. | Survey | 24 August 1995 |
| 004 | Population estimated at 6100-7500 reproductive and vegetative individuals in 1995. | 20 | Plants may be locally abundant, but colonies are patchy. No trend data. | Survey | 24 August 1995 |
| 005 | Population estimated at 1500-2000 reproductive and vegetative individuals in 1995. Vegetative rosettes appear to outnumber flowering plants by a ratio of 3:1. | 10-15 | Distribution patchy, but may be locally dense. This population was estimated to contain 35,560 plants in 1982 (based on extrapolation of a sample of 3556 plants). It appears that the population has declined sharply on BLM lands in the occurrence since then. No plants were found within a BLM range exclosure in 1995. | Survey | 23 August 1995 |
| 006 | Population estimated at 20,000-30,000 reproductive and vegetative individuals in 1995. Vegetative rosettes appear to outnumber flowering plants by about 5:1. | 35 | At one transect site, density was measured at 105.3 plants per square meter (including 17.7 flowering plants per square meter). This population was estimated to contain 30,700 plants in 1982, and so appears to be stable. | Survey | 2 September 1995 |
| 007 | Population estimated at 7800-8500 reproductive and vegetative individuals in one portion of the EO (TNC Sweetwater Preserve) in 1995. Vegetative rosettes appear to outnumber flowering plants by a ratio of 5.4:1. | 90 | At one transect site, density was measured at 38.8 plants per square meter (including just over 6 flowering plants per square meter). This EO has been known since 1982, but trend data are lacking. | Survey | 13 August 1997 |
| 009 | Population estimated at 8500-11,500 reproductive and vegetative individuals at 4 colonies in 1995. Rosettes may outnumber flowering plants by as much as | 70 | Plants often tightly clustered, but clusters themselves may be widely dispersed. This occurrence was estimated to contain over 20,000 plants in 1982. The entire area was not resurveyed in 1995, so trends | Survey | 22 August 1995 |

| | | | | | |
|---|---|---|---|---|---|
| | 15:1 at some sites. | | are not completely known. | | |
| 010 | 2 subpopulations in ca 0.75 x 0.75 mile.<br>1980-08-12: Both subpopulations. In flower and fruit. 797 plants observed, 5313 plants estimated. Surveyed by R. Lichvar.<br>1979-09-02: (Sec 14 SW4 of SE4) In flower. Ca 100 plants. About 9 mats or colonies with 10 to 20 individuals per mat. | 66.9 | No trend data. | Survey | 12 August 1980 |
| 011 | Population estimated at 3600-4200 reproductive and vegetative individuals in 5 colonies in 1995. Vegetative rosettes observed to outnumber flowering plants by ca 3:1 at some sites. | 10 + | Plants typically clumped, but clumps themselves are widely dispersed and patchy. This occurrence was first reported in 1982, but no population data were reported. "100 +" plants observed in brief 1986 survey. The higher numbers observed in 1995 may represent either be an artifact of more intensive sampling or an increase in population size in the last decade. | Survey | 20 August 1995 |
| 012 | Population estimated at 5300-8500 reproductive and vegetative individuals<br>in 2 colonies in 1995. 10-15% of all plants estimated to be in flower or fruit. | 25 | Plants tend to be clumped, but clumps themselves are widely dispersed. This population has been known since 1979. A census in 1980 estimated the total population at ca 3000 individuals. This colony appears to have doubled since then. No<br>plants were observed within 2 BLM exclosures in 1995. | Survey | 20 August 1995 |
| 013 | Population estimated at 1700-2300 reproductive and vegetative individuals in 2 colonies in 1995. Approximately 75% in vegetative condition. | 25 | Distribution non-random and clumped, each clump containing ca 30-50 individuals. Clumps often widely scattered. Population estimated at 3300 plants in 1982. A portion of the occurrence in 1995<br>appeared to have been replaced by shrubby vegetation since 1982, possibly accounting for a<br>decline in total population numbers at this site. | Survey | 22 August 1995 |
| 015 | Population estimated at 5200-6300 reproductive and vegetative individuals in two large colonies in 1995. Vegetative rosettes outnumbered flowering<br>plants by 40:1 in some patches. | 20 | As many as 20 plants per square foot were observed in some sites. Clones tend to be dense<br>but widely scattered. Population estimated at 3415 plants in 1982 in a smaller search area. The discrepancy in population size between 1982 and 1995 may be | Survey | 22 August 1995 |

| | | | | | |
|---|---|---|---|---|---|
| | | | due to more complete sampling in 1995 rather than a population increase. | | |
| 016 | Ca 0.6 mi of drainage. 5628 plants observed, population estimated at 28,140 plants. Surveyed by R. Lichvar. | 26.6 | No trend data. | Survey | 30 August 1982 |
| 017 | No plants could be found in surveys in 1995, surveyed by W. Fertig. | Not known | Density not known. This population contained an estimated 100-150 plants in 1986. The area mapped by Marriott (1986) appeared to be overgrown by shrubs and tall grasses in 1995 and may be locally extirpated. | Survey | 21 August 1986 |
| 018 | Population estimated at ca 250 mostly vegetative plants in 1995. Only 3 flowering plants observed. Surveyed by W. Fertig. | 2 + | Patches locally dense but widely scattered. Population estimated at 300-500 individuals in 1986. This occurrence may be in a slow decline. | Survey | 3 September 1995 |
| 019 | No plants could be found in 1995, surveyed by W. Fertig. | Not known | Density not known. Population estimated at 200-400 individuals in 1986. Relocated in 1990, but census data not available (Bayer 1992). Some potential habitat still exists in the vicinity and should be investigated before this occurrence is determined to be extirpated. | Survey | 10 July 1997 |
| 020 | 1986-08-24: At least 500 individuals, probably more (entire area not surveyed). Surveyed by H. Marriott. | 20 | No trend data. | Survey | 24 August 1986 |
| 021 | Population estimated at 200-300 reproductive and vegetative individuals in 1995, surveyed by W. Fertig. | 3-5 | Patches small and scattered. This population was reported in 1982, but no census data are available to determine trends. | Survey | 22 August 1995 |
| 022 | No data. Collected by L. Welp. | Not known | No trend data. | Specimen | 31 July 1995 |
| 023 | Population estimated at 18,250-20,000 reproductive and vegetative individuals in 1995. Surveyed by W. Fertig. | 7 | Locally abundant and densely clustered. Clusters themselves may be widely dispersed. This occurrence was newly discovered in 1995. No trend data are available. | Survey | 24 August 1995 |
| 025 | Ca 1500-2000 staminate and pistillate individuals. Surveyed by W. Fertig and L. Welp. | 7.7 | No trend data. | Survey | 10 July 1997 |

Pollination biology: Species of *Antennaria* are visited by many different insects even though the reduced flower size and lack of showy, petal-like ray flowers are non-specialized. Wind pollination may also take place. The pollination biology of *Antennaria arcuata* has not been studied, but there may be examples among similar species. In the case of *Antennaria dioica*,

another outcrossing diploid species, small-size patches of *A. dioica* tended to have biased sex ratios. Experimental hand-pollinations showed that the degree of pollen limitation increased with increasingly female-biased sex ratios in the closest vicinity of the experimental plants. Thus, even though *A. dioica* is pollinated by many different insects, fragmented population structures impact reproductive performance of *A. dioica* (Oster and Eriksson 2007).

Both pistillate and staminate plants of *Antennaria arcuata* were noted in most but not all populations surveyed in 2012, and the number of staminate plants appeared to make up the minority when present. This is in contrast with prior survey results in which there were ratios between the sexes that were often closer to 50:50 where noted in previous surveys (Fertig 1996). It is possible but not proven that skewed ratios between the sexes observed in 2012 may impede seed set in some populations of *A. arcuata* as they do in *A. dioica* (Oster and Eriksson 2007).

Seed dispersal and biology: Seeds of *Antennaria arcuata* are probably dispersed by wind and gravity (Lorain 1990). Fertig (1996) noted that establishment of seedlings appears to be restricted to relatively mesic microsites within existing colonies. He also noted that pistillate plants were found to have 20 fruits per head, on average. Despite this apparent fecundity, establishment of seedlings in new habitats outside of the current range of the species is unlikely under present climatic conditions (Bayer 1992).

**Population ecology:**

General summary: *Antennaria arcuata* is a perennial with rosettes that appear to be short-lived. It is possible that vegetative reproduction maintains genetically-identical ramets indefinitely with suitable habitat.

Competition: The following narrative is directly from Fertig (1996). In Wyoming, *Antennaria arcuata* appears to decrease in areas with tall or dense vegetation. Colonies within BLM exclosures have been found to be in decline or locally extirpated where grazing has been prevented and vegetation cover has become denser and taller. High cover may also promote greater water retention in the soil, creating microsites that appear to be too wet for *A. arcuata*. Several Wyoming colonies have also been shown to decline where shrubs have replaced graminoid vegetation over time.

Herbivory: No signs of livestock or wildlife herbivory were noted in 2012, but a small percentage of flowering plants were observed to have broken stems in Sublette County as in Fremont County surveys.

Livestock use is concentrated in and along the bottomland settings, and other potential effects of grazing include the indirect effects of trampling, successional shift in favor of increaser species, eutrophication, and habitat loss from associated range management practices (impoundments,

fencing, other). Bayer (1992) noted that the habitat suffers disturbance from domestic animals, and went as far as to say that the hummocks are created by cattle activity. He also noted that the same areas were perhaps also disturbed by plains bison. These statements have since been tempered by observations that the species declines in the absence of grazing, as found in BLM exclosures (Fertig 1996). It is not within the purview of this species survey to determine the origin of the hummocks, but many different forms of observation were made and ought to be expanded to address management needs. Dorn (1986) interpreted historical accounts to indicate that bison were originally present in all areas of the state including the Sweetwater Valley and Upper Green River Basin.

Hybridization: Bayer (1992) reported the presence of allozyme markers normally associated only with *Antennaria microphylla* in *A. arcuata* specimens from Mormon Creek, WY (EO#004), suggesting possibly hybridization or introgression between populations of these species at this site. Unlike polyploidy species of *Antennaria*, hybridization appears to be uncommon among the diploid species of the genus (Cronquist 1994). No putative intermediates were noted in 2012 surveys.

## ASSESSMENT AND MANAGEMENT RECOMMENDATIONS

### Potential threats to currently known populations

In summary, Marriott (1986) identified overgrazing, water development (stockpond construction), placer mining, and uranium mining as potential threats to *Antennaria arcuata*. Exclosure studies by the BLM suggest that grazing is less of a threat than originally thought, though trampling may still be a concern. Populations of *A. arcuata* often abruptly stop inside of ungrazed exclosures where graminoid cover is too dense and soils are too moist. Under appropriate stocking levels and rotation, grazing may be beneficial to this species by maintaining low cover and moist (but not too wet) soil conditions (Fertig 1996). Off-road vehicle damage, mineral development, and water projects that include both impoundments and stockponds appear to be the primary threats at present in Wyoming. Populations in the Upper Green River Basin may also be threatened by oil and gas development and habitat loss on private land. Competition from exotic weeds has also been cited as a threat in Idaho, and invasion by *Cirsium arvense* was noted in one Upper Green River Basin population in Wyoming. Its habitat may also be vulnerable to desiccating climate conditions.

Grazing: Throughout the range of *Antennaria arcuata*, livestock grazing is the dominant land-use. There has been a long history of concern over the effects of grazing on *A. arcuata*. For example, in 1978, it was noted as present in low numbers in a severely overgrazed meadow on BLM lands where the species appeared to be thriving on adjoining private land in excellent

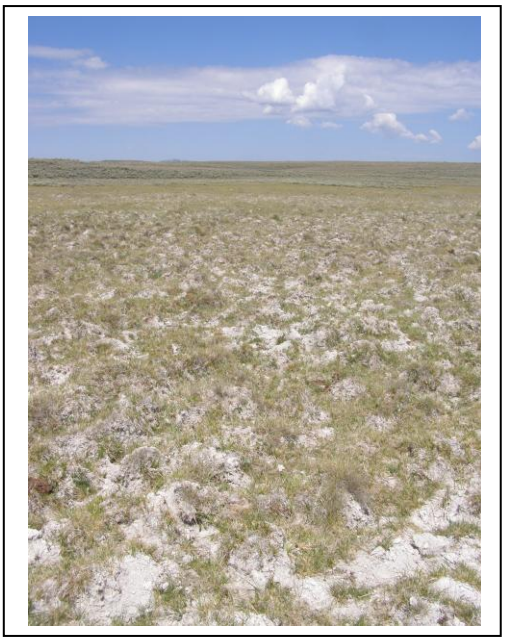


Figure 26. *Antennaria arcuata* is absent from this setting on Brodie Draw (#026) whether because of trampling or substrate unsuitability.

Figure 27. The downstream end of the Brodie Draw population (#026) ends near eroded channel segments that may be influenced by grazing.

Figure 28. Despite the lack of flowing water, settings such as Brodie Draw have use as reservoirs, which appears to limit *Antennaria arcuata* extent locally (#026).

Figure 29. Livestock use was centered on drainage bottoms in the latter half of the 2012 season as at the unnamed tributary of the Green River (#030).

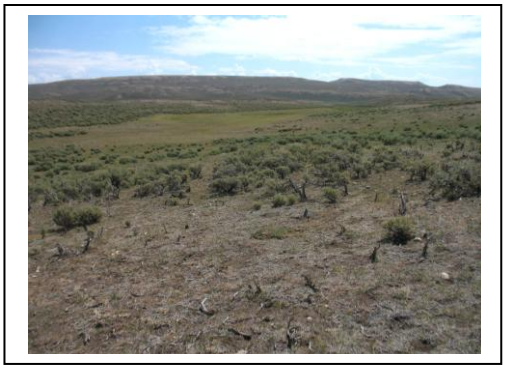


Figure 30. Prescribed burns were conducted around occupied habitat at Brodie Draw (#026); it would be valuable to know whether wetland zones burned. By M. Kirkpatrick.

Figure 31. Hummocks at Ryegrass Draw (#024) appeared as parched pedastals in 2012.

condition (Dorn 1978). He went on to note that "It is possible that the problem is more a distribution problem rather than overstocking per se." In 1982, the BLM Lander Field Office set up a one-acre exclosure for monitoring *Antennaria arcuata* (Winnepenninkx 1984a), the Atlantic City Exclosure (in EO#005), with frequency and productivity data collected inside and outside the exclosure, for reading every five years. Plot data was set up in places of high *A. arcuata* frequency (20-80%). It was first read in 1983 and reread in 1988. Overall *A. arcuata* % frequency changed from 75% to 0% inside the exclosure (1983 and 1988, respectively), and from 74% to 8% outside the exclosure (USDI BLM *Antennaria arcuata* monitoring files). A second exclosure, the Gilespie Exclosure, was set up in 1984 (Winnepienninkx 1984b) but apparently not monitored until 1988 (in EO#012; USDI BLM *Antennaria arcuata* monitoring files). In addition, an exclosure study was set up in 1987 near if not in the Long Creek population north of the Granite Mountains (EO#025). It was read in 1988 (USDI BLM *Antennaria arcuata* monitoring files). In 1985, an expanded evaluation of the effects of grazing on *Antennaria arcuata* was proposed, addressing seven study objectives as master's thesis research (Dodd and Mihlbachler 1985) but was not pursued.

In more recent reviews of potential grazing threats, Fertig (1996) cited the above-mentioned BLM exclosure studies as indicating that removal of grazing may result in habitat changes that are detrimental to the continued existence of *Antennaria arcuata*. He noted that the chosen exclosure sites may not be representative of conditions at all sites (based on the personal communication of A. Warren to H. Marriott; Marriott 1988). He also noted that populations of *A. arcuata* often abruptly stop inside of ungrazed exclosures where graminoid cover is too dense and soils are too moist. Under appropriate stocking levels and rotation, some degree of vegetation cover removal by grazing appears to be beneficial to this species (Fertig 1996).

In any case, *Antennaria arcuata* is not palatable, does not provide forage and is not directly grazed by cattle. It may be negatively affected by trampling and by grazing on surrounding vegetation, possibly due to removal of overstory species (Whiskey Basin Consultants 1982). It is also possible that removal of overstory species reduces competition.

The effects of trampling on soil properties and hydrology warrants further discussion. Trampling may contribute to formation of hummocks and associated succession, nutrient balance, water loss, and oxidation. Bayer (1992) went as far as to say that "*Antennaria arcuata* occurs on the sides of hummocks that are created by cattle activity in the moist sloughs." He also characterized the settings as disturbed from domestic animals, primarily range cattle, which are "attracted by moisture and the relatively lush vegetation. These same areas were perhaps also disturbed by plains bison during precolonial times" in keeping with statements by Dorn (1986) about the widespread distribution of bison in Wyoming historically. It is possible, but not proven, that adaptation of *A. arcuata* for hummock habitat is an adaptation to natural disturbance, and that hummocks may be pre-colonial features. The questions of hummock

naturalness and hummock succession have bearing in evaluating grazing response and in determining the degree to which maintenance, idling (revegetation), or exacerbation of hummock features are desired management practices or not.

Water Developments: Construction of impoundments may have impacted *Antennaria arcuata* populations or population segments in some Sublette County drainages. It was observed that two Brodie Draw tributaries of similar characteristics differed completely in presence/absence of *A. arcuata*; the species was absent from the tributary with an impoundment at its head (#026). However, there are populations or population segments downstream from impoundments, and the zone of influence is not known. Small, old water diversion ditches were present downstream from occupied habitat on the Willow Creek tributary. Ditches may limit the extent of the Duck Creek population (#028). Irrigated hayfields were in the vicinity of two or three Sublette County populations, and one rangeland site was irrigated in an adjoining pasture (Jensen Meadows, #032). Water developments were also identified as potential threats in Fremont County (Marriott 1986). Its presence in the middle of large valley bottoms as found along Duck Creek may indicate that large parts of its potential habitat lie on private land, habitat that may be widely subjected to draining and plowing or converting to non-native plantings used as hayfield. The degree to which upstream water and land management practices affect *A. arcuata* populations is not known. Over half of the Sublette County populations lie downstream from private land holdings and are potentially affected by upstream practices.

Oil and Gas Development: There are no oil and gas fields in place among *Antennaria arcuata* populations of Sublette County, whether or not the settings are less suited than major fields sited elsewhere in the County. It is possible that widespread infrastructure developments associated with oil and gas developments in the county (roads, pipelines, transmission lines) indirectly affects its habitat.

Wind Energy Development: There are no wind farms presently located in Sublette County. The surrounding foothill ridges may have potential for development, affecting *Antennaria arcuata* habitat only insofar as infrastructure crosses valley or otherwise fosters landscape-scale changes.

Roads and ORV Use: Damage by off-road vehicles and proliferation of two-track roads were reported as frequent in Fremont County (Fertig 1996) but are generally absent from Sublette County populations. A small two-track runs in the middle of a small subpopulation in the Soda Lake area, where the *Antennaria arcuata* plants seem concentrated at its margins. Other populations close to roads, like the Duck Creek population north of U.S. Hwy 191, are hydrologically separated from the road system by the creek in between.

Weeds: Exotic species were notably scarce or absent in surveying *Antennaria arcuata* habitat of Sublette County. Kentucky bluegrass (*Poa pratensis*), reported as common in Fremont County

habitat, was not found in Sublette County populations. The one noxious weed that has immediate potential for encroachment of its habitat is Canada thistle (*Cirsium arvensis*). The thistle is favored in sites of fluctuating water level, and formed dense swards on a reach of South Antelope Creek where affected by an impoundment. All the plants were vegetative and looked as though they were second-year plants. It is possible that disturbance in combination with wet years such as the region experienced in 2011 favor colonization of Canada thistle. Hummocky terrain, with variable moisture availability, may be especially vulnerable to encroachment of persistent, rhizomatous noxious weeds like Canada thistle. It was not observed at other occupied and unoccupied sites in 2012 surveys.

Mining and Quarrying: There are no mining developments at present in *Antennaria arcuata* habitat of Sublette County. The past placer mining and potential uranium mining in its Fremont County habitat are not known from Sublette County. Based on Fremont County potential threats, Whiskey Basin Consultants (1982) recommended withdrawing known areas of *A. arcuata* habitat from mineral development.

Other Threats: The study area was in critical drought condition by the time of 2012 surveys (National Drought Mitigation Center 2012). It is not known if drought and fire pose threats. On one hand, they are repeated phenomena in the Upper Green River Basin. On the other hand, the high organic content in the soil might be altered or lost under these conditions.

**Conservation recommendations**

Recommendations regarding present or anticipated activities: Fertig (1996) stated that demographic monitoring studies he initiated in 1995 should be continued and expanded to include a broader range of habitats. He added that existing BLM exclosure studies may need to be modified to test whether renewed grazing can help recolonize once occupied habitat. There is a need to discuss past monitoring in the Sweetwater drainage and priorities for maintaining or expanding it throughout the Green River and Sweetwater drainages.

For the interim, he suggested that livestock stocking rates should be carefully calculated to avoid overutilization or congregation of animals in wetland areas that could result in trampling. Water tanks and stock ponds should be located outside of riparian corridors to reduce trampling in more fragile habitats. Likewise, reservoir construction is a concern.

Most occurrences are in multiple-use land management. One occurrence of *Antennaria arcuata* is protected on The Nature Conservancy's Sweetwater River Preserve. Part of another occurrence is within the Sweetwater Canyon Wilderness Study Area and at least one occurrence is found within the BLM South Pass Historic Site ACEC. Except for the Sweetwater River Preserve, all known Wyoming populations occur on BLM and state lands.

Special designations might be considered for the largest population sites. In any case, it is appropriate to integrate *Antennaria arcuata* habitat management with BLM riparian habitat management, and possibly in discussions of wetland conservation in areas of high wetland density (Copeland et al. 2010), and of State Water Plan implementation in the Green River and Little Snake River basins and Platte River basin (Wyoming Water Development Office 2013).

Notification of BLM personnel of locations on BLM lands: To evaluate impacts to known populations of *Antennaria arcuata*, all appropriate BLM personnel involved in on-the-ground management activities that include range management, weed control, water resources, and travel planning should have access to location data for *A. arcuata*. The updated state species abstract (Appendix C) and this report will also be submitted and posted on-line for reference.

Status recommendations: *Antennaria arcuata* was reranked G3/S3 based on results of 2012 surveys. It may warrant review as to whether it is retained on the Wyoming Species of Concern list or transferred to the list of Wyoming Species of Potential Concern. However, it is a regionally-endemic species that has questions about species' response to livestock grazing which are not fully answered, as are questions about the relict nature of its habitat.

Summary: *Antennaria arcuata* is a regional endemic restricted to three areas: northeastern Nevada, south-central Idaho and southwestern to west-central Wyoming. As a result of this survey, the number of *A. arcuata* populations in Sublette County has tripled to nine, in addition to the 21 in Fremont County. Populations of the two counties are now treated as semi-continuous rather than as separate distribution centers. Populations throughout Wyoming are found on broad drainage bottoms in subirrigated, alluvial meadows with hummocky or flat wetland habitat and short vegetation cover. In Sublette County, the parent material is a wide variety of mainly Quaternary deposits and parent materials, located in high basins fringing foothills of the Wind River and Wyoming Ranges, whereas in Fremont County, the parent material is Quaternary sandy alluvium, in the high basin setting of the Sweetwater River watershed. Total Wyoming population number estimates were increased by on the order of 50% after Sublette County surveys, but population counts or estimates may not represent genetically-unique individuals because the species reproduces vegetatively, stolon connectivity between rosettes of the same plant are not readily apparent, and both stolons and rosettes may be short-lived. This is one more explanation for the exceptionally low genetic diversity found in the species (Bayer 1992), in addition to the habitat isolation and nature of its habitat. Associated with *A. arcuata* habitat are adjoining fen habitats that support five fen plant species. These relic fen habitats with their hydrological connectivity and high organic content like soils in *A. arcuata* habitat are basis for the hypothesis that its habitat is similarly relict and may have little or no restoration potential. Populations throughout Wyoming are potentially affected by congregated livestock use. Sublette County populations appear to be most threatened by impoundments and

water diversions, if not also draining and plowing, while Fremont County populations were reported to be most threatened by vehicle trampling, off-road recreation proliferation and mining.

## RESULTS – INFORMATION ON ADDITIONAL RARE SPECIES

While surveying wetlands for *Antennaria arcuata* in Sublette County, other wetland plant species of concern were documented at five sites. There had been no reports of associated rare wetland plant species in Fremont County surveys of *A. arcuata* (Fertig 1996), or anywhere else. These ancillary results from 2012 surveys may help understand the nature of *A. arcuata* habitat. All population records of these additional rare species are represented in Appendix D.

The first evidence that there may be other rare plant species in the same landscape as *Antennaria arcuata* in Sublette County was collected at Ryegrass Draw in 2006 at the Wyoming Native Plant Society annual meeting, when Steve Laster led attendees to an *A. arcuata* population that he discovered the year earlier. Directly adjoining the habitat of *A. arcuata* was a spring-fed area of peat accumulation where four species of concern were spotted by botanists on the field trip (initially reported as three species in Heidel 2006a). The four species represented the first time these particular species were found on BLM-administered lands in Wyoming and outside of mountains in the state.

*Antennaria arcuata* habitat is indirectly associated with groundwater discharge features, some of which have well-developed peatland directly associated with them. Groundwater-fed peatlands are technically referred to as fens. The cool, stable groundwater discharge maintains saturated conditions at or near the surface throughout the growing season, maintaining anaerobic conditions that prevent decay of organic matter.

Steve Laster later reported a rare peatland plant at Brodie Draw in 2009, hoary willow (*Salix candida*). Surveyors in 2012 relocated *A. arcuata* there but were unable to relocate the particular willow. No voucher of it was collected by Laster to verify his determination, and it remains undetermined whether 2012 surveyors just missed it or if there are other explanations. Instead, surveyors found a very small but fairly intact, well-developed peatland developed around a spring on one of the tributaries to Brodie Draw with two other rare species, false uncinia sedge (*Carex microglochin*) and yellowishwhite bladderwort (*Utricularia ochroleuca*). The latter has yet to be published as an addition to the Wyoming flora, expected with publication of work in Yellowstone National Park (Hellquist et al. in progress). The two populations in the Upper Green River populations represent county records. Specimens of the bladderwort were sent to Garrett Crow, the *Flora of North America* author of the Bladderwort Family (Lentibulariaceae) for review.

Five rare species were documented at five sites incidental to *Antennaria arcuata* surveys in confluent habitat. At three of the sites, *A. arcuata* was present, but at two sites, it was absent.

The five species are profiled in the following pages. The results of 2012 surveys will be used to update state species abstracts for four of the five species while the fifth awaits recognition as an addition to the flora. Rare peatland species are indicators of relict habitat (Heidel 2006b). The specialized wetland vegetation zones appear as inclusions within *A. arcuata* habitat so they are not listed as directly associated species. Graminoid fen dominants include analogue sedge (*Carex simulata*) and, to a lesser extent, few-flowered rush (*Eleocharis pauciflora*). Hoary willow (*Salix candida*) is a shrub dominant at one site. The peatland habitat is very small.

The five rare species are boreal species that are disjunct or sparse in the Rocky Mountains of the continental United States, and in Wyoming. The following pages of species information may or may not have a place in the BLM special status species program, but peatlands as a wetland type are features that generally cannot be mitigated (U.S. Fish and Wildlife Service 1998, 1999). Thus, the new species information may be pertinent to BLM riparian habitat management. A worldwide overview of peatland systems is given in Rydin and Jeglum (2006), and an overview of peatlands in the northern Rocky Mountains is given in Chadde et al. (1998) for background.

***Carex microglochin***

Classification
Scientific name: *Carex microglochin*
Synonyms: none
Common name: False uncinia sedge
Family: Cyperaceae

Legal Status
USFWS: none
Agency status: none

Heritage Rank: G5/S2

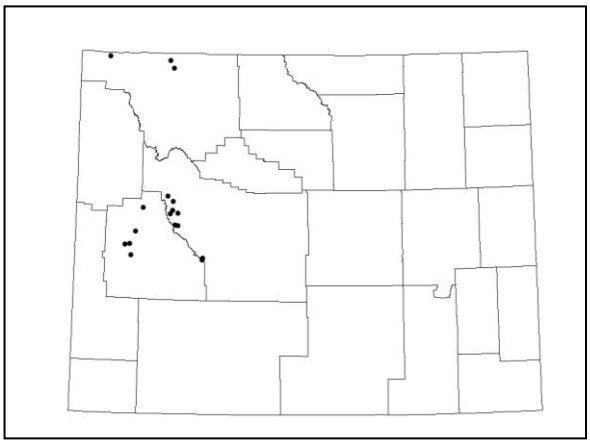


Figure 32. Distribution of *Carex microglochin* in Wyoming

Geographic Range in the State and Study Area: *Carex microglochin* is known in Wyoming from the Yellowstone Plateau, the northern Absaroka and Wind River Ranges, and from the Upper Green River Basin, in Fremont, Park and Sublette counties. The Upper Green River populations lie on the north and west sides of the basin, below the Wyoming Range (Figure 32).

Number of Populations in the State and Study Area: *Carex microglochin* is known from 17 extant occurrences in Wyoming, all of which have been discovered since 1985 (last observed in 2012). Four occurrences are in the Upper Green River Basin (Table 5).

Size and Extent: *Carex microglochin* may be locally abundant but the populations are usually in very small areas, and mapping represents outer boundaries rather than occupied habitat. The four populations in the Upper Green River Basin have outer population boundaries ranging from 0.1-3.3 acres (Table 6).

Table 5. Locations of *Carex microglochin* in the Upper Green River Basin

| EO# | Directions | County | Legal Description | Elevation ft (m) | USGS 7.5' Quad | Public Land |
|---|---|---|---|---|---|---|
| **BLM PINEDALE FIELD OFFICE** | | | | | | |
| 006 | Ryegrass Draw, about 7 air miles west of Daniel. | Sublette | T34N R112W Sec. 34 | 7450 (2271) | Webb Draw | BLM Pinedale FO |
| 016 | Unnamed tributary of Brodie Draw, west of Aspen Ridge, ca. 10 miles west of Daniel. | Sublette | T34N R113W Sec. 36 | 7520 (2292) | Halfway | BLM Pinedale FO |
| 017 | Muddy Creek above confluence with Antelope Draw, ca 12.5 air miles northwest of Marbleton. | Sublette | T32N R112W Sec. 21 | 7200 (2195) | Budd Reservoir, Onion Springs | BLM Pinedale FO |
| 019 | Warren Bridge area, west side of river and U.S. Hwy 191, ca 9.3 air miles north of Daniel Jct. | Sublette | T35N R111W Sec. 8 | 7480 (2280) | Warren Bridge | BLM Pinedale FO |

Table 6. Size and extent of *Carex microglochin* populations in the Upper Green River Basin

| EO# | Population overview | Area | Documen -tation | Last obs. date |
|---|---|---|---|---|
| 006 | 2012: Possibly 100's of flowering stalks but in small area. Surveyed by B. Heidel and M. Kirkpatrick.<br>2006-07-16: In late fruit. Uncommon. Surveyed by B. Heidel. | 1.5 | Survey | 7 July 2012 |
| 016 | Est. 100-200 plants. Surveyed by B. Heidel and M. Kirkpatrick. | 0.1 | Survey | 8 July 2012 |
| 017 | Locally common but highly restricted in two or more areas. Surveyed by B. Heidel. | 3.3 | Survey | 8 Aug 2012 |
| 019 | Common in very small areas. Surveyed by B. Heidel. | 2.6 | Survey | 21 Aug 2012 |

Habitat in the State and Study Area: In Wyoming, *Carex microglochin* occupies graminoid and shrub fens, including floating mat and patterned zones, often with marl accumulation. Upper

Green River populations have only been found in graminoid fens, specifically on hummocks with marl accumulation at the surface.

Species and Habitat Images:

Figure 33. *Carex microglochin.* Photos above by M. Kirkpatrick.

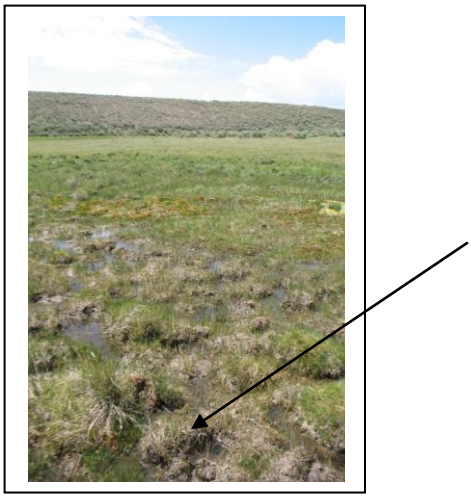


Figure 34. Habitat of *Carex microglochin* at Brodie Draw

***Kobresia simpliciuscula***

Classification
Scientific name: *Kobresia simpliciuscula*
Synonyms: none
Common name: Simple kobresia
Family: Cyperaceae

Legal Status
USFWS: none
Agency status: USFS R2 sensitive

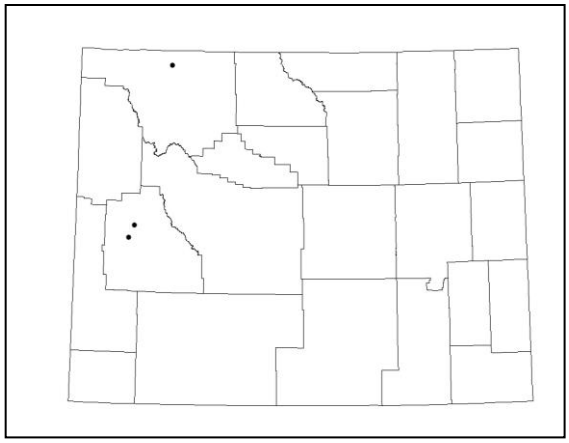


Figure 35. Distribution of *Kobresia simpliuscula* in Wyoming

Heritage Rank: G5/S1

Geographic Range in the State and Study Area: *Kobresia simpliciuscula* is known in Wyoming from the Clarks Fork Valley and the Upper Green River Basin, in Park and Sublette counties. The Upper Green River populations lie on the north and west sides of the basin, below the Wyoming Range (Figure 35).

Number of Populations in the State and Study Area: *Kobresia simpliciuscula* is known from three extant occurrences in Wyoming, all of which have been discovered since 1985 (last observed in 2012). Two populations are in the Upper Green River Basin (Table 7).

Table 7. Locations of *Kobresia simpliuscula* in the Upper Green River Basin

| EO# | Directions | County | Legal description | Elevation ft (m) | USGS 7.5' quad | Public land |
|---|---|---|---|---|---|---|
| 002 | Ryegrass Draw, about 7 air miles west of Daniel. | Sublette | T34N R112W Sec. 34 | 7450 (2271) | Webb Draw | BLM Pinedale FO |
| 003 | Upper Green River Basin, Warren Bridge area, west side of Green River and U.S. Hwy 191, ca 9.3 miles north of Daniel Jct. | Sublette | T35N R111W Sec. 8 | 7480 (2280) | Warren Bridge | BLM Pinedale FO |

Size and Extent: The species is occasional or uncommon. The two populations in the Upper Green River Basin have outer population boundaries ranging from 1.2-2.6 acres (Table 8).

Table 8. Size and extent of *Kobresia simpliuscula* populations in the Upper Green River Basin

| EO# | Population overview | Area | Density | Documentation | Last obs. date |
|---|---|---|---|---|---|
| 002 | Occasional. In small tufts of 1-few stems. Surveyed by B. Heidel. | 1.2 | new, low density | Survey | 13 July 2012 |
| 003 | Uncommon on marl mounds. Surveyed by B. Heidel. | 2.6 | new, low density | Survey | 21 August 2012 |

Habitat in the State and Study Area: In Wyoming, *Kobresia simpliuscula* occurs in graminoid fens with *Carex simulata* and *Triglochin maritimum*. Upper Green River populations occupy graminoid fens on hummocks with marl accumulation at the surface. Elevation ranges from 6600-7500 feet.

Species and Habitat Images:

Figure 36. *Kobresia simpliuscula*

Figure 37. Habitat of *Kobresia simpliuscula* at Ryegrass Draw

***Salix candida***

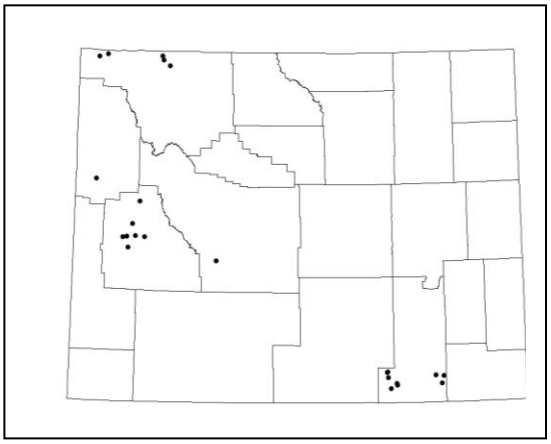


Figure 38. Distribution of *Salix candida* in Wyoming

Classification
Scientific name: *Salix candida*
Synonyms: none
Common name: Hoary willow
Family: Salicaceae

Legal Status
USFWS: none
Agency status: USFS R2 sensitive

Heritage Rank: G5/S2

Geographic Range in the State and Study Area: *Salix candida* is known in Wyoming from the Absaroka, Beartooth, Laramie, Medicine Bow and Wind River ranges, Yellowstone Plateau, and upper Green River Basin, in Albany, Carbon, Fremont, Park, Sublette and Teton counties. The Upper Green River Basin populations lie on the north and west sides of the basin (Figure 38).

Number of Populations in the State and Study Area: *Salix candida* is known from 21 extant occurrences in the state, plus two historic records, not counting two that have low viability or unknown contributions to species' viability. In the Upper Green River Basin there are five occurrences, one of which could not be relocated, and another of extremely low numbers.

Table 9. Locations of *Salix candida* in the Upper Green River Basin

| EO# | Directions | County | Legal description | Elevation ft (m) | USGS 7.5' quad | Public land |
|---|---|---|---|---|---|---|
| 018 | Ryegrass Draw, about 7 air miles west of Daniel. | Sublette | T34N R112W Sec. 34 | 7450 (2271) | Webb Draw | BLM Pinedale FO |
| 021 | Brodie Draw, west of Aspen Ridge. | Sublette | T34NR112W Sec 31 T34NR113W Sec 36 | 7520 (2292) | Halfway, Merna | BLM Pinedale FO |
| 024 | Warren Bridge area, west side of river and U.S. Hwy 191, ca 9.3 air miles north of Daniel Jct. | Sublette | T35N R111W Sec. 8 | 7480 (2280) | Signal Hill, Warren Bridge | BLM Pinedale FO |
| 025 | Duck Creek, ca. 4 air miles west of Pinedale, on north side of U.S. Hwy 191 and north side of creek. | Sublette | T34N R110W Sec. 36 | 7210 (2198) | Cora, Mount Airy | State of Wyoming |
| 026 | Muddy Creek above confluence with Antelope Draw, ca 12.5 air miles northwest of Marbleton. | Sublette | T32N R112W Sec. 21 | 7200 (2195) | Budd Reservoir, Onion Springs | BLM Pinedale FO |

Size and Extent: *Salix candida* population sizes range from as low as 20 plants to numbers approaching or exceeding 1000, locally dominant in the latter.

Habitat in the State and Study Area: In Wyoming, *Salix candida* occupies graminoid and shrub fens, including floating mats, sometimes with marl accumulation. Upper Green River populations are mostly in graminoid fens on hummocks with marl accumulation at the surface. At Muddy Creek, the species is a shrub fen dominant (Figure 40).

Table 10. Size and extent of *Salix candida* populations in the Upper Green River Basin

| EO# | Population overview | Area (ac.) | Documen-tation | Last obs. date |
|---|---|---|---|---|
| 018 | 2012: Vegetative. 20-50 clumps. Most plants less than 15 cm tall, heavily browsed, dead plants present. Surveyed by B. Heidel.<br>2006-07-15/16: Vegetative. 20-50 clumps. Estimates may be low due to severe herbivory and some dieback. Surveyed by B. Heidel, S. Laster, WNPS field trip members. | 0.5 | Survey | 13 July 2012 |
| 021 | 2012: Not found. Sought by B. Heidel and M. Kirkpatrick incidental to *Antennaria arcuata* survey.<br>2009-06-27: Observed by S. Laster. | Unk. | Observ. | 8 July 2012 |
| 024 | Est. 500-1500, common in large areas. Surveyed by B. Heidel. | 20.4 | Survey | 21 August 2012 |
| 025 | Two subpopulations. The larger with est. 100-200 plants and less than 0.5 m tall, and the smaller with est. 20-50 plants, most 0.5+ m tall. Surveyed by B. Heidel. | 7.4 | Survey | 21 August 2012 |
| 026 | Est. 500-1000, locally dominant. Surveyed by B. Heidel. | 3.3 | Survey | 8 August 2012 |

Species and Habitat Images:

Figure 39. *Salix candida*

Figure 40. Habitat of *Salix candida* at Muddy Creek

***Trichophorum pumilum***

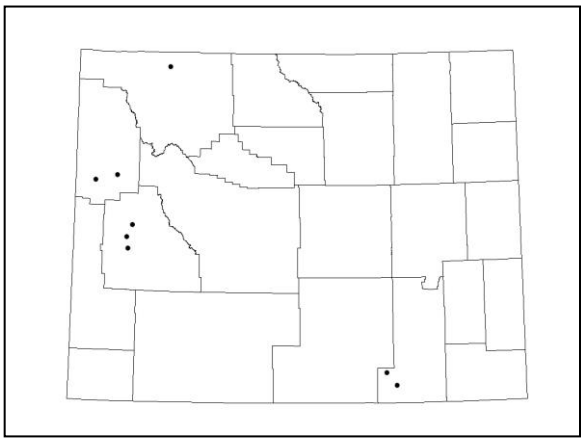


Figure 41. Distribution of *Trichophorum pumilum* in Wyoming

Classification
Scientific name: *Trichophorum pumilum*
Synonyms: *Scirpus pumilus*
Common name: Pygmy bulrush
Family: Cyperaceae

Legal Status
USFWS status: none
Agency status: none

Heritage Rank: G5/S2
Results of Sublette County work support the rank change from S1 to S2.

Geographic Range in the State and Study Area: *Trichophorum pumilum* is known in Wyoming from the Absaroka, Gros Ventre and Medicine Bow ranges, Jackson Hole, and the Upper Green River Basin in Albany, Park, Sublette and Teton counties. In the Upper Green River Basin, it is known from the north and west sides (Figure 41).

Number of Populations in the State and Study Area: *Trichophorum pumilum* is known from eight extant occurrences in the state, three of which are in the Upper Green River Basin.

Size and Extent: *Trichophorum pumilum* occupies very small areas. It appears to grow in vegetative clumps, in very low numbers.

Table 11. Locations of *Trichophorum pumilum* in the Upper Green River Basin

| EO# | Directions | County | Legal Description | Elevation ft (m) | USGS 7.5' Quad | Public Land |
|---|---|---|---|---|---|---|
| 006 | Ryegrass Draw, about 7 air miles west of Daniel. | Sublette | T34N R112W Sec. 34 | 7450 (2271) | Webb Draw | BLM Pinedale FO |
| 007 | Warren Bridge area, west side of Green River and U.S. Hwy191, ca 9.3 air miles north of Daniel Jct. | Sublette | T35N R111W Sec. 8 | 7480 (2280) | Warren Bridge | BLM Pinedale FO |
| 009 | Muddy Creek above confluence with Antelope Draw, ca 12.5 air miles northwest of Marbleton. | Sublette | T32N R112W Sec. 21 | 7200 (2195) | Budd Reservoir, Onion Springs | BLM Pinedale FO |

Habitat in the State and Study Area: In Wyoming and the Upper Green River study area, *Trichophorum pumilum* occupies graminoid fens, usually with marl accumulation.

Table 12. Size and extent of *Trichophorum pumilum* populations in the Upper Green River Basin

| EO# | Population overview | Area (ac.) | Documentation | Last Observed Date |
|---|---|---|---|---|
| 006 | Rare, but occurring in dense clumps almost 10 cm diameter that could have over 50 stems each. Surveyed by B. Heidel. | 0.5 | Survey | 16 July 2006 |
| 007 | Uncommon and possibly restricted to south end. Surveyed by B. Heidel. | 2.6 | Survey | 21 August 2012 |
| 009 | Uncommon at one spot. Surveyed by B. Heidel. | 0.1 | Survey | 8 August 2012 |

Species and Habitat Images:

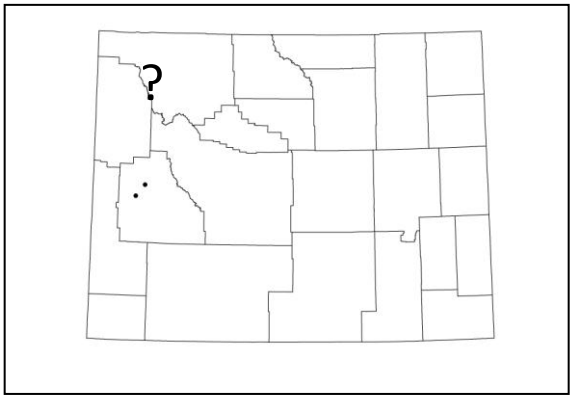
Figure 42. *Trichophorum pumilum*

Figure 43. Habitat of *Trichophorum pumilum*

### *Utricularia ochroleuca*

Classification
Scientific name: *Utricularia ochroleuca*
Synonyms: none
Common name: Yellowishwhite bladderwort
Family: Lentibulariaceae

Legal Status
USFWS status: none
Agency status: none




Distribution of *Utricularia ochroleuca* in Wyoming

Heritage Rank: G4?/SNR
The state rank remains to be determined pending publication of Yellowstone NP information.

Geographic Range in the State and Study Area: *Utricularia ochroleuca* is known from Alaska to Greenland, and south to New York, Minnesota, Colorado, and California. It is known in Wyoming from the Yellowstone Plateau (Hellquist et al. in progress). Garrett Crow refers to it as "rare in North America and probably under collected." (Crow pers. commun. 2013.) Information on its Wyoming distribution is incomplete at present, represented by Figure 44.

Number of Populations in the State and Study Area: *Utricularia ochroleuca* is known less than 10 other collections in the state, all in the Greater Yellowstone area (Hellquist et al. in progress).

Table 13. Locations of *Utricularia ochroleuca* in the Upper Green River Basin

| EO# | Directions | County | Legal Description | Elevation ft (m) | USGS 7.5' Quad | Public Land |
|---|---|---|---|---|---|---|
| 003 | Unnamed tributary of Brodie Draw, west of Aspen Ridge, ca. 10 miles west of Daniel. | Sublette | T34NR113W Sec. 36 | 7520 (2292) | Halfway | BLM Pinedale FO |
| 005 | Warren Bridge area, west side of river and U.S. Hwy 191, ca 9.3 air miles north of Daniel Jct. | Sublette | T35N R111W Sec. 8 | 7480 (2280) | Warren Bridge | BLM Pinedale FO |

Size and Extent: It is not possible to estimate numbers of a submerged aquatic plant such as *Utricularia ochroleuca* unless it can be consistently detected at the surface and individuals discerned. The species appeared to be uncommon at both sites, occupying much less than 1 acre.

Table 14. Size and extent of *Utricularia ochroleuca* populations in the Upper Green River Basin

| EO# | Population overview | Area (ac.) | Documen-tation | Last obs. date |
|---|---|---|---|---|
| 003 | 20-100 plants. Surveyed by B. Heidel and M. Kirkpatrick. | 0.08 | Survey | 8 July 2012 |
| 005 | Uncommon. Surveyed by B. Heidel. | 2.6 | Survey | 21 August 2012 |

Habitat in the State and Study Area: In the Upper Green River study area, *Utricularia ochroleuca* occupies openwater pools that have marl accumulation, within graminoid fens.

Species and Habitat Images: See Weber and Wittmann (2012) for a technical key.

Figure 45. *Utricularia ochroleuca*

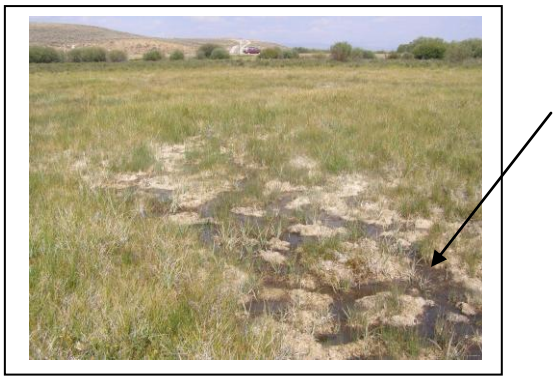


Figure 46. Habitat of *Utricularia**ochroleuca* at Warren Bridge

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