

**STATUS OF *PYRROCOMA CLEMENTIS* VAR. *VILLOSA*
(HAIRY TRANQUIL GOLDENWEED),
BIGHORN MOUNTAINS, NORTH-CENTRAL WYOMING**



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ABSTRACT

Pyrocoma clementis var. *villosa* (hairy tranquil goldenweed) is endemic to the Bighorn Mountains, Wyoming. Surveys of *P. c.* var. *villosa* were conducted on Bighorn National Forest in 2010, and state status information synthesized. Less than a decade ago, this taxon was known from two extant populations and four historic records. To date it is known from ten extant populations, in addition to three historic records. *Pyrocoma clementis* var. *villosa* has been found to be locally common in a band of habitat across the western margin of the Bighorn Mountains, in the Medicine Wheel and Tongue River Ranger Districts, but could not be relocated on the east side. No threats to *P. c.* var. *villosa* have been documented. Taxonomic questions associated with this variety are summarized and provisional interpretations presented as part of this status report to support the case that this variety is restricted to the Bighorn Mountains, whereas all records in the Wind River Range, located in Shoshone National Forest, are *P. c.* var. *clementis*, and that reports of a collection record in Carbon County, Wyoming, presumably on Medicine Bow National Forest, could not be substantiated.

ACKNOWLEDGEMENTS

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Cover: *Pyrocoma clementis* var. *villosa* (hairy tranquil goldenweed). By Earl Jensen.

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INTRODUCTION

Pyrocoma clementis var. *villosa* (hairy tranquil goldenweed) is a state endemic of the Bighorn Mountains in north-central Wyoming. The first surveys for *P. c.* var. *villosa* ever conducted were in 2005 (Jensen 2005, Scott 2006).

Pyrocoma clementis var. *villosa* was first discovered in 1899 in the Bighorn Mountains by Frank Tweedy. It was published as *P. clementis* by Rydberg (1900). It is on the current sensitive species list maintained by the Rocky Mountain Region (USDA Forest Service 2009). This project was undertaken in collaboration with Bighorn National Forest to broaden the systematic survey and address the most pressing information needs for *P. c.* var. *villosa*.

Some of the most pressing information needs proved to be a review of the taxonomic status of *Pyrocoma clementis* var. *villosa*, and that of *P. c.* var. *clementis* in Wyoming. A taxonomic thesis that was never published (Mayes 1976) remains the primary taxonomic reference to date, as cited in the *Flora of North America* treatment (Bogler 2006), and the treatment of *P. c.* var. *villosa* in it was presented as provisionl. Both varieties are tracked as Wyoming plant species of concern although only *P. c.* var. *villosa* is designated as sensitive by the Rocky Mountain Region (USDA Forest Service 2009).

METHODS

At the start of this project, information on the habitat and distribution of *Pyrocoma clementis* var. *villosa* was compiled and reviewed at the Rocky Mountain Herbarium (RM 2010) and the Wyoming Natural Diversity Database (WYNDD 2010). A two-pronged approach was taken in conducting 2010 field surveys.

1. Digital color infrared orthophotographs (2000) were used to compare *P. c.* var. *villosa* habitat signatures with other areas on the Forest having calcareous limestone bedrock, identifying major areas of similar habitat not previously surveyed.
2. Known distribution was overlain with a compilation of calcium carbonate-rich bedrock formations (Love and Christiansen 1985) to compare known distribution with geology as basis for interpolation and extrapolation.

The fieldwork was conducted in the same year as surveys for two other rare calciphilic plants, *Physaria didymocarpa* var. *lanata* (woolly twinpod) and *Musineon vaginatum* (sheathed musineon) in order to pursue Forest-wide surveys of all three, on the grounds that concurrent surveys for all three might be more efficient together than separately.

In preparation for fieldwork, digital orthophotographs with distribution of *Pyrocoma clementis* var. *villosa* superimposed were printed out onto 8 ½ x 11 paper, representing about the same scale as 1:24,000 USGS topographic maps. The aerials and maps were both used for reference in setting field survey priorities and navigation in the field.

Surveys for *Pyrrcoma clementis* var. *villosa* were conducted between 2 August and 24 August 2011. When *P. c.* var. *villosa* was found in a survey area, the first tasks were to estimate its numbers, determine extent, and describe occupied habitat including topography, vegetation, and plant associates. Coordinates were recorded from GPS units for georeferencing population boundaries, later used to digitize polygonal population boundaries. Information was compiled and recorded onto WYNDD sensitive plant survey forms, and later entered in the WYNDD database.

Survey data of Richard and Beverly Scott, from 2005-2006 was incorporated after the 2010 field season. Further study of the taxonomic differences between varieties ensued.

RESULTS - SPECIES INFORMATION

Classification

Scientific name: *Pyrrcoma clementis* Rydb. var. *villosa* (Rydb.) Mayes ex Brown & Keil

Synonyms: *Haplopappus clementis* (Rydb.) S.F. Blake

Common name: Hairy tranquil goldenweed

Family: Asteraceae (previously referred to as Compositae; Aster family or Sunflower family)

Size of genus: *Pyrrcoma clementis* var. *villosa* is one of 14 species in the genus, a genus that is restricted to North America (Bogler 2006). There are six species and one variety of *Pyrrcoma* in Wyoming (Bogler 2006, Dorn 2001). This genus was first described by Hooker in 1833. The genus is characterized by its persistent basal rosettes of leaves, yellow-rayed heads on scapiform or few-bracteate peduncles, and obtuse, acute or mucronate phyllaries. The genus has also been treated as a section within the genus *Haplopappus* (Hall 1928, Cronquist 1994). It was presented as a separate genus in the dissertation by Mayes (1976), though some of the nomenclatural changes were not validated, including that for *P. c.* var. *villosa*. It was validated as a new combination by Brown and Keil (1992), along with other *Pyrrcoma* taxa.

Phylogenetic relationships: *Pyrrcoma clementis* var. *villosa* falls within a portion of the genus having radiate heads that are in clusters of 1-6+. Its chromosome number is not known. Most species in the genus have a diploid chromosome number ($2n=12$). There are also a lesser number of tetraploid and hexaploid *Pyrrcoma* species.

There are many unanswered questions about the phylogenetic relation between *Pyrrcoma clementis* var. *villosa* and the type variety, *P. c.* var. *clementis*, and between other species of the genus. Rydberg (1900) considered *P. c.* var. *villosa* to be closely related to *P. uniflora*, but

readily distinguished from the latter by its larger heads and foliaceous involucre bracts imbricated in 3-4 series. In their treatment of the Rocky Mountain flora, Coulter and Nelson (1909) reduced *P. villosa* to a synonym under *P. uniflora*.

Hall (1928) was the first taxonomist to detect close relationships between *Pyrocoma villosa* and *P. clementis*. Mayes (1976) treated *P. villosa* as a variety of *P. clementis*, *P. c. var. villosa* (Rydb.) Mayes. However, he said he had been unable to investigate this taxon adequately in the field, and its provisional treatment at the variety level was based on several characteristics and geographic isolation that he termed a “compromise.” Mayes (1976) noted that the type variety is closely related to *P. crocea* and *P. integrifolia*, perhaps more closely related to these other species than to *P. clementis var. villosa*. This provisional treatment remained the basis for its circumscription in the *Flora of North America* (Bogler 2006) and in Dorn (2001), though not accepted by the RM (2010). Cronquist (1994) noted without further research that he considered it to be most closely related to *P. integrifolia* rather than *P. clementis var. villosa*. Thus, the relationships between the two varieties of *P. clementis* and with other members of the genus (*P. uniflora*, *P. integrifolia*, and *P. crocea*) has had many different opinions over time but no rigorous research.

Present legal or other formal status

U.S. Fish & Wildlife Service status: None.

U.S. Forest Service status: *Pyrocoma clementis var. villosa* is on the current sensitive species list maintained by the U.S. Forest Service Rocky Mountain Region (USDA Forest Service 2009).

Global Heritage rank: G3G4T2. This indicates that the species may be either globally vulnerable or potentially secure across its entire range, but the variety may be globally imperiled.

State Legal status: None.

State Heritage rank: S2 in Wyoming. This indicates that the variety is potentially imperiled in the state. In this case, the state and global heritage ranks are equal because the taxon is restricted to the state.

History of Taxon: The taxon was first discovered by Frank Tweedy (2063 NY) in August 1899 in the Bighorn Mountains at “Willow Creek.” The following year, Rydberg (1900) published the description for *Pyrocoma villosa* Rydb. Also in 1900, Tweedy made a second collection (3042 RM) at “the headwaters of Clear Creek and Crazy Woman River.” It was not collected again until 1952, “2 miles west of [Bighorn National] Forest Boundary” by Eugene H. Cronin (*s.n.* RM) in the vicinity of Trapper Canyon. In 1955, it was collected south of Burgess Junction by R.K. Gierisch (1780 RM).

The type variety, *Pyrracoma clementis* var. *clementis* (tranquil goldenweed) was first discovered by Frederick Clements (44 NY) on Mount Harvard in Colorado, and named after him by Rydberg. *Pyrracoma villosa* was first identified as a relative of *P. clementis* by Hall (1928) and was proposed as a variety of the latter by Mayes (1976), later validated as a new combination by Brown and Keil (1992).

The story becomes more complicated with two collections of *Pyrracoma clementis* in the Wind River Range by Fisser (638, 702 RM) made in 1961. These collection stations appear to correspond with the two distribution points for *P. clementis* var. *clementis* shown on the distribution map by Mayes (1976). However, one of the Fisser collections (702) was annotated to *P. c.* var. *villosa* by Mayes (1976) although Mayes did not map *P. c.* var. *villosa* as present in the Wind River Range. The other Fisser collection (638) was more recently annotated to *P. integrifolia*. Mayes (1976) also represented a third location of *P. c.* var. *clementis* in Carbon County, Wyoming. The source of this report has been sought online among Intermountain Region Herbarium Network (2011) and not found. One possible explanation is that an immature *Pyrracoma* collected by C.O. Williamson (13) and identified as *P. villosa* in Carbon County, Montana and kept in the U.S. Forest Service Herbarium was not available for review and was mistakenly placed in Carbon County, Wyoming by Mayes (1976). [The Forest Service collection is now housed at the Rocky Mountain Herbarium and the specimen in question has immature flowers that does not appear to fit either variety.] Dorn (2001) reported that both varieties are present in Fremont County, possibly in keeping with the map by Mayes (1976) and the annotated specimen (Fisser 702 RM).

More recently, systematic floristic inventory was conducted in the Bighorn Mountains (Nelson and Hartman 1984). Two new collections were made from the southern end of the Mountains in Washakie County in 1979 and 1981 (Nelson 8159, Hartman 10549 RM). Until recently, *Pyrracoma clementis* var. *villosa* was reported from two extant occurrences and four historic occurrences (Fertig 2000). More recent floristic thesis inventories conducted out of the Rocky Mountain Herbarium produced four population records (Lum 2004, Massatti 2007) in the Bighorn Basin and Wind River Range, respectively. Another four new populations were discovered and mapped in survey work conducted by Earl Jensen in Bighorn National Forest (Jensen 2005), the first recent records in the Forest. Finally, surveys conducted by Richard and Beverly Scott in 2005 and 2006 located three new locales in the Bighorn National Forest.

Review of the *Pyrracoma clementis* var. *villosa* specimens at RM was conducted as part of this project. This update is offered as preliminary support for the taxonomic validity of *P. c.* var. *villosa*, upon which results are predicated.

Description

General non-technical description: *Pyrracoma clementis* var. *villosa* is a perennial forb with 1 to many stems from a branched rootstock. Stems are 3-15 (30) cm tall and loosely white-hairy to glabrous. Basal leaves are oblanceolate to narrowly elliptic, 2-12 cm long, and sparsely pubescent to glabrate on the surface. Stem leaves are progressively smaller and sessile to clasping. Flower heads are solitary or number 2-4 with involucre 9-15 mm high and woolly to glabrous lanceolate to oblanceolate, attenuate bracts that are green throughout. Ray flowers are yellow and 10-15 mm long while disk flowers are 6-8.5 mm long. Fruits are 4-sided glabrous achenes with tawny to brown bristles (Cronquist 1994; Dorn 2001, Bogler 2006, Fertig 2000; Figures 1-4).

The basis for the epithet, “hairy (*villosa*)”, is not discussed in taxonomic works. Both varieties of *Pyrracoma clementis* often have stems with long, tangled hairs, particularly on the upper stem below the flower. Rydberg (1900) described *P. c.* var. *villosa* as having a villous bract surface. However, taxonomists later determined that this is not a consistent variety trait.

Technical description: Perennial from a branched caudex with 1-many stems. Stems decumbent or curved-ascending, red-tinged, villous with long hairs to occasionally woolly and 3-15 (30) cm long. Leaves basal and cauline, simple. Basal leaves oblanceolate to narrowly elliptic, 2-12 cm long, and sparsely pubescent to glabrate on the surface. Cauline leaves progressively smaller and sessile to clasping. Flower heads solitary or few 2-4(5) and cymosely-arranged, radiate, with involucre 9-15 mm high and woolly to glabrous lanceolate to oblanceolate, attenuate phyllaries that are green throughout, in 3-4 series, margins ciliate. Ray flowers yellow, pistillate and 10-15 mm long. Disk flowers yellow, bisexual, fertile, and 6-8.5 mm long. Fruits 4-sided glabrous achenes with tawny to brown bristles. Crypsela faces glabrous. Pappi persistent, of brownish, rigid, unequal bristles in 1 series (Cronquist 1994; Dorn 2001, Bogler 2006).

Local field characters: The deep, golden-yellow flower color of *Pyrracoma clementis* var. *villosa* resembles that of *Arnica* spp. Unlike *Arnica* spp., it has alternate leaves. It could also be mistaken from a distance for *Taraxacum officinale* (common dandelion) or *Agoseris glauca* (false dandelion; Jensen 2005, 2010). Its flowering overlaps with the end of *T. officinale* flowering and the start of *A. glauca* flowering. Unlike *A. glauca* and *T. officinale*, it has stem leaves, and has a central disk with both ray and disk flowers. It often produces only one flower, but occasionally has 3+ flower heads. The stems are usually decumbent or curved-ascending to upright, growth form characteristics that give it different appearances in the field (Figures 2-3).

Similar species: *Pyrracoma clementis* var. *clementis* has acute tipped involucre bracts, hairy achenes, and sericeous crypsela faces (Table 1). *Pyrracoma integrifolia* has green tips or green just on upper lengths of the involucre bracts. *Pyrracoma uniflora* has 1-4 flowering heads with involucre 5-10 mm long and usually grows on wet, alkali soils. *Pyrracoma lanceolata* has 4 or



Figure 1. *Pyrocoma clementis* var. *villosa* bracts. By B. Heidel.



Figures 2 and 3: *Pyrocoma clementis* var. *villosa* whole plants; multi-stemmed vs. two-stemmed, and ascending vs. decumbent. By Earl Jensen.



Figure 4. *Pyrrcoma clementis* var. *villosa* specimen close-up. Note glabrous seeds and acuminate bracts. (Hartman 10549; with Nelson 8159 as insert)

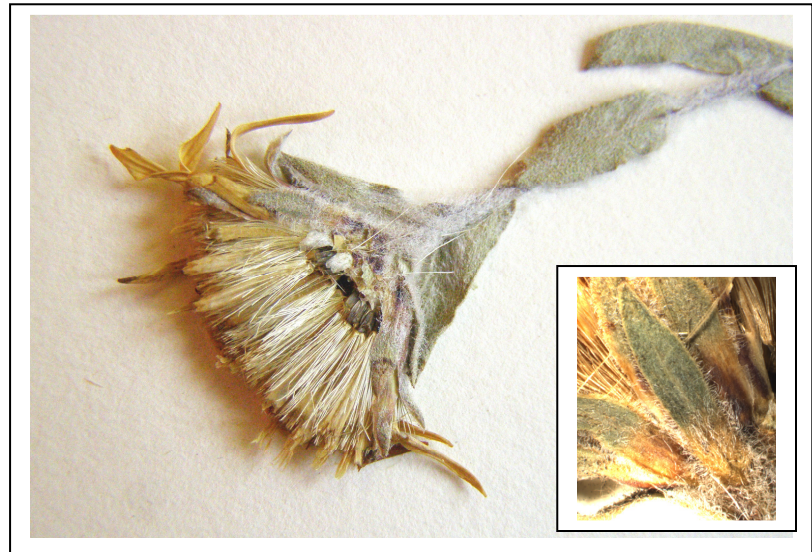


Table 1. Characteristics that distinguish *Pyrrcoma clementis* var. *villosa* from other taxa in the genus (Cronquist 1994, Dorn 2001, Mayes 1976, Bogler 2006)

Taxon	No. of flower heads	Involucre length (mm)	Involucre shape, tip	Involucre texture, surface	Disk corolla length (mm)	Leaf outline, surface	Growth form
<i>Pyrrcoma clementis</i> var. <i>villosa</i>	Usually solitary, occasionally 2-3(4)	9-14	Lanceolate or oblanceolate, with attenuate tip	Green most of length	7-14	Entire or slightly undulate, glabrous	Stems decumbent curved-ascending to ascending
<i>Pyrrcoma clementis</i> var. <i>clementis</i>	Usually solitary, occasionally 2-3(4)	9-14	Obovate, with abruptly acute tip	Green most of length	7-14	Entire or slightly undulate, glabrous	Stems ascending
<i>Pyrrcoma crocea</i>	Usually solitary, occasionally 2-3	15-20	Oblong to spatulate, with obtuse tip	Green or yellowish, with pale margins	7-14	Entire or undulate, glabrous	Stems erect or ascending, robust
<i>Pyrrcoma integrifolia</i>	4+	11-17	Oblanceolate to oblong, with acuminate tip	Green-tipped	5-7 (7.5)	Entire or undulate, glabrous	Stems erect or ascending
<i>Pyrrcoma lanceolata</i>	Usually numerous; (1) 5-20 (50)	7-10	Linear lanceolate to lanceolate, with acute tip	Green-tipped	5-7	Finely toothed, glabrous	Stems erect, ascending or decumbent
<i>Pyrrcoma uniflora</i>	Usually solitary, occasionally 2-4	6-13	Linear-lanceolate, with acute tip	Green most of length	5-7 (7.5)	Toothed, with fine, tangled hairs	Stems curved-ascending to decumbent

more flower heads per stem with involucre 5-10 mm long of green-tipped bracts (Dorn 2001; Cronquist 1994, Bogler 2006, Fertig 2000). In the genus, there is limited geographic overlap with *P. c.* var. *clementis*. Both *P. integrifolia* and *P. uniflora* are known from the south end of the Bighorn Mountains in Washakie County (Nelson and Hartman 1984, Dorn 2001, Rocky Mountain Herbarium 2010). *Pyrocoma integrifolia* is an upland plant last collected from the Bighorn Mountains in Washakie County by Leslie Gooding in 1901.

Geographical distribution

Range: *Pyrocoma clementis* var. *villosa* is a state endemic of the Bighorn Mountains in north-central Wyoming. Its extant populations are on the western slopes of the Mountains in Big Horn and Washakie counties, but the earliest collections of it were apparently made on the east side.

By contrast, *P. c.* var. *clementis* is widespread in Colorado and Utah and appears to be consistent with all material examined from the Wind River Range (*Fisser 702* RM) or posted (*Massatti 5911, 6107* RM). We sought to locate specimens of *P. c.* var. *clementis* to support Mayes (1976) report for the type variety in Carbon County, Wyoming, using on-line search tools of the Intermountain Regional Herbarium Network (2011) but no supporting data were found.

Extant sites: *Pyrocoma clementis* var. *villosa* is known from ten extant occurrences, along the west slope of the Bighorn Mountains (Table 2, Figure 5). The highest concentration is along a 20+ mile western margin of the Bighorn National Forest. There are also three occurrences at the southern end of the Bighorn Mountains on BLM lands. There is only one collection of *Pyrocoma clementis* var. *villosa* on the Bighorn National Forest in the past decade (*Heidel 3514* RM), so there is a need for more complete vouchered material deposited into regional herbaria so that herbarium records and sensitive species records are consistent.

Historical sites: There are three historical collection records of *Pyrocoma clementis* var. *villosa* in the Bighorn Mountains, including the only two collections made on the east side. The 1899 specimen collected from “Willow Creek” was interpreted at RM by reviewing the collecting journal as corresponding to Willow Creek in Sheridan County, possibly near Park Reservoir. Grassland habitat was traversed in this area incidental to wetland surveys in the area, mostly on glacial till parent material, but no species of *Pyrocoma* were found. There was also a survey in grassland habitat above Willow Creek in Johnson County, west of Buffalo, on limestone parent material, but no species of *Pyrocoma* were found. The 1900 specimen collected from “headwaters of Clear Creek and Crazy Woman River” fits the township T49N R84W or immediately adjoining townships, where additional grassland habitat was surveyed, mostly on Archean metamorphic parent material mapped as gneiss. These surveys in grassland habitat were incidental to wetland surveys, or conducted as spot-checks from the road. They were unsuccessful. Geology is mentioned because there is no limestone parent material in these areas analogous to that where *P. c.* var. *villosa* has occurs on the west side. It may have a broader

range of habitat than previously documented. Alternatively, both of the east-side historical collections might have been made on limestone parent material that lies below Forest boundaries.

The third historical collection “2 miles west of the Forest Boundary” has not been relocated. This is close to the Spanish Karst Area of Critical Environmental Concern (ACEC), which might or might not have suitable habitat.

Table 2. Location information for *Pyrrocoma clementis* var. *villosa*

EO#	Location	County	Legal Description	Elev.	USGS 7.5'	Ownership
001	Headwaters of Finger, Three Springs, Willey, Owen, Cedar, and Prospect creeks	Big Horn Sheridan	T54N R89W Sec. 4, 5, 9, 10, 14, 15, 16, 22, 23, 32	9200-9700	Granite Pass	Bighorn NF
002	Trapper Canyon vicinity	Big Horn	T52N R89W (imprecise location)	?	Spanish Butte Bush Butte	BLM Worland
003	Middle Fork Power River	Johnson Washakie	T41N R86W Sec. 26 T42N R86W Sec. 2, 11	7300-8000	Gordon Creek Cherry Creek Hill	BLM Worland
004	Headwaters of Clear Creek and Crazy Woman River	Johnson	T50N R84W (imprecise location)	?	Hunter Mesa	Bighorn NF
006	Willow Creek (tentatively near Park Reservoir on Willow)	Johnson?	T53N R86W? (imprecise location)	?	Park Reservoir?	Bighorn NF
007	Crooked Creek Hill and slopes above Battle, Crooked, Jack, and Johnny creeks	Big Horn	T52N R88W Sec. 4, 5, 8, 9, 16, 17, 21; T 52N R89W Sec. 1, 12; T53N R88W Sec. 32; 33	8700-9600	Spanish Point Shell Canyon	Bighorn NF BLM Worland, pvt?
013	Spanish Point, northeast slopes	Big Horn	T52N R88W Sec. 33	8700-8900	Spanish Point	Bighorn NF
014	Spring Creek, slopes west of Spring Creek	Washakie	T41N R86W Sec. 26, 27	8250	Cherry Creek Hill	BLM Worland
015	Middle Fork Powder River, slopes north and west of	Washakie	T42N R86W Sec. 33	8100-8160	Cherry Creek Hill	BLM Worland
017	Road between Cold Springs Campground	Big Horn	T51N R88W Sec. 36	9000	Allen Draw	Bighorn NF
018	Upper south slopes of Sunlight Mesa	Big Horn	T54N R90W Sec. 33	8050	Black Mountain	Bighorn NF
021	McKay Creek	Big Horn	T53N R89W Sec. 19	8100	Shell Falls	Bighorn NF
022	West end of Snowshoe Mountain	Big Horn	T53N R89W Sec. 26	9050	Shell Falls	Bighorn NF

Unverified/Undocumented reports: None known.

Sites where present status not known: The 2010 surveys did not address habitat outside Bighorn National Forest boundaries.

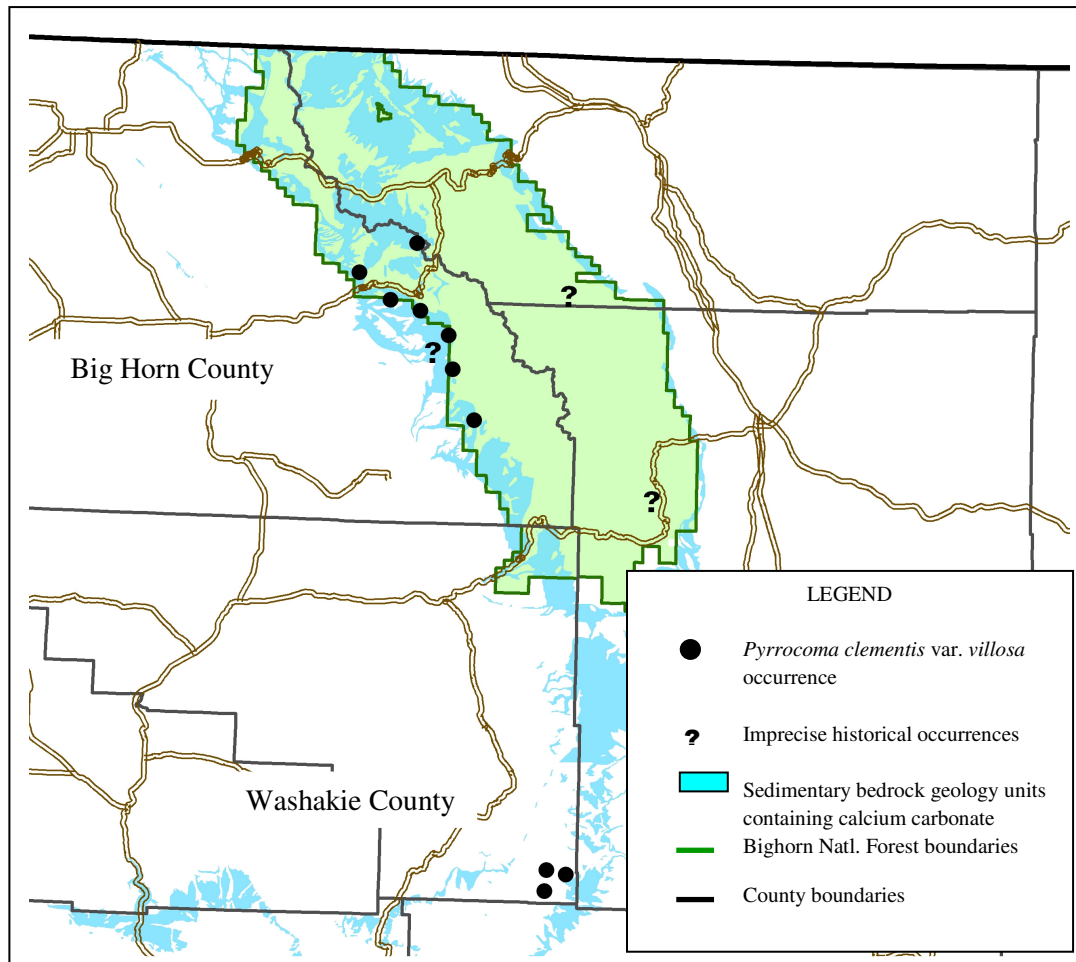


Figure 5. Distribution and geology of *Pyrocoma clementis* var. *villosa*

Areas surveyed but species not located: Appendix A represents locales surveyed for *Pyrocoma clementis* var. *villosa*. This study identified many areas that appear to be suitable where it was not found. It was also sought but not found in part of the Elephant Head area (Welp et al. 1998).

Land ownership: *Pyrocoma clementis* var. *villosa* occurs on lands managed by the Bighorn National Forest and the BLM Worland Field Office. One of the largest populations straddles the Forest boundary (Crooked Hill #007), occurring on Bighorn National Forest, BLM Worland Field Office lands and possibly private lands. One somewhat vague record might occur in the Spanish Karst ACEC and Trapper Canyon Wilderness Study Area. All other known population records are from public lands managed for multiple use.

Habitat

Pyrocoma clementis var. *villosa* is found in montane meadows on limestone substrates, in or between sagebrush steppe but not directly associated with sagebrush. Elevations range from 2225-2957 m (7300-9700 ft). The known elevation differs from that given by Mayes (1976) who reported *P. c.* var. *villosa* it from "meadows, forest openings, and above timberline at elevations

of 10,000 to 11,500 feet in association with *Pinus aristata*, *P. contorta*, *Populus tremuloides*, *Poa alpina*, *P. fendleriana*, and *Haplopappus macronema*.” There are many collections of *P. c.* var. *clementis* from Colorado that are in alpine elevations, and it reaches elevations up to 12,500 ft (Mayes 1976), but there are no known collections of *P. c.* var. *villosa* at alpine elevations. One of the associated species report by Mayes (1976), *Pinus aristata* (bristlecone pine), is associated with *P. c.* var. *clementis* in Colorado but is not present in Wyoming.

Recent surveys found *Pyrrcoma clementis* var. *villosa* on Nathrop-Passcreek-Starley/ Limestone. The southern occurrences of it on BLM lands were apparently collected in an area of Archean metamorphic parent material mapped as gneiss (Love and Christiansen 1985). Survey work in these areas might help determine the substrate breadth or narrowness of *P. c.* var. *villosa*, information that would be useful for expanded survey on similar substrate on the east side of Bighorn National Forest.

Pyrrcoma clementis var. *villosa* occurs on gently contoured landforms that, at least in Bighorn National Forest, have limestone bedrock (Figure 6). The landform outcrops form striated patterns that show up on aerial photos as bands of high reflectance, corresponding with high limestone gravel cover or small outcrop blocks at the surface.

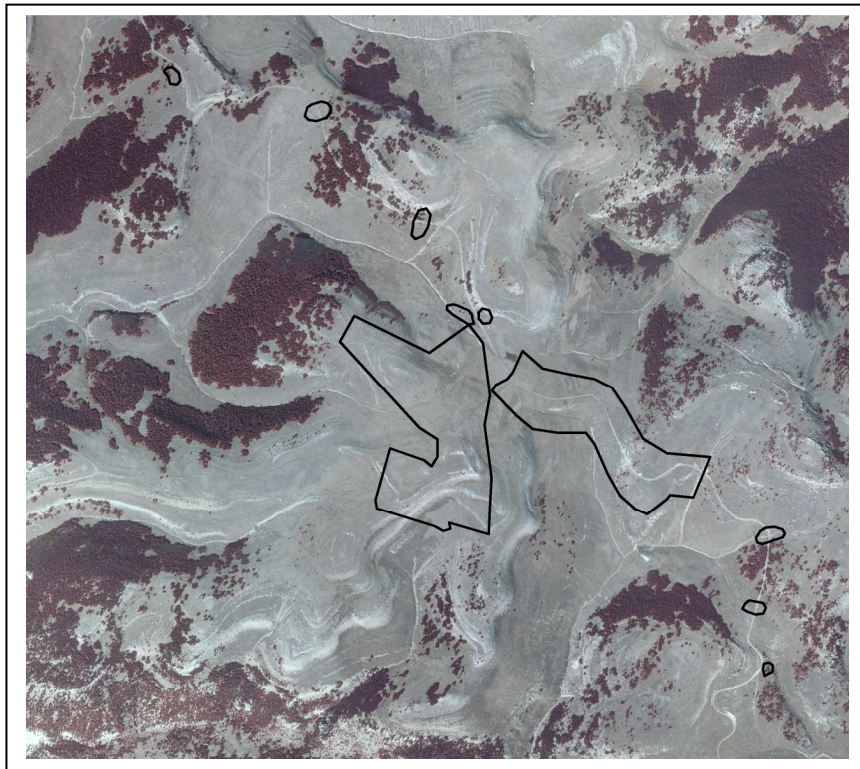


Figure 6. Color infrared aerial photograph of *Pyrrcoma clementis* var. *villosa* occupied habitat in the center of the Granite Pass population complex, #001 (Granite Pass Quad, 1:24,000). Note limestone outcrops in repeated bands, a pattern found around the largest known populations.

The breadth of occupied habitat is indicated by a series of photographs taken in the Granite Pass population complex (#001; Figures 7-10). It remains to be determined whether the habitats are prevailing vegetation types or secondary ones.



Figure 7. *Pyrocoma clementis* var. *villosa* on relatively steep habitat, Granite Pass (#001)
By Matthew Spann.



Figure 8. *Pyrocoma clementis* var. *villosa* on forb-rich meadow, Granite Pass (#001). By Earl Jensen.



Figure 9. *Pyrocoma clementis* var. *villosa* on stream headwaters, Granite Pass (#001).
By Earl Jensen.



Figure 10. *Pyrocoma clementis* var. *villosa*. at edge of sagebrush steppe, Granite Pass (#001). By Earl Jensen.

Frequently associated species: The species noted in association with *Pyrrocomma clementis* var. *villosa* are mainly widespread species of montane meadows (Table 3).

Table 3. Species associated with *Pyrrocomma clementis* var. *villosa*¹

Scientific name	Common name	On Bighorn NF?
<i>Achillea millefolium</i>	Yarrow	YES
<i>Agoseris glauca</i>	False dandelion	YES
<i>Anemone multifida</i>	Red windflower	YES
<i>Antennaria microphylla</i>	Small-leaf pussytoes	YES
<i>Arnica rydbergii</i>	Rydberg's arnica	YES
<i>Artemisia tridentata</i> ssp. <i>vaseyana</i>	Mountain big sagebrush	YES
<i>Castilleja</i> spp.	Paintbrush	YES
<i>Cerastium arvense</i>	Field chickweed	YES
<i>Elymus spicatus</i>	Bluebunch wheatgrass	YES
<i>Eremogone congesta</i>	Ballhead sandwort	YES
<i>Eriogonum flavum</i>	Yellow buckwheat	NO
<i>Festuca idahonis</i>	Idaho fescue	YES
<i>Fragaria virginiana</i>	Wild strawberry	YES
<i>Frasera speciosa</i>	Green gentian	YES
<i>Geum triflorum</i>	Prairie smoke	YES
<i>Geranium viscosissimum</i>	Sticky geranium	YES
<i>Hedysarum sulphurescens</i>	Sulfur sweetvetch	YES
<i>Linum perenne</i>	Wild blue flax	YES
<i>Lupinus argenteus</i>	Silver lupine	YES
<i>Oxytropis campestris</i>	Field locoweed	YES
<i>Penstemon</i> spp.	Beardtongue	YES
<i>Phlox multiflora</i>	Flowery phlox	YES
<i>Pinus contorta</i>	Lodgepole pine	YES
<i>Pinus flexilis</i>	Limber pine	YES
<i>Poa secunda</i>	Sandberg's bluegrass	YES
<i>Polygonum bistortoides</i>	Bistort	YES
<i>Potentilla paradoxa</i>	Paradox cinquefoil	YES
<i>Sedum lanceolatum</i>	Stonecrop	YES
<i>Senecio</i> or <i>Packera</i> spp.	Ragwort or Groundsel	YES
<i>Solidago multiradiata</i>	Rocky Mountain goldenrod	YES
<i>Symphotrichum</i> spp.	Aster	YES
<i>Taraxacum officinale</i>	Common dandelion	YES
<i>Valeriana</i> spp.	Valerian	YES
<i>Zigadenus elegans</i>	Death camas	YES

Associated species of concern: There is limited overlap of *Pyrrocomma clementis* var. *villosa* with other Wyoming plant species of concern. It overlaps with part of the distribution of *Symphotrichum molle* (smooth aster), though there are no sites where they have been found growing together. It does not occur with the other two rare species surveyed in 2010, *Physaria didymocarpa* var. *lanata* and *Musineon vaginatum*.

¹ Nomenclature generally follows Dorn (2001).

Topography: *Pyrracoma clementis* var. *villosa* occupies ridge tops, tablelands, shoulders and upper to midslope positions with soil development.

Soil relationships: The soils where *Pyrracoma clementis* var. *villosa* is found are well-developed loamy mollisols. Most sites have gravel and bare soil at the surface, the bare soil possibly caused by burrowing activity. Some also have small rocks, platy blocks or ledges of limestone at the surface.

Regional climate: The montane climate of the Bighorn Mountains is best represented by meteorological data from Burgess Junction (USDI NOAA 2010; Station 481220; collected from 9/18/1960 to 12/31/2005). Annual precipitation averages 53.3 cm (21.0 in). Snowfall is a major contribution to total annual precipitation, with an average of 6.2 m (242.8 in) amounting to about 53% of mean annual precipitation. April and May are the months of highest precipitation, much of which falls as snow. July is the warmest month with mean monthly temperature of 12.9 °C (55.2 °F) and January is the coldest with mean monthly temperature of -8.5 °C (16.7 °F). There is a 50% probability of having a 40-day period during the growing season when temperatures are at or above freezing.

From what is known about current distribution, *Pyrracoma clementis* var. *villosa* appears to favor the drier climates. There is a rain shadow pattern associated with the Bighorn Mountains where moisture-bearing systems come out of the east. This is well-documented in foothills settings in comparing the precipitation of Buffalo and Sheridan on the east side where annual precipitation is 33.8 cm and 37.1 cm (13.3 in and 14.6 in, respectively) against the precipitation of Shell and Worland on the west side where annual precipitation is 25.5 cm and 19.6 cm (9.9 in and 7.7 in, respectively; USDI NOAA 2010).

Local microclimate: The settings that support *Pyrracoma clementis* var. *villosa* all have loamy, moisture-retaining soils. The availability of subsurface moisture during flowering and seed maturation may be particularly important in the production of seeds at dry times of the growing season. Many of the settings have a west aspect, directly exposed to the force of prevailing winds.

Population biology and demography

Phenology: *Pyrracoma clementis* var. *villosa* flowers from July-mid August, and produces seed from late July-September. Flowering is staggered and prolonged if there are multiple flower heads per stem.

Population size and condition: *Pyrracoma clementis* var. *villosa* occurs in scattered clusters with numbers ranging from less than 50 plants to numbers in the 1000's (Table 4). Detailed survey and mapping are available for two occurrences (#001, #007), where total numbers approach or

surpass the 10,000 magnitude (Table 4). The difficulty of accurate estimates is compounded by the high density of plants in places (Figures 11 and 12), where numbers are apt to be seriously underestimated. Total occupied habitat is likely to be much more than 405 ha (1000+ ac).



Figure 11. *Pyrracoma clementis* var. *villosa* in high density, Granite Pass (#001). By Susan Bell.



Figure 12. *Pyrracoma clementis* var. *villosa* in high density, Granite Pass (#001). By Susan Bell.

Table 4. Size and extent of *Pyrracoma clementis* var. *villosa* populations

EO#	Numbers/Extent ha (ac)
001	Probably several thousand plants across 138 ha (340 ac)
002	Unknown
003	Unknown
004	Unknown
006	Unknown
007	Possibly thousands across 162 ha (400 ac)
013	Less than 100 in app. 6 ha (15 ac)
014	Unknown
015	Unknown
017	Unknown
018	Unknown
021	Unknown
022	Unknown

There is no evidence to suggest that *Pyrracoma clementis* var. *villosa* has lost habitat or that its habitat has declined. Disturbance frequency or successional rates might affect population trends if it is restricted to a successional habitat maintained by periodic disturbance such as fire, or favors a successional habitat.

Reproductive biology

Type of reproduction: Reproduction is sexual, by seed.

Pollination biology: *Pyrrcoma clementis* var. *villosa* has conspicuous inflorescences with pistillate ray flowers that mature first, fostering outcrossing, and bisexual disk flowers, possibly self-pollinated. Beetles have been observed feeding for nectar and getting dusted with pollen.

Seed dispersal and biology: The flower head doesn't shed seeds until it dries out, late in the growing season, sometimes after frost. The bristles on the achene aid in wind dispersal.

Population ecology

General summary: *Pyrrcoma clementis* var. *villosa* is a perennial. There are no available data on its life history, or a way to characterize the age or life history stage of individual plants, either in the field or in the herbarium. It is possible, but not proven, that the taproot diameter or vestiges of leaf sheathes reflect age.

Competition: *Pyrrcoma clementis* var. *villosa* grows in grassland plant communities that are part of a mosaic with *Artemisia tridentata* ssp. *vaseyana* (mountain big sagebrush). It is not clear what is cause and what is effect, but its absence from areas with sagebrush may be due to some intermediate variable such as gopher avoidance of sagebrush habitat, the allelopathic affects of sagebrush, or the disturbance represented by gaps in sagebrush cover.

Herbivory: Few signs of herbivory were observed on *Pyrrcoma clementis* var. *villosa* plants in the field or on herbarium specimens. The hairiness of the flowering stalk and the stiff bracts may deter herbivory.

Hybridization: No evidence.

ASSESSMENT AND MANAGEMENT RECOMMENDATIONS

Potential threats to currently known populations

Grazing: *Pyrrcoma clementis* var. *villosa* occupies habitats that are generally in the middle of primary range for livestock. No signs of grazing or browsing were observed. Evidence of trampling was not observed. Grazing can sometimes be associated with habitat degradation and associated vegetation shifts. Some of the species associated with it such as *Taraxacum officinale* (common dandelion), are exotic species that can occupy a wide range of intact and degraded habitat. There was not sufficient information collected to characterize *P. c.* var. *villosa* as a decreaser or increaser under livestock grazing.

Logging: *Pyrracoma clementis* var. *villosa* does not occupy forest stands so would not be affected by logging practices except in the construction of access roads.

Roads: Motorized vehicles are restricted to open, designated roads or motorized trails during the growing season in nearly all areas occupied by *Pyrracoma clementis* var. *villosa*, although people can drive up to 300 ft off of the road for a specific purpose such as camping. Parts of its habitat are on gentle terrain that can be affected by such practices. Roads run through the center of some of the largest populations, and occasionally plants are found in graded margins but the topographic position that *P. c.* var. *villosa* occupies appears to be the main reason for this overlap, rather than because it is associated in any way with roadwork or road use.

Weeds: There were no noxious weeds found in 2010 surveys of *Pyrracoma clementis* var. *villosa*.

Fire: There are charred remnants of scattered, old trees at some sites of *Pyrracoma clementis* var. *villosa* (Figure 13). It is sometimes found in gaps between stands of *Artemisia tridentata* ssp. *vaseyana* (mountain big sagebrush), but the vegetation borders have not been examined closely to look for signs of fire or other disturbance history.



Figure 13. *Pyrracoma clementis* var. *villosa* habitat with dead trees, Granite Pass (#001).
By Earl Jensen.



Figure 14. *Pyrracoma clementis* var. *villosa* habitat with bare soil possibly due to burrowing activity, Granite Pass. (#001).
By Earl Jensen.

Other: *Pyrracoma clementis* var. *villosa* is often found on substrates that often appear to be churned by pocket gopher activity (Figure 14). It is possible that frost action or other processes are involved rather than rodent burrowing. In any case, this natural disturbance might account for the high frequency of plants such as *Taraxacum officinale* (common dandelion) associated

with *P. c. var. villosa*. In places along gentle, headwater drainages, its local distribution might also be shaped by slight differences in erosion or snowmelt patterns (Figure 9).

Management practices and response

There have been no studies of management practices and associated responses of *Pyrrocomma clementis* var. *villosa*. It would be insightful to document before-and-after conditions for any new grazing developments implemented in occupied habitat, prescribed burn activity, or any actions affecting burrowing mammals. It would be especially insightful to set up a study with a control plot containing a portion of the population that is excluded from treatment.

Conservation recommendations

Recommendations regarding present or anticipated activities: It would be appropriate to integrate allotment information with *Pyrrocomma clementis* var. *villosa* distribution. The occurrence maps provided in electronic format with this report (Appendix A) are available for this use.

Notification of U.S. Forest Service personnel of locations on national forest: To prevent inadvertent impacts to known *Pyrrocomma clementis* var. *villosa* populations, all appropriate USFS personnel and cooperators involved in planning and on-the-ground land management activities, should have access to species information and location data. Key activities include grazing, fire management and weed control. Towards this end, the updated Forest Service species evaluation (Appendix C) and state species abstract (Appendix D) are updated, accompanied by GIS files of all currently known occurrences.

Status recommendations: All status recommendations are contingent on taxonomic treatment. Bighorn National Forest occurrences of *Pyrrocomma clementis* var. *villosa* represent the core of its global distribution. No immediate threats have been identified, but it would be useful to gather more detailed information on responses to natural disturbance regimes and land use disturbances.

Summary: *Pyrrocomma clementis* var. *villosa* is a state endemic restricted to the Bighorn Mountains. The only extant occurrences are in Big Horn and Washakie counties, and the highest number of them are on Bighorn National Forest, all documented since 2005. All extant occurrences are on public land, managed for multiple use. This species is found in montane grassland on limestone parent material. Based on the results of this project, *P. c. var. villosa* has been found to be locally common, forming extensive populations, and with limited vulnerability to most land management practices. The negative survey information has been significantly expanded *Pyrrocomma clementis* var. *villosa* remains a Wyoming plant species of concern.

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**STATUS OF *PYRROCOMA CLEMENTIS* VAR. *VILLOSA*
(HAIRY TRANQUIL GOLDENWEED),
BIGHORN MOUNTAINS, NORTH-CENTRAL WYOMING**



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ABSTRACT

Pyrocoma clementis var. *villosa* (hairy tranquil goldenweed) is endemic to the Bighorn Mountains, Wyoming. Surveys of *P. c.* var. *villosa* were conducted on Bighorn National Forest in 2010, and state status information synthesized. Less than a decade ago, this taxon was known from two extant populations and four historic records. To date it is known from ten extant populations, in addition to three historic records. *Pyrocoma clementis* var. *villosa* has been found to be locally common in a band of habitat across the western margin of the Bighorn Mountains, in the Medicine Wheel and Tongue River Ranger Districts, but could not be relocated on the east side. No threats to *P. c.* var. *villosa* have been documented. Taxonomic questions associated with this variety are summarized and provisional interpretations presented as part of this status report to support the case that this variety is restricted to the Bighorn Mountains, whereas all records in the Wind River Range, located in Shoshone National Forest, are *P. c.* var. *clementis*, and that reports of a collection record in Carbon County, Wyoming, presumably on Medicine Bow National Forest, could not be substantiated.

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Cover: *Pyrocoma clementis* var. *villosa* (hairy tranquil goldenweed). By Earl Jensen.

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INTRODUCTION

Pyrocoma clementis var. *villosa* (hairy tranquil goldenweed) is a state endemic of the Bighorn Mountains in north-central Wyoming. The first surveys for *P. c.* var. *villosa* ever conducted were in 2005 (Jensen 2005, Scott 2006).

Pyrocoma clementis var. *villosa* was first discovered in 1899 in the Bighorn Mountains by Frank Tweedy. It was published as *P. clementis* by Rydberg (1900). It is on the current sensitive species list maintained by the Rocky Mountain Region (USDA Forest Service 2009). This project was undertaken in collaboration with Bighorn National Forest to broaden the systematic survey and address the most pressing information needs for *P. c.* var. *villosa*.

Some of the most pressing information needs proved to be a review of the taxonomic status of *Pyrocoma clementis* var. *villosa*, and that of *P. c.* var. *clementis* in Wyoming. A taxonomic thesis that was never published (Mayes 1976) remains the primary taxonomic reference to date, as cited in the *Flora of North America* treatment (Bogler 2006), and the treatment of *P. c.* var. *villosa* in it was presented as provisionl. Both varieties are tracked as Wyoming plant species of concern although only *P. c.* var. *villosa* is designated as sensitive by the Rocky Mountain Region (USDA Forest Service 2009).

METHODS

At the start of this project, information on the habitat and distribution of *Pyrocoma clementis* var. *villosa* was compiled and reviewed at the Rocky Mountain Herbarium (RM 2010) and the Wyoming Natural Diversity Database (WYNDD 2010). A two-pronged approach was taken in conducting 2010 field surveys.

1. Digital color infrared orthophotographs (2000) were used to compare *P. c.* var. *villosa* habitat signatures with other areas on the Forest having calcareous limestone bedrock, identifying major areas of similar habitat not previously surveyed.
2. Known distribution was overlain with a compilation of calcium carbonate-rich bedrock formations (Love and Christiansen 1985) to compare known distribution with geology as basis for interpolation and extrapolation.

The fieldwork was conducted in the same year as surveys for two other rare calciphilic plants, *Physaria didymocarpa* var. *lanata* (woolly twinpod) and *Musineon vaginatum* (sheathed musineon) in order to pursue Forest-wide surveys of all three, on the grounds that concurrent surveys for all three might be more efficient together than separately.

In preparation for fieldwork, digital orthophotographs with distribution of *Pyrocoma clementis* var. *villosa* superimposed were printed out onto 8 ½ x 11 paper, representing about the same scale as 1:24,000 USGS topographic maps. The aerials and maps were both used for reference in setting field survey priorities and navigation in the field.

Surveys for *Pyrrcoma clementis* var. *villosa* were conducted between 2 August and 24 August 2011. When *P. c.* var. *villosa* was found in a survey area, the first tasks were to estimate its numbers, determine extent, and describe occupied habitat including topography, vegetation, and plant associates. Coordinates were recorded from GPS units for georeferencing population boundaries, later used to digitize polygonal population boundaries. Information was compiled and recorded onto WYNDD sensitive plant survey forms, and later entered in the WYNDD database.

Survey data of Richard and Beverly Scott, from 2005-2006 was incorporated after the 2010 field season. Further study of the taxonomic differences between varieties ensued.

RESULTS - SPECIES INFORMATION

Classification

Scientific name: *Pyrrcoma clementis* Rydb. var. *villosa* (Rydb.) Mayes ex Brown & Keil

Synonyms: *Haplopappus clementis* (Rydb.) S.F. Blake

Common name: Hairy tranquil goldenweed

Family: Asteraceae (previously referred to as Compositae; Aster family or Sunflower family)

Size of genus: *Pyrrcoma clementis* var. *villosa* is one of 14 species in the genus, a genus that is restricted to North America (Bogler 2006). There are six species and one variety of *Pyrrcoma* in Wyoming (Bogler 2006, Dorn 2001). This genus was first described by Hooker in 1833. The genus is characterized by its persistent basal rosettes of leaves, yellow-rayed heads on scapiform or few-bracteate peduncles, and obtuse, acute or mucronate phyllaries. The genus has also been treated as a section within the genus *Haplopappus* (Hall 1928, Cronquist 1994). It was presented as a separate genus in the dissertation by Mayes (1976), though some of the nomenclatural changes were not validated, including that for *P. c.* var. *villosa*. It was validated as a new combination by Brown and Keil (1992), along with other *Pyrrcoma* taxa.

Phylogenetic relationships: *Pyrrcoma clementis* var. *villosa* falls within a portion of the genus having radiate heads that are in clusters of 1-6+. Its chromosome number is not known. Most species in the genus have a diploid chromosome number ($2n=12$). There are also a lesser number of tetraploid and hexaploid *Pyrrcoma* species.

There are many unanswered questions about the phylogenetic relation between *Pyrrcoma clementis* var. *villosa* and the type variety, *P. c.* var. *clementis*, and between other species of the genus. Rydberg (1900) considered *P. c.* var. *villosa* to be closely related to *P. uniflora*, but

readily distinguished from the latter by its larger heads and foliaceous involucre bracts imbricated in 3-4 series. In their treatment of the Rocky Mountain flora, Coulter and Nelson (1909) reduced *P. villosa* to a synonym under *P. uniflora*.

Hall (1928) was the first taxonomist to detect close relationships between *Pyrocoma villosa* and *P. clementis*. Mayes (1976) treated *P. villosa* as a variety of *P. clementis*, *P. c. var. villosa* (Rydb.) Mayes. However, he said he had been unable to investigate this taxon adequately in the field, and its provisional treatment at the variety level was based on several characteristics and geographic isolation that he termed a “compromise.” Mayes (1976) noted that the type variety is closely related to *P. crocea* and *P. integrifolia*, perhaps more closely related to these other species than to *P. clementis var. villosa*. This provisional treatment remained the basis for its circumscription in the *Flora of North America* (Bogler 2006) and in Dorn (2001), though not accepted by the RM (2010). Cronquist (1994) noted without further research that he considered it to be most closely related to *P. integrifolia* rather than *P. clementis var. villosa*. Thus, the relationships between the two varieties of *P. clementis* and with other members of the genus (*P. uniflora*, *P. integrifolia*, and *P. crocea*) has had many different opinions over time but no rigorous research.

Present legal or other formal status

U.S. Fish & Wildlife Service status: None.

U.S. Forest Service status: *Pyrocoma clementis var. villosa* is on the current sensitive species list maintained by the U.S. Forest Service Rocky Mountain Region (USDA Forest Service 2009).

Global Heritage rank: G3G4T2. This indicates that the species may be either globally vulnerable or potentially secure across its entire range, but the variety may be globally imperiled.

State Legal status: None.

State Heritage rank: S2 in Wyoming. This indicates that the variety is potentially imperiled in the state. In this case, the state and global heritage ranks are equal because the taxon is restricted to the state.

History of Taxon: The taxon was first discovered by Frank Tweedy (2063 NY) in August 1899 in the Bighorn Mountains at “Willow Creek.” The following year, Rydberg (1900) published the description for *Pyrocoma villosa* Rydb. Also in 1900, Tweedy made a second collection (3042 RM) at “the headwaters of Clear Creek and Crazy Woman River.” It was not collected again until 1952, “2 miles west of [Bighorn National] Forest Boundary” by Eugene H. Cronin (*s.n.* RM) in the vicinity of Trapper Canyon. In 1955, it was collected south of Burgess Junction by R.K. Gierisch (1780 RM).

The type variety, *Pyrracoma clementis* var. *clementis* (tranquil goldenweed) was first discovered by Frederick Clements (44 NY) on Mount Harvard in Colorado, and named after him by Rydberg. *Pyrracoma villosa* was first identified as a relative of *P. clementis* by Hall (1928) and was proposed as a variety of the latter by Mayes (1976), later validated as a new combination by Brown and Keil (1992).

The story becomes more complicated with two collections of *Pyrracoma clementis* in the Wind River Range by Fisser (638, 702 RM) made in 1961. These collection stations appear to correspond with the two distribution points for *P. clementis* var. *clementis* shown on the distribution map by Mayes (1976). However, one of the Fisser collections (702) was annotated to *P. c.* var. *villosa* by Mayes (1976) although Mayes did not map *P. c.* var. *villosa* as present in the Wind River Range. The other Fisser collection (638) was more recently annotated to *P. integrifolia*. Mayes (1976) also represented a third location of *P. c.* var. *clementis* in Carbon County, Wyoming. The source of this report has been sought online among Intermountain Region Herbarium Network (2011) and not found. One possible explanation is that an immature *Pyrracoma* collected by C.O. Williamson (13) and identified as *P. villosa* in Carbon County, Montana and kept in the U.S. Forest Service Herbarium was not available for review and was mistakenly placed in Carbon County, Wyoming by Mayes (1976). [The Forest Service collection is now housed at the Rocky Mountain Herbarium and the specimen in question has immature flowers that does not appear to fit either variety.] Dorn (2001) reported that both varieties are present in Fremont County, possibly in keeping with the map by Mayes (1976) and the annotated specimen (Fisser 702 RM).

More recently, systematic floristic inventory was conducted in the Bighorn Mountains (Nelson and Hartman 1984). Two new collections were made from the southern end of the Mountains in Washakie County in 1979 and 1981 (Nelson 8159, Hartman 10549 RM). Until recently, *Pyrracoma clementis* var. *villosa* was reported from two extant occurrences and four historic occurrences (Fertig 2000). More recent floristic thesis inventories conducted out of the Rocky Mountain Herbarium produced four population records (Lum 2004, Massatti 2007) in the Bighorn Basin and Wind River Range, respectively. Another four new populations were discovered and mapped in survey work conducted by Earl Jensen in Bighorn National Forest (Jensen 2005), the first recent records in the Forest. Finally, surveys conducted by Richard and Beverly Scott in 2005 and 2006 located three new locales in the Bighorn National Forest.

Review of the *Pyrracoma clementis* var. *villosa* specimens at RM was conducted as part of this project. This update is offered as preliminary support for the taxonomic validity of *P. c.* var. *villosa*, upon which results are predicated.

Description

General non-technical description: *Pyrracoma clementis* var. *villosa* is a perennial forb with 1 to many stems from a branched rootstock. Stems are 3-15 (30) cm tall and loosely white-hairy to glabrous. Basal leaves are oblanceolate to narrowly elliptic, 2-12 cm long, and sparsely pubescent to glabrate on the surface. Stem leaves are progressively smaller and sessile to clasping. Flower heads are solitary or number 2-4 with involucre 9-15 mm high and woolly to glabrous lanceolate to oblanceolate, attenuate bracts that are green throughout. Ray flowers are yellow and 10-15 mm long while disk flowers are 6-8.5 mm long. Fruits are 4-sided glabrous achenes with tawny to brown bristles (Cronquist 1994; Dorn 2001, Bogler 2006, Fertig 2000; Figures 1-4).

The basis for the epithet, “hairy (*villosa*)”, is not discussed in taxonomic works. Both varieties of *Pyrracoma clementis* often have stems with long, tangled hairs, particularly on the upper stem below the flower. Rydberg (1900) described *P. c.* var. *villosa* as having a villous bract surface. However, taxonomists later determined that this is not a consistent variety trait.

Technical description: Perennial from a branched caudex with 1-many stems. Stems decumbent or curved-ascending, red-tinged, villous with long hairs to occasionally woolly and 3-15 (30) cm long. Leaves basal and cauline, simple. Basal leaves oblanceolate to narrowly elliptic, 2-12 cm long, and sparsely pubescent to glabrate on the surface. Cauline leaves progressively smaller and sessile to clasping. Flower heads solitary or few 2-4(5) and cymosely-arranged, radiate, with involucre 9-15 mm high and woolly to glabrous lanceolate to oblanceolate, attenuate phyllaries that are green throughout, in 3-4 series, margins ciliate. Ray flowers yellow, pistillate and 10-15 mm long. Disk flowers yellow, bisexual, fertile, and 6-8.5 mm long. Fruits 4-sided glabrous achenes with tawny to brown bristles. Crypsela faces glabrous. Pappi persistent, of brownish, rigid, unequal bristles in 1 series (Cronquist 1994; Dorn 2001, Bogler 2006).

Local field characters: The deep, golden-yellow flower color of *Pyrracoma clementis* var. *villosa* resembles that of *Arnica* spp. Unlike *Arnica* spp., it has alternate leaves. It could also be mistaken from a distance for *Taraxacum officinale* (common dandelion) or *Agoseris glauca* (false dandelion; Jensen 2005, 2010). Its flowering overlaps with the end of *T. officinale* flowering and the start of *A. glauca* flowering. Unlike *A. glauca* and *T. officinale*, it has stem leaves, and has a central disk with both ray and disk flowers. It often produces only one flower, but occasionally has 3+ flower heads. The stems are usually decumbent or curved-ascending to upright, growth form characteristics that give it different appearances in the field (Figures 2-3).

Similar species: *Pyrracoma clementis* var. *clementis* has acute tipped involucre bracts, hairy achenes, and sericeous crypsela faces (Table 1). *Pyrracoma integrifolia* has green tips or green just on upper lengths of the involucre bracts. *Pyrracoma uniflora* has 1-4 flowering heads with involucre 5-10 mm long and usually grows on wet, alkali soils. *Pyrracoma lanceolata* has 4 or



Figure 1. *Pyrocoma clementis* var. *villosa* bracts. By B. Heidel.



Figures 2 and 3: *Pyrocoma clementis* var. *villosa* whole plants; multi-stemmed vs. two-stemmed, and ascending vs. decumbent. By Earl Jensen.



Figure 4. *Pyrrcoma clementis* var. *villosa* specimen close-up. Note glabrous seeds and acuminate bracts. (Hartman 10549; with Nelson 8159 as insert)

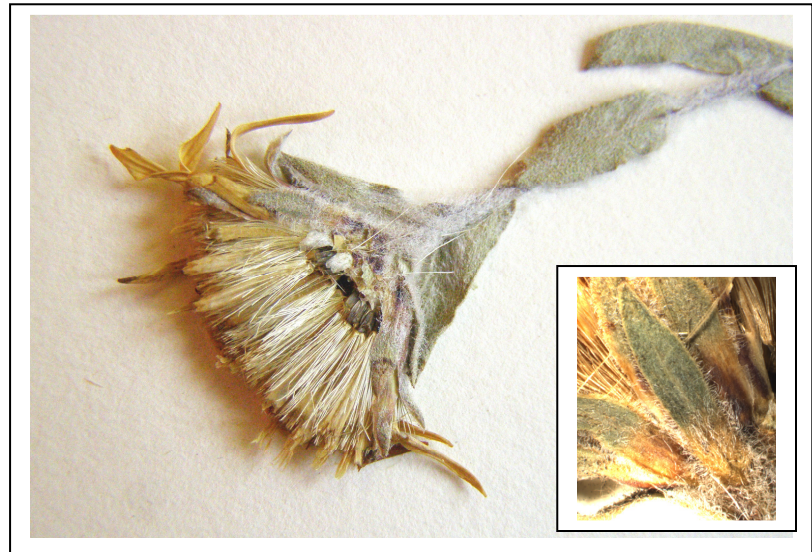


Table 1. Characteristics that distinguish *Pyrrcoma clementis* var. *villosa* from other taxa in the genus (Cronquist 1994, Dorn 2001, Mayes 1976, Bogler 2006)

Taxon	No. of flower heads	Involucre length (mm)	Involucre shape, tip	Involucre texture, surface	Disk corolla length (mm)	Leaf outline, surface	Growth form
<i>Pyrrcoma clementis</i> var. <i>villosa</i>	Usually solitary, occasionally 2-3(4)	9-14	Lanceolate or oblanceolate, with attenuate tip	Green most of length	7-14	Entire or slightly undulate, glabrous	Stems decumbent curved-ascending to ascending
<i>Pyrrcoma clementis</i> var. <i>clementis</i>	Usually solitary, occasionally 2-3(4)	9-14	Obovate, with abruptly acute tip	Green most of length	7-14	Entire or slightly undulate, glabrous	Stems ascending
<i>Pyrrcoma crocea</i>	Usually solitary, occasionally 2-3	15-20	Oblong to spatulate, with obtuse tip	Green or yellowish, with pale margins	7-14	Entire or undulate, glabrous	Stems erect or ascending, robust
<i>Pyrrcoma integrifolia</i>	4+	11-17	Oblanceolate to oblong, with acuminate tip	Green-tipped	5-7 (7.5)	Entire or undulate, glabrous	Stems erect or ascending
<i>Pyrrcoma lanceolata</i>	Usually numerous; (1) 5-20 (50)	7-10	Linear lanceolate to lanceolate, with acute tip	Green-tipped	5-7	Finely toothed, glabrous	Stems erect, ascending or decumbent
<i>Pyrrcoma uniflora</i>	Usually solitary, occasionally 2-4	6-13	Linear-lanceolate, with acute tip	Green most of length	5-7 (7.5)	Toothed, with fine, tangled hairs	Stems curved-ascending to decumbent

more flower heads per stem with involucre 5-10 mm long of green-tipped bracts (Dorn 2001; Cronquist 1994, Bogler 2006, Fertig 2000). In the genus, there is limited geographic overlap with *P. c.* var. *clementis*. Both *P. integrifolia* and *P. uniflora* are known from the south end of the Bighorn Mountains in Washakie County (Nelson and Hartman 1984, Dorn 2001, Rocky Mountain Herbarium 2010). *Pyrocoma integrifolia* is an upland plant last collected from the Bighorn Mountains in Washakie County by Leslie Gooding in 1901.

Geographical distribution

Range: *Pyrocoma clementis* var. *villosa* is a state endemic of the Bighorn Mountains in north-central Wyoming. Its extant populations are on the western slopes of the Mountains in Big Horn and Washakie counties, but the earliest collections of it were apparently made on the east side.

By contrast, *P. c.* var. *clementis* is widespread in Colorado and Utah and appears to be consistent with all material examined from the Wind River Range (*Fisser 702* RM) or posted (*Massatti 5911, 6107* RM). We sought to locate specimens of *P. c.* var. *clementis* to support Mayes (1976) report for the type variety in Carbon County, Wyoming, using on-line search tools of the Intermountain Regional Herbarium Network (2011) but no supporting data were found.

Extant sites: *Pyrocoma clementis* var. *villosa* is known from ten extant occurrences, along the west slope of the Bighorn Mountains (Table 2, Figure 5). The highest concentration is along a 20+ mile western margin of the Bighorn National Forest. There are also three occurrences at the southern end of the Bighorn Mountains on BLM lands. There is only one collection of *Pyrocoma clementis* var. *villosa* on the Bighorn National Forest in the past decade (*Heidel 3514* RM), so there is a need for more complete vouchered material deposited into regional herbaria so that herbarium records and sensitive species records are consistent.

Historical sites: There are three historical collection records of *Pyrocoma clementis* var. *villosa* in the Bighorn Mountains, including the only two collections made on the east side. The 1899 specimen collected from “Willow Creek” was interpreted at RM by reviewing the collecting journal as corresponding to Willow Creek in Sheridan County, possibly near Park Reservoir. Grassland habitat was traversed in this area incidental to wetland surveys in the area, mostly on glacial till parent material, but no species of *Pyrocoma* were found. There was also a survey in grassland habitat above Willow Creek in Johnson County, west of Buffalo, on limestone parent material, but no species of *Pyrocoma* were found. The 1900 specimen collected from “headwaters of Clear Creek and Crazy Woman River” fits the township T49N R84W or immediately adjoining townships, where additional grassland habitat was surveyed, mostly on Archean metamorphic parent material mapped as gneiss. These surveys in grassland habitat were incidental to wetland surveys, or conducted as spot-checks from the road. They were unsuccessful. Geology is mentioned because there is no limestone parent material in these areas analogous to that where *P. c.* var. *villosa* has occurs on the west side. It may have a broader

range of habitat than previously documented. Alternatively, both of the east-side historical collections might have been made on limestone parent material that lies below Forest boundaries.

The third historical collection “2 miles west of the Forest Boundary” has not been relocated. This is close to the Spanish Karst Area of Critical Environmental Concern (ACEC), which might or might not have suitable habitat.

Table 2. Location information for *Pyrrocoma clementis* var. *villosa*

EO#	Location	County	Legal Description	Elev.	USGS 7.5'	Ownership
001	Headwaters of Finger, Three Springs, Willey, Owen, Cedar, and Prospect creeks	Big Horn Sheridan	T54N R89W Sec. 4, 5, 9, 10, 14, 15, 16, 22, 23, 32	9200-9700	Granite Pass	Bighorn NF
002	Trapper Canyon vicinity	Big Horn	T52N R89W (imprecise location)	?	Spanish Butte Bush Butte	BLM Worland
003	Middle Fork Power River	Johnson Washakie	T41N R86W Sec. 26 T42N R86W Sec. 2, 11	7300-8000	Gordon Creek Cherry Creek Hill	BLM Worland
004	Headwaters of Clear Creek and Crazy Woman River	Johnson	T50N R84W (imprecise location)	?	Hunter Mesa	Bighorn NF
006	Willow Creek (tentatively near Park Reservoir on Willow)	Johnson?	T53N R86W? (imprecise location)	?	Park Reservoir?	Bighorn NF
007	Crooked Creek Hill and slopes above Battle, Crooked, Jack, and Johnny creeks	Big Horn	T52N R88W Sec. 4, 5, 8, 9, 16, 17, 21; T 52N R89W Sec. 1, 12; T53N R88W Sec. 32; 33	8700-9600	Spanish Point Shell Canyon	Bighorn NF BLM Worland, pvt?
013	Spanish Point, northeast slopes	Big Horn	T52N R88W Sec. 33	8700-8900	Spanish Point	Bighorn NF
014	Spring Creek, slopes west of Spring Creek	Washakie	T41N R86W Sec. 26, 27	8250	Cherry Creek Hill	BLM Worland
015	Middle Fork Powder River, slopes north and west of	Washakie	T42N R86W Sec. 33	8100-8160	Cherry Creek Hill	BLM Worland
017	Road between Cold Springs Campground	Big Horn	T51N R88W Sec. 36	9000	Allen Draw	Bighorn NF
018	Upper south slopes of Sunlight Mesa	Big Horn	T54N R90W Sec. 33	8050	Black Mountain	Bighorn NF
021	McKay Creek	Big Horn	T53N R89W Sec. 19	8100	Shell Falls	Bighorn NF
022	West end of Snowshoe Mountain	Big Horn	T53N R89W Sec. 26	9050	Shell Falls	Bighorn NF

Unverified/Undocumented reports: None known.

Sites where present status not known: The 2010 surveys did not address habitat outside Bighorn National Forest boundaries.

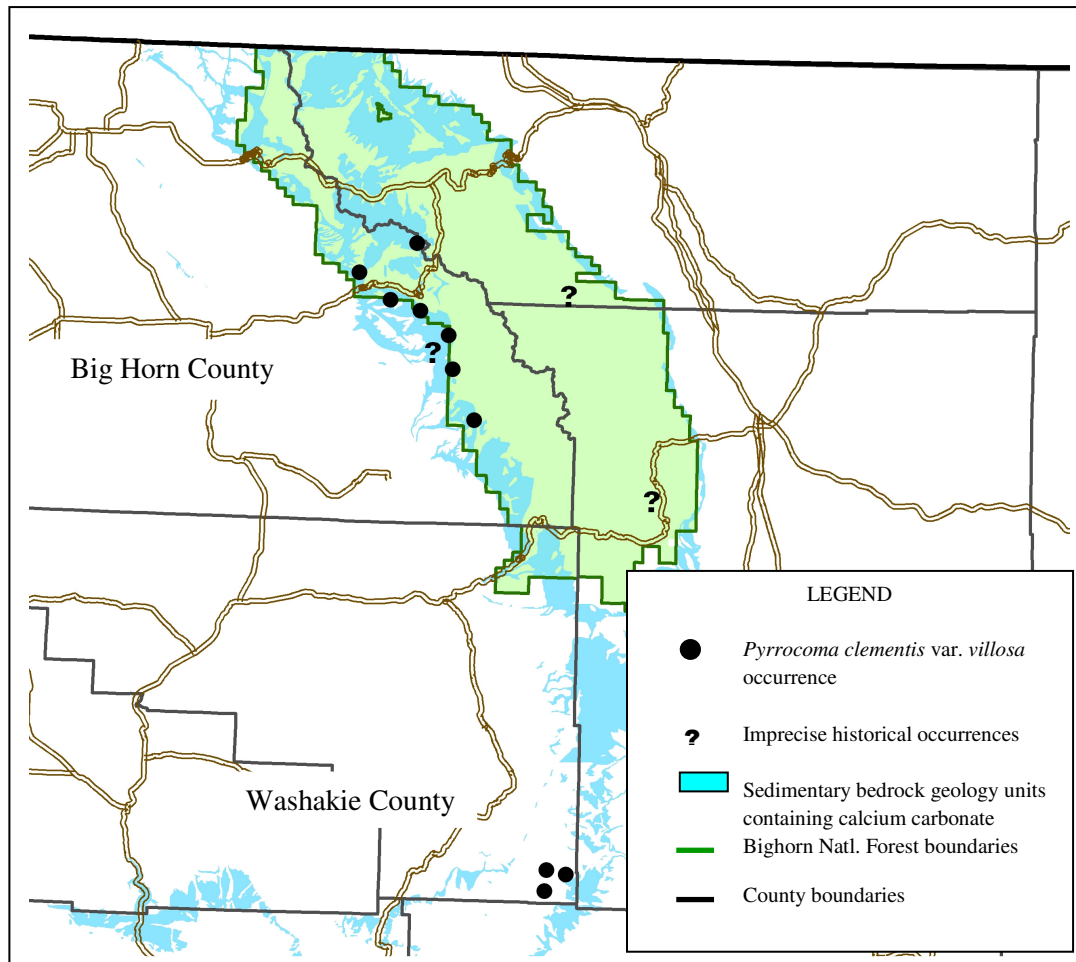


Figure 5. Distribution and geology of *Pyrocoma clementis* var. *villosa*

Areas surveyed but species not located: Appendix A represents locales surveyed for *Pyrocoma clementis* var. *villosa*. This study identified many areas that appear to be suitable where it was not found. It was also sought but not found in part of the Elephant Head area (Welp et al. 1998).

Land ownership: *Pyrocoma clementis* var. *villosa* occurs on lands managed by the Bighorn National Forest and the BLM Worland Field Office. One of the largest populations straddles the Forest boundary (Crooked Hill #007), occurring on Bighorn National Forest, BLM Worland Field Office lands and possibly private lands. One somewhat vague record might occur in the Spanish Karst ACEC and Trapper Canyon Wilderness Study Area. All other known population records are from public lands managed for multiple use.

Habitat

Pyrocoma clementis var. *villosa* is found in montane meadows on limestone substrates, in or between sagebrush steppe but not directly associated with sagebrush. Elevations range from 2225-2957 m (7300-9700 ft). The known elevation differs from that given by Mayes (1976) who reported *P. c.* var. *villosa* it from "meadows, forest openings, and above timberline at elevations

of 10,000 to 11,500 feet in association with *Pinus aristata*, *P. contorta*, *Populus tremuloides*, *Poa alpina*, *P. fendleriana*, and *Haplopappus macronema*.” There are many collections of *P. c.* var. *clementis* from Colorado that are in alpine elevations, and it reaches elevations up to 12,500 ft (Mayes 1976), but there are no known collections of *P. c.* var. *villosa* at alpine elevations. One of the associated species report by Mayes (1976), *Pinus aristata* (bristlecone pine), is associated with *P. c.* var. *clementis* in Colorado but is not present in Wyoming.

Recent surveys found *Pyrrhoma clementis* var. *villosa* on Nathrop-Passcreek-Starley/ Limestone. The southern occurrences of it on BLM lands were apparently collected in an area of Archean metamorphic parent material mapped as gneiss (Love and Christiansen 1985). Survey work in these areas might help determine the substrate breadth or narrowness of *P. c.* var. *villosa*, information that would be useful for expanded survey on similar substrate on the east side of Bighorn National Forest.

Pyrrhoma clementis var. *villosa* occurs on gently contoured landforms that, at least in Bighorn National Forest, have limestone bedrock (Figure 6). The landform outcrops form striated patterns that show up on aerial photos as bands of high reflectance, corresponding with high limestone gravel cover or small outcrop blocks at the surface.

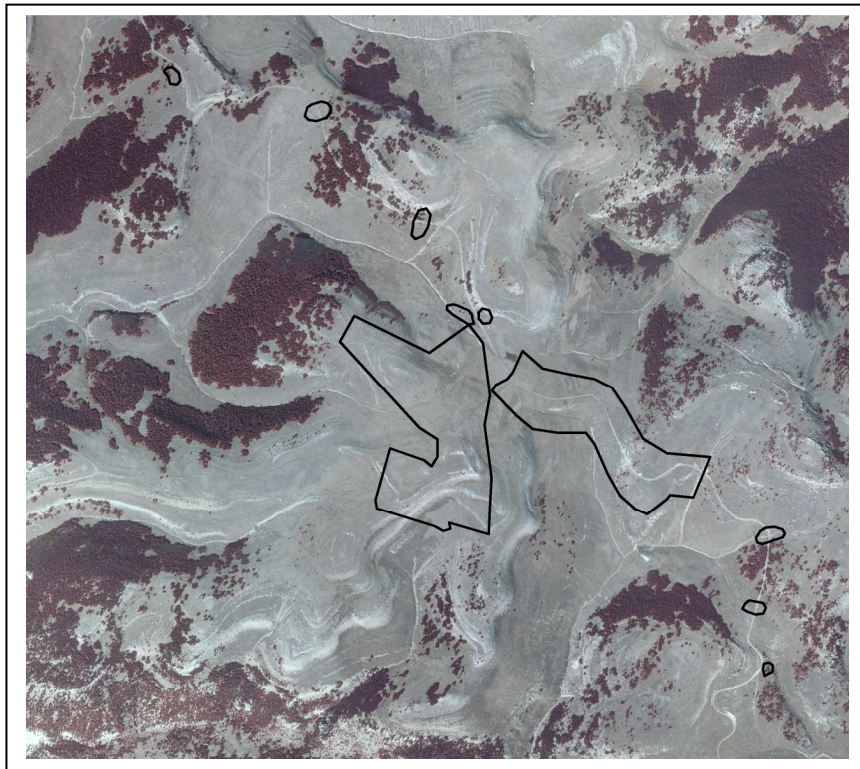


Figure 6. Color infrared aerial photograph of *Pyrrhoma clementis* var. *villosa* occupied habitat in the center of the Granite Pass population complex, #001 (Granite Pass Quad, 1:24,000). Note limestone outcrops in repeated bands, a pattern found around the largest known populations.

The breadth of occupied habitat is indicated by a series of photographs taken in the Granite Pass population complex (#001; Figures 7-10). It remains to be determined whether the habitats are prevailing vegetation types or secondary ones.



Figure 7. *Pyrocoma clementis* var. *villosa* on relatively steep habitat, Granite Pass (#001)
By Matthew Spann.



Figure 8. *Pyrocoma clementis* var. *villosa* on forb-rich meadow, Granite Pass (#001). By Earl Jensen.



Figure 9. *Pyrocoma clementis* var. *villosa* on stream headwaters, Granite Pass (#001).
By Earl Jensen.



Figure 10. *Pyrocoma clementis* var. *villosa*. at edge of sagebrush steppe, Granite Pass (#001). By Earl Jensen.

Frequently associated species: The species noted in association with *Pyrrocomma clementis* var. *villosa* are mainly widespread species of montane meadows (Table 3).

Table 3. Species associated with *Pyrrocomma clementis* var. *villosa*¹

Scientific name	Common name	On Bighorn NF?
<i>Achillea millefolium</i>	Yarrow	YES
<i>Agoseris glauca</i>	False dandelion	YES
<i>Anemone multifida</i>	Red windflower	YES
<i>Antennaria microphylla</i>	Small-leaf pussytoes	YES
<i>Arnica rydbergii</i>	Rydberg's arnica	YES
<i>Artemisia tridentata</i> ssp. <i>vaseyana</i>	Mountain big sagebrush	YES
<i>Castilleja</i> spp.	Paintbrush	YES
<i>Cerastium arvense</i>	Field chickweed	YES
<i>Elymus spicatus</i>	Bluebunch wheatgrass	YES
<i>Eremogone congesta</i>	Ballhead sandwort	YES
<i>Eriogonum flavum</i>	Yellow buckwheat	NO
<i>Festuca idahonis</i>	Idaho fescue	YES
<i>Fragaria virginiana</i>	Wild strawberry	YES
<i>Frasera speciosa</i>	Green gentian	YES
<i>Geum triflorum</i>	Prairie smoke	YES
<i>Geranium viscosissimum</i>	Sticky geranium	YES
<i>Hedysarum sulphurescens</i>	Sulfur sweetvetch	YES
<i>Linum perenne</i>	Wild blue flax	YES
<i>Lupinus argenteus</i>	Silver lupine	YES
<i>Oxytropis campestris</i>	Field locoweed	YES
<i>Penstemon</i> spp.	Beardtongue	YES
<i>Phlox multiflora</i>	Flowery phlox	YES
<i>Pinus contorta</i>	Lodgepole pine	YES
<i>Pinus flexilis</i>	Limber pine	YES
<i>Poa secunda</i>	Sandberg's bluegrass	YES
<i>Polygonum bistortoides</i>	Bistort	YES
<i>Potentilla paradoxa</i>	Paradox cinquefoil	YES
<i>Sedum lanceolatum</i>	Stonecrop	YES
<i>Senecio</i> or <i>Packera</i> spp.	Ragwort or Groundsel	YES
<i>Solidago multiradiata</i>	Rocky Mountain goldenrod	YES
<i>Symphotrichum</i> spp.	Aster	YES
<i>Taraxacum officinale</i>	Common dandelion	YES
<i>Valeriana</i> spp.	Valerian	YES
<i>Zigadenus elegans</i>	Death camas	YES

Associated species of concern: There is limited overlap of *Pyrrocomma clementis* var. *villosa* with other Wyoming plant species of concern. It overlaps with part of the distribution of *Symphotrichum molle* (smooth aster), though there are no sites where they have been found growing together. It does not occur with the other two rare species surveyed in 2010, *Physaria didymocarpa* var. *lanata* and *Musineon vaginatum*.

¹ Nomenclature generally follows Dorn (2001).

Topography: *Pyrracoma clementis* var. *villosa* occupies ridge tops, tablelands, shoulders and upper to midslope positions with soil development.

Soil relationships: The soils where *Pyrracoma clementis* var. *villosa* is found are well-developed loamy mollisols. Most sites have gravel and bare soil at the surface, the bare soil possibly caused by burrowing activity. Some also have small rocks, platy blocks or ledges of limestone at the surface.

Regional climate: The montane climate of the Bighorn Mountains is best represented by meteorological data from Burgess Junction (USDI NOAA 2010; Station 481220; collected from 9/18/1960 to 12/31/2005). Annual precipitation averages 53.3 cm (21.0 in). Snowfall is a major contribution to total annual precipitation, with an average of 6.2 m (242.8 in) amounting to about 53% of mean annual precipitation. April and May are the months of highest precipitation, much of which falls as snow. July is the warmest month with mean monthly temperature of 12.9 °C (55.2 °F) and January is the coldest with mean monthly temperature of -8.5 °C (16.7 °F). There is a 50% probability of having a 40-day period during the growing season when temperatures are at or above freezing.

From what is known about current distribution, *Pyrracoma clementis* var. *villosa* appears to favor the drier climates. There is a rain shadow pattern associated with the Bighorn Mountains where moisture-bearing systems come out of the east. This is well-documented in foothills settings in comparing the precipitation of Buffalo and Sheridan on the east side where annual precipitation is 33.8 cm and 37.1 cm (13.3 in and 14.6 in, respectively) against the precipitation of Shell and Worland on the west side where annual precipitation is 25.5 cm and 19.6 cm (9.9 in and 7.7 in, respectively; USDI NOAA 2010).

Local microclimate: The settings that support *Pyrracoma clementis* var. *villosa* all have loamy, moisture-retaining soils. The availability of subsurface moisture during flowering and seed maturation may be particularly important in the production of seeds at dry times of the growing season. Many of the settings have a west aspect, directly exposed to the force of prevailing winds.

Population biology and demography

Phenology: *Pyrracoma clementis* var. *villosa* flowers from July-mid August, and produces seed from late July-September. Flowering is staggered and prolonged if there are multiple flower heads per stem.

Population size and condition: *Pyrracoma clementis* var. *villosa* occurs in scattered clusters with numbers ranging from less than 50 plants to numbers in the 1000's (Table 4). Detailed survey and mapping are available for two occurrences (#001, #007), where total numbers approach or

surpass the 10,000 magnitude (Table 4). The difficulty of accurate estimates is compounded by the high density of plants in places (Figures 11 and 12), where numbers are apt to be seriously underestimated. Total occupied habitat is likely to be much more than 405 ha (1000+ ac).



Figure 11. *Pyrocoma clementis* var. *villosa* in high density, Granite Pass (#001). By Susan Bell.

Figure 12. *Pyrocoma clementis* var. *villosa* in high density, Granite Pass (#001). By Susan Bell.

Table 4. Size and extent of *Pyrocoma clementis* var. *villosa* populations

EO#	Numbers/Extent ha (ac)
001	Probably several thousand plants across 138 ha (340 ac)
002	Unknown
003	Unknown
004	Unknown
006	Unknown
007	Possibly thousands across 162 ha (400 ac)
013	Less than 100 in app. 6 ha (15 ac)
014	Unknown
015	Unknown
017	Unknown
018	Unknown
021	Unknown
022	Unknown

There is no evidence to suggest that *Pyrocoma clementis* var. *villosa* has lost habitat or that its habitat has declined. Disturbance frequency or successional rates might affect population trends if it is restricted to a successional habitat maintained by periodic disturbance such as fire, or favors a successional habitat.

Reproductive biology

Type of reproduction: Reproduction is sexual, by seed.

Pollination biology: *Pyrrcoma clementis* var. *villosa* has conspicuous inflorescences with pistillate ray flowers that mature first, fostering outcrossing, and bisexual disk flowers, possibly self-pollinated. Beetles have been observed feeding for nectar and getting dusted with pollen.

Seed dispersal and biology: The flower head doesn't shed seeds until it dries out, late in the growing season, sometimes after frost. The bristles on the achene aid in wind dispersal.

Population ecology

General summary: *Pyrrcoma clementis* var. *villosa* is a perennial. There are no available data on its life history, or a way to characterize the age or life history stage of individual plants, either in the field or in the herbarium. It is possible, but not proven, that the taproot diameter or vestiges of leaf sheathes reflect age.

Competition: *Pyrrcoma clementis* var. *villosa* grows in grassland plant communities that are part of a mosaic with *Artemisia tridentata* ssp. *vaseyana* (mountain big sagebrush). It is not clear what is cause and what is effect, but its absence from areas with sagebrush may be due to some intermediate variable such as gopher avoidance of sagebrush habitat, the allelopathic affects of sagebrush, or the disturbance represented by gaps in sagebrush cover.

Herbivory: Few signs of herbivory were observed on *Pyrrcoma clementis* var. *villosa* plants in the field or on herbarium specimens. The hairiness of the flowering stalk and the stiff bracts may deter herbivory.

Hybridization: No evidence.

ASSESSMENT AND MANAGEMENT RECOMMENDATIONS

Potential threats to currently known populations

Grazing: *Pyrrcoma clementis* var. *villosa* occupies habitats that are generally in the middle of primary range for livestock. No signs of grazing or browsing were observed. Evidence of trampling was not observed. Grazing can sometimes be associated with habitat degradation and associated vegetation shifts. Some of the species associated with it such as *Taraxacum officinale* (common dandelion), are exotic species that can occupy a wide range of intact and degraded habitat. There was not sufficient information collected to characterize *P. c.* var. *villosa* as a decreaser or increaser under livestock grazing.

Logging: *Pyrracoma clementis* var. *villosa* does not occupy forest stands so would not be affected by logging practices except in the construction of access roads.

Roads: Motorized vehicles are restricted to open, designated roads or motorized trails during the growing season in nearly all areas occupied by *Pyrracoma clementis* var. *villosa*, although people can drive up to 300 ft off of the road for a specific purpose such as camping. Parts of its habitat are on gentle terrain that can be affected by such practices. Roads run through the center of some of the largest populations, and occasionally plants are found in graded margins but the topographic position that *P. c.* var. *villosa* occupies appears to be the main reason for this overlap, rather than because it is associated in any way with roadwork or road use.

Weeds: There were no noxious weeds found in 2010 surveys of *Pyrracoma clementis* var. *villosa*.

Fire: There are charred remnants of scattered, old trees at some sites of *Pyrracoma clementis* var. *villosa* (Figure 13). It is sometimes found in gaps between stands of *Artemisia tridentata* ssp. *vaseyana* (mountain big sagebrush), but the vegetation borders have not been examined closely to look for signs of fire or other disturbance history.



Figure 13. *Pyrracoma clementis* var. *villosa* habitat with dead trees, Granite Pass (#001).
By Earl Jensen.



Figure 14. *Pyrracoma clementis* var. *villosa* habitat with bare soil possibly due to burrowing activity, Granite Pass. (#001).
By Earl Jensen.

Other: *Pyrracoma clementis* var. *villosa* is often found on substrates that often appear to be churned by pocket gopher activity (Figure 14). It is possible that frost action or other processes are involved rather than rodent burrowing. In any case, this natural disturbance might account for the high frequency of plants such as *Taraxacum officinale* (common dandelion) associated

with *P. c. var. villosa*. In places along gentle, headwater drainages, its local distribution might also be shaped by slight differences in erosion or snowmelt patterns (Figure 9).

Management practices and response

There have been no studies of management practices and associated responses of *Pyrrocomma clementis* var. *villosa*. It would be insightful to document before-and-after conditions for any new grazing developments implemented in occupied habitat, prescribed burn activity, or any actions affecting burrowing mammals. It would be especially insightful to set up a study with a control plot containing a portion of the population that is excluded from treatment.

Conservation recommendations

Recommendations regarding present or anticipated activities: It would be appropriate to integrate allotment information with *Pyrrocomma clementis* var. *villosa* distribution. The occurrence maps provided in electronic format with this report (Appendix A) are available for this use.

Notification of U.S. Forest Service personnel of locations on national forest: To prevent inadvertent impacts to known *Pyrrocomma clementis* var. *villosa* populations, all appropriate USFS personnel and cooperators involved in planning and on-the-ground land management activities, should have access to species information and location data. Key activities include grazing, fire management and weed control. Towards this end, the updated Forest Service species evaluation (Appendix C) and state species abstract (Appendix D) are updated, accompanied by GIS files of all currently known occurrences.

Status recommendations: All status recommendations are contingent on taxonomic treatment. Bighorn National Forest occurrences of *Pyrrocomma clementis* var. *villosa* represent the core of its global distribution. No immediate threats have been identified, but it would be useful to gather more detailed information on responses to natural disturbance regimes and land use disturbances.

Summary: *Pyrrocomma clementis* var. *villosa* is a state endemic restricted to the Bighorn Mountains. The only extant occurrences are in Big Horn and Washakie counties, and the highest number of them are on Bighorn National Forest, all documented since 2005. All extant occurrences are on public land, managed for multiple use. This species is found in montane grassland on limestone parent material. Based on the results of this project, *P. c. var. villosa* has been found to be locally common, forming extensive populations, and with limited vulnerability to most land management practices. The negative survey information has been significantly expanded *Pyrrocomma clementis* var. *villosa* remains a Wyoming plant species of concern.

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**STATUS OF *PYRROCOMA CLEMENTIS* VAR. *VILLOSA*
(HAIRY TRANQUIL GOLDENWEED),
BIGHORN MOUNTAINS, NORTH-CENTRAL WYOMING**



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ABSTRACT

Pyrocoma clementis var. *villosa* (hairy tranquil goldenweed) is endemic to the Bighorn Mountains, Wyoming. Surveys of *P. c.* var. *villosa* were conducted on Bighorn National Forest in 2010, and state status information synthesized. Less than a decade ago, this taxon was known from two extant populations and four historic records. To date it is known from ten extant populations, in addition to three historic records. *Pyrocoma clementis* var. *villosa* has been found to be locally common in a band of habitat across the western margin of the Bighorn Mountains, in the Medicine Wheel and Tongue River Ranger Districts, but could not be relocated on the east side. No threats to *P. c.* var. *villosa* have been documented. Taxonomic questions associated with this variety are summarized and provisional interpretations presented as part of this status report to support the case that this variety is restricted to the Bighorn Mountains, whereas all records in the Wind River Range, located in Shoshone National Forest, are *P. c.* var. *clementis*, and that reports of a collection record in Carbon County, Wyoming, presumably on Medicine Bow National Forest, could not be substantiated.

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The 2010 surveys for *Pyrocoma clementis* var. *villosa* (hairy tranquil goldenweed) were conducted by Earl Jensen. The survey information of Richard and Beverly Scott was kindly provided by the Scotts. The facilities and resources of the Rocky Mountain Herbarium and expertise of Ronald Hartman and B.E. Nelson are gratefully acknowledged. The coordination of Bernie Bornong, Bighorn National Forest, was instrumental at all stages. Annie Munn (Wyoming Natural Diversity Database; WYNDD) assisted in preparations before the field season and in digitizing survey routes. Joy Handley (WYNDD) provided GIS support. This study was one in a set of botanical studies conducted through a challenge cost-share agreement between Bighorn National Forest and Wyoming Natural Diversity Database, University of Wyoming.

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Cover: *Pyrocoma clementis* var. *villosa* (hairy tranquil goldenweed). By Earl Jensen.

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INTRODUCTION

Pyrocoma clementis var. *villosa* (hairy tranquil goldenweed) is a state endemic of the Bighorn Mountains in north-central Wyoming. The first surveys for *P. c.* var. *villosa* ever conducted were in 2005 (Jensen 2005, Scott 2006).

Pyrocoma clementis var. *villosa* was first discovered in 1899 in the Bighorn Mountains by Frank Tweedy. It was published as *P. clementis* by Rydberg (1900). It is on the current sensitive species list maintained by the Rocky Mountain Region (USDA Forest Service 2009). This project was undertaken in collaboration with Bighorn National Forest to broaden the systematic survey and address the most pressing information needs for *P. c.* var. *villosa*.

Some of the most pressing information needs proved to be a review of the taxonomic status of *Pyrocoma clementis* var. *villosa*, and that of *P. c.* var. *clementis* in Wyoming. A taxonomic thesis that was never published (Mayes 1976) remains the primary taxonomic reference to date, as cited in the *Flora of North America* treatment (Bogler 2006), and the treatment of *P. c.* var. *villosa* in it was presented as provisionl. Both varieties are tracked as Wyoming plant species of concern although only *P. c.* var. *villosa* is designated as sensitive by the Rocky Mountain Region (USDA Forest Service 2009).

METHODS

At the start of this project, information on the habitat and distribution of *Pyrocoma clementis* var. *villosa* was compiled and reviewed at the Rocky Mountain Herbarium (RM 2010) and the Wyoming Natural Diversity Database (WYNDD 2010). A two-pronged approach was taken in conducting 2010 field surveys.

1. Digital color infrared orthophotographs (2000) were used to compare *P. c.* var. *villosa* habitat signatures with other areas on the Forest having calcareous limestone bedrock, identifying major areas of similar habitat not previously surveyed.
2. Known distribution was overlain with a compilation of calcium carbonate-rich bedrock formations (Love and Christiansen 1985) to compare known distribution with geology as basis for interpolation and extrapolation.

The fieldwork was conducted in the same year as surveys for two other rare calciphilic plants, *Physaria didymocarpa* var. *lanata* (woolly twinpod) and *Musineon vaginatum* (sheathed musineon) in order to pursue Forest-wide surveys of all three, on the grounds that concurrent surveys for all three might be more efficient together than separately.

In preparation for fieldwork, digital orthophotographs with distribution of *Pyrocoma clementis* var. *villosa* superimposed were printed out onto 8 ½ x 11 paper, representing about the same scale as 1:24,000 USGS topographic maps. The aerials and maps were both used for reference in setting field survey priorities and navigation in the field.

Surveys for *Pyrrcoma clementis* var. *villosa* were conducted between 2 August and 24 August 2011. When *P. c.* var. *villosa* was found in a survey area, the first tasks were to estimate its numbers, determine extent, and describe occupied habitat including topography, vegetation, and plant associates. Coordinates were recorded from GPS units for georeferencing population boundaries, later used to digitize polygonal population boundaries. Information was compiled and recorded onto WYNDD sensitive plant survey forms, and later entered in the WYNDD database.

Survey data of Richard and Beverly Scott, from 2005-2006 was incorporated after the 2010 field season. Further study of the taxonomic differences between varieties ensued.

RESULTS - SPECIES INFORMATION

Classification

Scientific name: *Pyrrcoma clementis* Rydb. var. *villosa* (Rydb.) Mayes ex Brown & Keil

Synonyms: *Haplopappus clementis* (Rydb.) S.F. Blake

Common name: Hairy tranquil goldenweed

Family: Asteraceae (previously referred to as Compositae; Aster family or Sunflower family)

Size of genus: *Pyrrcoma clementis* var. *villosa* is one of 14 species in the genus, a genus that is restricted to North America (Bogler 2006). There are six species and one variety of *Pyrrcoma* in Wyoming (Bogler 2006, Dorn 2001). This genus was first described by Hooker in 1833. The genus is characterized by its persistent basal rosettes of leaves, yellow-rayed heads on scapiform or few-bracteate peduncles, and obtuse, acute or mucronate phyllaries. The genus has also been treated as a section within the genus *Haplopappus* (Hall 1928, Cronquist 1994). It was presented as a separate genus in the dissertation by Mayes (1976), though some of the nomenclatural changes were not validated, including that for *P. c.* var. *villosa*. It was validated as a new combination by Brown and Keil (1992), along with other *Pyrrcoma* taxa.

Phylogenetic relationships: *Pyrrcoma clementis* var. *villosa* falls within a portion of the genus having radiate heads that are in clusters of 1-6+. Its chromosome number is not known. Most species in the genus have a diploid chromosome number ($2n=12$). There are also a lesser number of tetraploid and hexaploid *Pyrrcoma* species.

There are many unanswered questions about the phylogenetic relation between *Pyrrcoma clementis* var. *villosa* and the type variety, *P. c.* var. *clementis*, and between other species of the genus. Rydberg (1900) considered *P. c.* var. *villosa* to be closely related to *P. uniflora*, but

readily distinguished from the latter by its larger heads and foliaceous involucre bracts imbricated in 3-4 series. In their treatment of the Rocky Mountain flora, Coulter and Nelson (1909) reduced *P. villosa* to a synonym under *P. uniflora*.

Hall (1928) was the first taxonomist to detect close relationships between *Pyrocoma villosa* and *P. clementis*. Mayes (1976) treated *P. villosa* as a variety of *P. clementis*, *P. c. var. villosa* (Rydb.) Mayes. However, he said he had been unable to investigate this taxon adequately in the field, and its provisional treatment at the variety level was based on several characteristics and geographic isolation that he termed a “compromise.” Mayes (1976) noted that the type variety is closely related to *P. crocea* and *P. integrifolia*, perhaps more closely related to these other species than to *P. clementis var. villosa*. This provisional treatment remained the basis for its circumscription in the *Flora of North America* (Bogler 2006) and in Dorn (2001), though not accepted by the RM (2010). Cronquist (1994) noted without further research that he considered it to be most closely related to *P. integrifolia* rather than *P. clementis var. villosa*. Thus, the relationships between the two varieties of *P. clementis* and with other members of the genus (*P. uniflora*, *P. integrifolia*, and *P. crocea*) has had many different opinions over time but no rigorous research.

Present legal or other formal status

U.S. Fish & Wildlife Service status: None.

U.S. Forest Service status: *Pyrocoma clementis var. villosa* is on the current sensitive species list maintained by the U.S. Forest Service Rocky Mountain Region (USDA Forest Service 2009).

Global Heritage rank: G3G4T2. This indicates that the species may be either globally vulnerable or potentially secure across its entire range, but the variety may be globally imperiled.

State Legal status: None.

State Heritage rank: S2 in Wyoming. This indicates that the variety is potentially imperiled in the state. In this case, the state and global heritage ranks are equal because the taxon is restricted to the state.

History of Taxon: The taxon was first discovered by Frank Tweedy (2063 NY) in August 1899 in the Bighorn Mountains at “Willow Creek.” The following year, Rydberg (1900) published the description for *Pyrocoma villosa* Rydb. Also in 1900, Tweedy made a second collection (3042 RM) at “the headwaters of Clear Creek and Crazy Woman River.” It was not collected again until 1952, “2 miles west of [Bighorn National] Forest Boundary” by Eugene H. Cronin (*s.n.* RM) in the vicinity of Trapper Canyon. In 1955, it was collected south of Burgess Junction by R.K. Gierisch (1780 RM).

The type variety, *Pyrracoma clementis* var. *clementis* (tranquil goldenweed) was first discovered by Frederick Clements (44 NY) on Mount Harvard in Colorado, and named after him by Rydberg. *Pyrracoma villosa* was first identified as a relative of *P. clementis* by Hall (1928) and was proposed as a variety of the latter by Mayes (1976), later validated as a new combination by Brown and Keil (1992).

The story becomes more complicated with two collections of *Pyrracoma clementis* in the Wind River Range by Fisser (638, 702 RM) made in 1961. These collection stations appear to correspond with the two distribution points for *P. clementis* var. *clementis* shown on the distribution map by Mayes (1976). However, one of the Fisser collections (702) was annotated to *P. c.* var. *villosa* by Mayes (1976) although Mayes did not map *P. c.* var. *villosa* as present in the Wind River Range. The other Fisser collection (638) was more recently annotated to *P. integrifolia*. Mayes (1976) also represented a third location of *P. c.* var. *clementis* in Carbon County, Wyoming. The source of this report has been sought online among Intermountain Region Herbarium Network (2011) and not found. One possible explanation is that an immature *Pyrracoma* collected by C.O. Williamson (13) and identified as *P. villosa* in Carbon County, Montana and kept in the U.S. Forest Service Herbarium was not available for review and was mistakenly placed in Carbon County, Wyoming by Mayes (1976). [The Forest Service collection is now housed at the Rocky Mountain Herbarium and the specimen in question has immature flowers that does not appear to fit either variety.] Dorn (2001) reported that both varieties are present in Fremont County, possibly in keeping with the map by Mayes (1976) and the annotated specimen (Fisser 702 RM).

More recently, systematic floristic inventory was conducted in the Bighorn Mountains (Nelson and Hartman 1984). Two new collections were made from the southern end of the Mountains in Washakie County in 1979 and 1981 (Nelson 8159, Hartman 10549 RM). Until recently, *Pyrracoma clementis* var. *villosa* was reported from two extant occurrences and four historic occurrences (Fertig 2000). More recent floristic thesis inventories conducted out of the Rocky Mountain Herbarium produced four population records (Lum 2004, Massatti 2007) in the Bighorn Basin and Wind River Range, respectively. Another four new populations were discovered and mapped in survey work conducted by Earl Jensen in Bighorn National Forest (Jensen 2005), the first recent records in the Forest. Finally, surveys conducted by Richard and Beverly Scott in 2005 and 2006 located three new locales in the Bighorn National Forest.

Review of the *Pyrracoma clementis* var. *villosa* specimens at RM was conducted as part of this project. This update is offered as preliminary support for the taxonomic validity of *P. c.* var. *villosa*, upon which results are predicated.

Description

General non-technical description: *Pyrracoma clementis* var. *villosa* is a perennial forb with 1 to many stems from a branched rootstock. Stems are 3-15 (30) cm tall and loosely white-hairy to glabrous. Basal leaves are oblanceolate to narrowly elliptic, 2-12 cm long, and sparsely pubescent to glabrate on the surface. Stem leaves are progressively smaller and sessile to clasping. Flower heads are solitary or number 2-4 with involucre 9-15 mm high and woolly to glabrous lanceolate to oblanceolate, attenuate bracts that are green throughout. Ray flowers are yellow and 10-15 mm long while disk flowers are 6-8.5 mm long. Fruits are 4-sided glabrous achenes with tawny to brown bristles (Cronquist 1994; Dorn 2001, Bogler 2006, Fertig 2000; Figures 1-4).

The basis for the epithet, “hairy (*villosa*)”, is not discussed in taxonomic works. Both varieties of *Pyrracoma clementis* often have stems with long, tangled hairs, particularly on the upper stem below the flower. Rydberg (1900) described *P. c.* var. *villosa* as having a villous bract surface. However, taxonomists later determined that this is not a consistent variety trait.

Technical description: Perennial from a branched caudex with 1-many stems. Stems decumbent or curved-ascending, red-tinged, villous with long hairs to occasionally woolly and 3-15 (30) cm long. Leaves basal and cauline, simple. Basal leaves oblanceolate to narrowly elliptic, 2-12 cm long, and sparsely pubescent to glabrate on the surface. Cauline leaves progressively smaller and sessile to clasping. Flower heads solitary or few 2-4(5) and cymosely-arranged, radiate, with involucre 9-15 mm high and woolly to glabrous lanceolate to oblanceolate, attenuate phyllaries that are green throughout, in 3-4 series, margins ciliate. Ray flowers yellow, pistillate and 10-15 mm long. Disk flowers yellow, bisexual, fertile, and 6-8.5 mm long. Fruits 4-sided glabrous achenes with tawny to brown bristles. Crypsela faces glabrous. Pappi persistent, of brownish, rigid, unequal bristles in 1 series (Cronquist 1994; Dorn 2001, Bogler 2006).

Local field characters: The deep, golden-yellow flower color of *Pyrracoma clementis* var. *villosa* resembles that of *Arnica* spp. Unlike *Arnica* spp., it has alternate leaves. It could also be mistaken from a distance for *Taraxacum officinale* (common dandelion) or *Agoseris glauca* (false dandelion; Jensen 2005, 2010). Its flowering overlaps with the end of *T. officinale* flowering and the start of *A. glauca* flowering. Unlike *A. glauca* and *T. officinale*, it has stem leaves, and has a central disk with both ray and disk flowers. It often produces only one flower, but occasionally has 3+ flower heads. The stems are usually decumbent or curved-ascending to upright, growth form characteristics that give it different appearances in the field (Figures 2-3).

Similar species: *Pyrracoma clementis* var. *clementis* has acute tipped involucre bracts, hairy achenes, and sericeous crypsela faces (Table 1). *Pyrracoma integrifolia* has green tips or green just on upper lengths of the involucre bracts. *Pyrracoma uniflora* has 1-4 flowering heads with involucre 5-10 mm long and usually grows on wet, alkali soils. *Pyrracoma lanceolata* has 4 or



Figure 1. *Pyrocoma clementis* var. *villosa* bracts. By B. Heidel.



Figures 2 and 3: *Pyrocoma clementis* var. *villosa* whole plants; multi-stemmed vs. two-stemmed, and ascending vs. decumbent. By Earl Jensen.



Figure 4. *Pyrrcoma clementis* var. *villosa* specimen close-up. Note glabrous seeds and acuminate bracts. (Hartman 10549; with Nelson 8159 as insert)

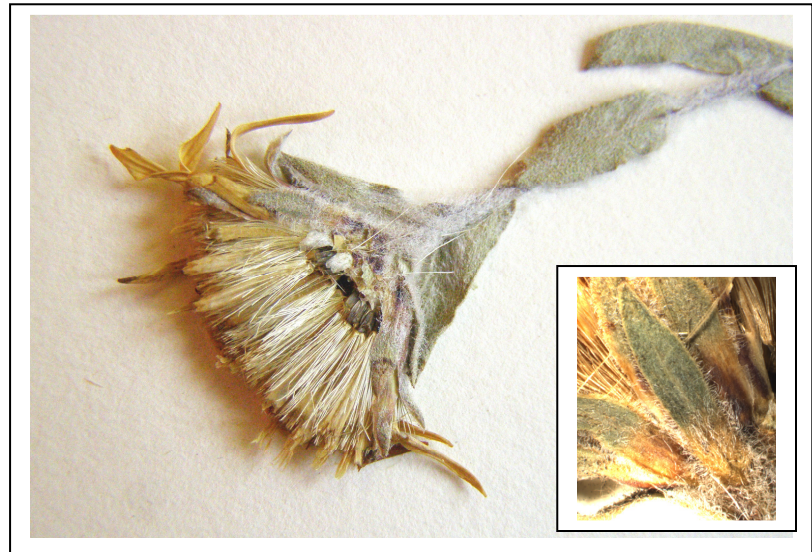


Table 1. Characteristics that distinguish *Pyrrcoma clementis* var. *villosa* from other taxa in the genus (Cronquist 1994, Dorn 2001, Mayes 1976, Bogler 2006)

Taxon	No. of flower heads	Involucre length (mm)	Involucre shape, tip	Involucre texture, surface	Disk corolla length (mm)	Leaf outline, surface	Growth form
<i>Pyrrcoma clementis</i> var. <i>villosa</i>	Usually solitary, occasionally 2-3(4)	9-14	Lanceolate or oblanceolate, with attenuate tip	Green most of length	7-14	Entire or slightly undulate, glabrous	Stems decumbent curved-ascending to ascending
<i>Pyrrcoma clementis</i> var. <i>clementis</i>	Usually solitary, occasionally 2-3(4)	9-14	Obovate, with abruptly acute tip	Green most of length	7-14	Entire or slightly undulate, glabrous	Stems ascending
<i>Pyrrcoma crocea</i>	Usually solitary, occasionally 2-3	15-20	Oblong to spatulate, with obtuse tip	Green or yellowish, with pale margins	7-14	Entire or undulate, glabrous	Stems erect or ascending, robust
<i>Pyrrcoma integrifolia</i>	4+	11-17	Oblanceolate to oblong, with acuminate tip	Green-tipped	5-7 (7.5)	Entire or undulate, glabrous	Stems erect or ascending
<i>Pyrrcoma lanceolata</i>	Usually numerous; (1) 5-20 (50)	7-10	Linear lanceolate to lanceolate, with acute tip	Green-tipped	5-7	Finely toothed, glabrous	Stems erect, ascending or decumbent
<i>Pyrrcoma uniflora</i>	Usually solitary, occasionally 2-4	6-13	Linear-lanceolate, with acute tip	Green most of length	5-7 (7.5)	Toothed, with fine, tangled hairs	Stems curved-ascending to decumbent

more flower heads per stem with involucre 5-10 mm long of green-tipped bracts (Dorn 2001; Cronquist 1994, Bogler 2006, Fertig 2000). In the genus, there is limited geographic overlap with *P. c.* var. *clementis*. Both *P. integrifolia* and *P. uniflora* are known from the south end of the Bighorn Mountains in Washakie County (Nelson and Hartman 1984, Dorn 2001, Rocky Mountain Herbarium 2010). *Pyrocoma integrifolia* is an upland plant last collected from the Bighorn Mountains in Washakie County by Leslie Gooding in 1901.

Geographical distribution

Range: *Pyrocoma clementis* var. *villosa* is a state endemic of the Bighorn Mountains in north-central Wyoming. Its extant populations are on the western slopes of the Mountains in Big Horn and Washakie counties, but the earliest collections of it were apparently made on the east side.

By contrast, *P. c.* var. *clementis* is widespread in Colorado and Utah and appears to be consistent with all material examined from the Wind River Range (*Fisser 702 RM*) or posted (*Massatti 5911, 6107 RM*). We sought to locate specimens of *P. c.* var. *clementis* to support Mayes (1976) report for the type variety in Carbon County, Wyoming, using on-line search tools of the Intermountain Regional Herbarium Network (2011) but no supporting data were found.

Extant sites: *Pyrocoma clementis* var. *villosa* is known from ten extant occurrences, along the west slope of the Bighorn Mountains (Table 2, Figure 5). The highest concentration is along a 20+ mile western margin of the Bighorn National Forest. There are also three occurrences at the southern end of the Bighorn Mountains on BLM lands. There is only one collection of *Pyrocoma clementis* var. *villosa* on the Bighorn National Forest in the past decade (*Heidel 3514 RM*), so there is a need for more complete vouchered material deposited into regional herbaria so that herbarium records and sensitive species records are consistent.

Historical sites: There are three historical collection records of *Pyrocoma clementis* var. *villosa* in the Bighorn Mountains, including the only two collections made on the east side. The 1899 specimen collected from “Willow Creek” was interpreted at RM by reviewing the collecting journal as corresponding to Willow Creek in Sheridan County, possibly near Park Reservoir. Grassland habitat was traversed in this area incidental to wetland surveys in the area, mostly on glacial till parent material, but no species of *Pyrocoma* were found. There was also a survey in grassland habitat above Willow Creek in Johnson County, west of Buffalo, on limestone parent material, but no species of *Pyrocoma* were found. The 1900 specimen collected from “headwaters of Clear Creek and Crazy Woman River” fits the township T49N R84W or immediately adjoining townships, where additional grassland habitat was surveyed, mostly on Archean metamorphic parent material mapped as gneiss. These surveys in grassland habitat were incidental to wetland surveys, or conducted as spot-checks from the road. They were unsuccessful. Geology is mentioned because there is no limestone parent material in these areas analogous to that where *P. c.* var. *villosa* has occurs on the west side. It may have a broader

range of habitat than previously documented. Alternatively, both of the east-side historical collections might have been made on limestone parent material that lies below Forest boundaries.

The third historical collection “2 miles west of the Forest Boundary” has not been relocated. This is close to the Spanish Karst Area of Critical Environmental Concern (ACEC), which might or might not have suitable habitat.

Table 2. Location information for *Pyrrocoma clementis* var. *villosa*

EO#	Location	County	Legal Description	Elev.	USGS 7.5'	Ownership
001	Headwaters of Finger, Three Springs, Willey, Owen, Cedar, and Prospect creeks	Big Horn Sheridan	T54N R89W Sec. 4, 5, 9, 10, 14, 15, 16, 22, 23, 32	9200-9700	Granite Pass	Bighorn NF
002	Trapper Canyon vicinity	Big Horn	T52N R89W (imprecise location)	?	Spanish Butte Bush Butte	BLM Worland
003	Middle Fork Power River	Johnson Washakie	T41N R86W Sec. 26 T42N R86W Sec. 2, 11	7300-8000	Gordon Creek Cherry Creek Hill	BLM Worland
004	Headwaters of Clear Creek and Crazy Woman River	Johnson	T50N R84W (imprecise location)	?	Hunter Mesa	Bighorn NF
006	Willow Creek (tentatively near Park Reservoir on Willow)	Johnson?	T53N R86W? (imprecise location)	?	Park Reservoir?	Bighorn NF
007	Crooked Creek Hill and slopes above Battle, Crooked, Jack, and Johnny creeks	Big Horn	T52N R88W Sec. 4, 5, 8, 9, 16, 17, 21; T 52N R89W Sec. 1, 12; T53N R88W Sec. 32; 33	8700-9600	Spanish Point Shell Canyon	Bighorn NF BLM Worland, pvt?
013	Spanish Point, northeast slopes	Big Horn	T52N R88W Sec. 33	8700-8900	Spanish Point	Bighorn NF
014	Spring Creek, slopes west of Spring Creek	Washakie	T41N R86W Sec. 26, 27	8250	Cherry Creek Hill	BLM Worland
015	Middle Fork Powder River, slopes north and west of	Washakie	T42N R86W Sec. 33	8100-8160	Cherry Creek Hill	BLM Worland
017	Road between Cold Springs Campground	Big Horn	T51N R88W Sec. 36	9000	Allen Draw	Bighorn NF
018	Upper south slopes of Sunlight Mesa	Big Horn	T54N R90W Sec. 33	8050	Black Mountain	Bighorn NF
021	McKay Creek	Big Horn	T53N R89W Sec. 19	8100	Shell Falls	Bighorn NF
022	West end of Snowshoe Mountain	Big Horn	T53N R89W Sec. 26	9050	Shell Falls	Bighorn NF

Unverified/Undocumented reports: None known.

Sites where present status not known: The 2010 surveys did not address habitat outside Bighorn National Forest boundaries.

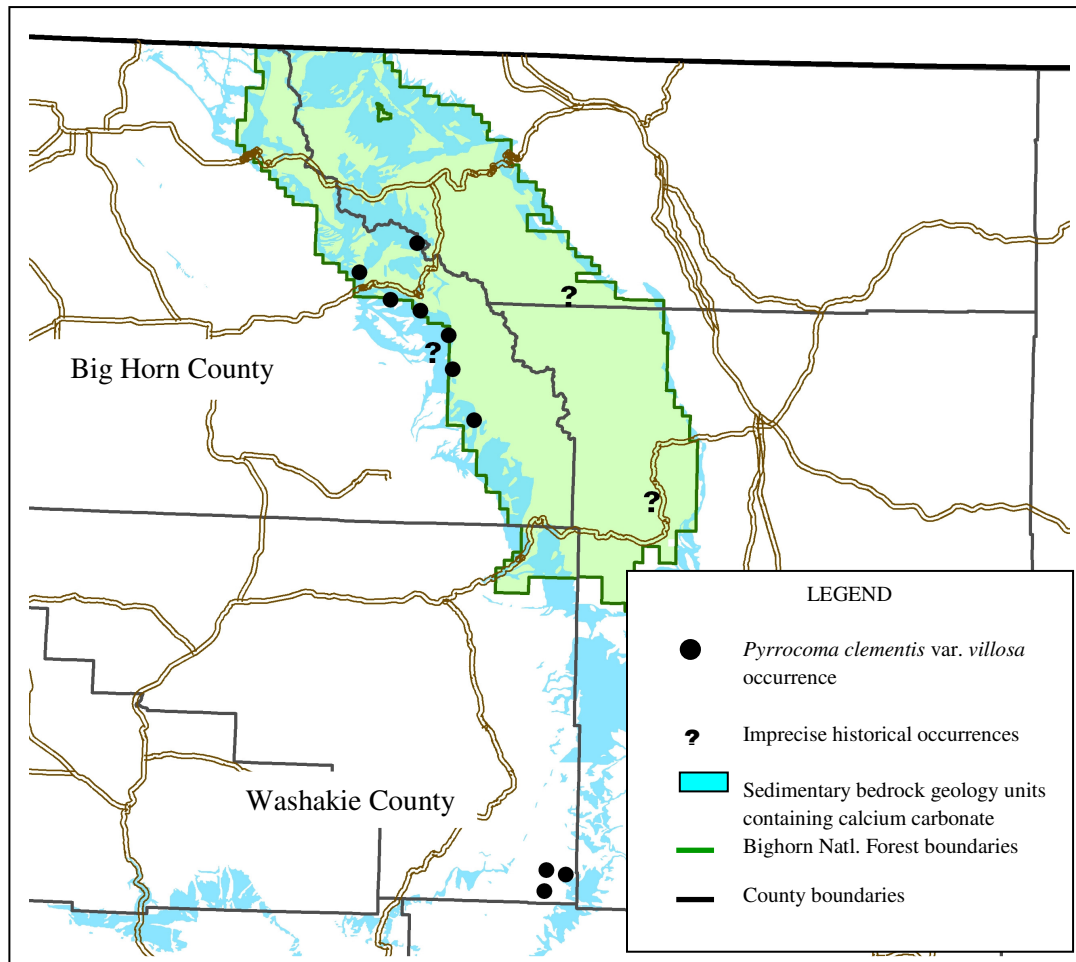


Figure 5. Distribution and geology of *Pyrocoma clementis* var. *villosa*

Areas surveyed but species not located: Appendix A represents locales surveyed for *Pyrocoma clementis* var. *villosa*. This study identified many areas that appear to be suitable where it was not found. It was also sought but not found in part of the Elephant Head area (Welp et al. 1998).

Land ownership: *Pyrocoma clementis* var. *villosa* occurs on lands managed by the Bighorn National Forest and the BLM Worland Field Office. One of the largest populations straddles the Forest boundary (Crooked Hill #007), occurring on Bighorn National Forest, BLM Worland Field Office lands and possibly private lands. One somewhat vague record might occur in the Spanish Karst ACEC and Trapper Canyon Wilderness Study Area. All other known population records are from public lands managed for multiple use.

Habitat

Pyrocoma clementis var. *villosa* is found in montane meadows on limestone substrates, in or between sagebrush steppe but not directly associated with sagebrush. Elevations range from 2225-2957 m (7300-9700 ft). The known elevation differs from that given by Mayes (1976) who reported *P. c.* var. *villosa* it from "meadows, forest openings, and above timberline at elevations

of 10,000 to 11,500 feet in association with *Pinus aristata*, *P. contorta*, *Populus tremuloides*, *Poa alpina*, *P. fendleriana*, and *Haplopappus macronema*.” There are many collections of *P. c.* var. *clementis* from Colorado that are in alpine elevations, and it reaches elevations up to 12,500 ft (Mayes 1976), but there are no known collections of *P. c.* var. *villosa* at alpine elevations. One of the associated species report by Mayes (1976), *Pinus aristata* (bristlecone pine), is associated with *P. c.* var. *clementis* in Colorado but is not present in Wyoming.

Recent surveys found *Pyrrhoma clementis* var. *villosa* on Nathrop-Passcreek-Starley/ Limestone. The southern occurrences of it on BLM lands were apparently collected in an area of Archean metamorphic parent material mapped as gneiss (Love and Christiansen 1985). Survey work in these areas might help determine the substrate breadth or narrowness of *P. c.* var. *villosa*, information that would be useful for expanded survey on similar substrate on the east side of Bighorn National Forest.

Pyrrhoma clementis var. *villosa* occurs on gently contoured landforms that, at least in Bighorn National Forest, have limestone bedrock (Figure 6). The landform outcrops form striated patterns that show up on aerial photos as bands of high reflectance, corresponding with high limestone gravel cover or small outcrop blocks at the surface.

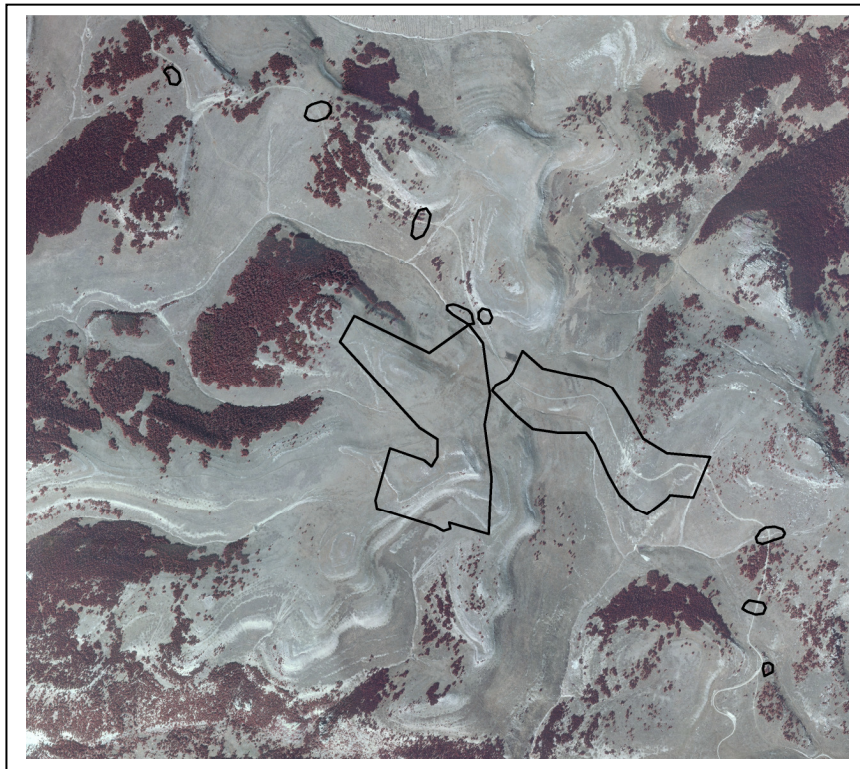


Figure 6. Color infrared aerial photograph of *Pyrrhoma clementis* var. *villosa* occupied habitat in the center of the Granite Pass population complex, #001 (Granite Pass Quad, 1:24,000). Note limestone outcrops in repeated bands, a pattern found around the largest known populations.

The breadth of occupied habitat is indicated by a series of photographs taken in the Granite Pass population complex (#001; Figures 7-10). It remains to be determined whether the habitats are prevailing vegetation types or secondary ones.



Figure 7. *Pyrrcoma clementis* var. *villosa* on relatively steep habitat, Granite Pass (#001)
By Matthew Spann.



Figure 8. *Pyrrcoma clementis* var. *villosa* on forb-rich meadow, Granite Pass (#001). By Earl Jensen.



Figure 9. *Pyrrcoma clementis* var. *villosa* on stream headwaters, Granite Pass (#001).
By Earl Jensen.



Figure 10. *Pyrrcoma clementis* var. *villosa*. at edge of sagebrush steppe, Granite Pass (#001). By Earl Jensen.

Frequently associated species: The species noted in association with *Pyrrocomma clementis* var. *villosa* are mainly widespread species of montane meadows (Table 3).

Table 3. Species associated with *Pyrrocomma clementis* var. *villosa*¹

Scientific name	Common name	On Bighorn NF?
<i>Achillea millefolium</i>	Yarrow	YES
<i>Agoseris glauca</i>	False dandelion	YES
<i>Anemone multifida</i>	Red windflower	YES
<i>Antennaria microphylla</i>	Small-leaf pussytoes	YES
<i>Arnica rydbergii</i>	Rydberg's arnica	YES
<i>Artemisia tridentata</i> ssp. <i>vaseyana</i>	Mountain big sagebrush	YES
<i>Castilleja</i> spp.	Paintbrush	YES
<i>Cerastium arvense</i>	Field chickweed	YES
<i>Elymus spicatus</i>	Bluebunch wheatgrass	YES
<i>Eremogone congesta</i>	Ballhead sandwort	YES
<i>Eriogonum flavum</i>	Yellow buckwheat	NO
<i>Festuca idahonis</i>	Idaho fescue	YES
<i>Fragaria virginiana</i>	Wild strawberry	YES
<i>Frasera speciosa</i>	Green gentian	YES
<i>Geum triflorum</i>	Prairie smoke	YES
<i>Geranium viscosissimum</i>	Sticky geranium	YES
<i>Hedysarum sulphurescens</i>	Sulfur sweetvetch	YES
<i>Linum perenne</i>	Wild blue flax	YES
<i>Lupinus argenteus</i>	Silver lupine	YES
<i>Oxytropis campestris</i>	Field locoweed	YES
<i>Penstemon</i> spp.	Beardtongue	YES
<i>Phlox multiflora</i>	Flowery phlox	YES
<i>Pinus contorta</i>	Lodgepole pine	YES
<i>Pinus flexilis</i>	Limber pine	YES
<i>Poa secunda</i>	Sandberg's bluegrass	YES
<i>Polygonum bistortoides</i>	Bistort	YES
<i>Potentilla paradoxa</i>	Paradox cinquefoil	YES
<i>Sedum lanceolatum</i>	Stonecrop	YES
<i>Senecio</i> or <i>Packera</i> spp.	Ragwort or Groundsel	YES
<i>Solidago multiradiata</i>	Rocky Mountain goldenrod	YES
<i>Symphotrichum</i> spp.	Aster	YES
<i>Taraxacum officinale</i>	Common dandelion	YES
<i>Valeriana</i> spp.	Valerian	YES
<i>Zigadenus elegans</i>	Death camas	YES

Associated species of concern: There is limited overlap of *Pyrrocomma clementis* var. *villosa* with other Wyoming plant species of concern. It overlaps with part of the distribution of *Symphotrichum molle* (smooth aster), though there are no sites where they have been found growing together. It does not occur with the other two rare species surveyed in 2010, *Physaria didymocarpa* var. *lanata* and *Musineon vaginatum*.

¹ Nomenclature generally follows Dorn (2001).

Topography: *Pyrracoma clementis* var. *villosa* occupies ridge tops, tablelands, shoulders and upper to midslope positions with soil development.

Soil relationships: The soils where *Pyrracoma clementis* var. *villosa* is found are well-developed loamy mollisols. Most sites have gravel and bare soil at the surface, the bare soil possibly caused by burrowing activity. Some also have small rocks, platy blocks or ledges of limestone at the surface.

Regional climate: The montane climate of the Bighorn Mountains is best represented by meteorological data from Burgess Junction (USDI NOAA 2010; Station 481220; collected from 9/18/1960 to 12/31/2005). Annual precipitation averages 53.3 cm (21.0 in). Snowfall is a major contribution to total annual precipitation, with an average of 6.2 m (242.8 in) amounting to about 53% of mean annual precipitation. April and May are the months of highest precipitation, much of which falls as snow. July is the warmest month with mean monthly temperature of 12.9 °C (55.2 °F) and January is the coldest with mean monthly temperature of -8.5 °C (16.7 °F). There is a 50% probability of having a 40-day period during the growing season when temperatures are at or above freezing.

From what is known about current distribution, *Pyrracoma clementis* var. *villosa* appears to favor the drier climates. There is a rain shadow pattern associated with the Bighorn Mountains where moisture-bearing systems come out of the east. This is well-documented in foothills settings in comparing the precipitation of Buffalo and Sheridan on the east side where annual precipitation is 33.8 cm and 37.1 cm (13.3 in and 14.6 in, respectively) against the precipitation of Shell and Worland on the west side where annual precipitation is 25.5 cm and 19.6 cm (9.9 in and 7.7 in, respectively; USDI NOAA 2010).

Local microclimate: The settings that support *Pyrracoma clementis* var. *villosa* all have loamy, moisture-retaining soils. The availability of subsurface moisture during flowering and seed maturation may be particularly important in the production of seeds at dry times of the growing season. Many of the settings have a west aspect, directly exposed to the force of prevailing winds.

Population biology and demography

Phenology: *Pyrracoma clementis* var. *villosa* flowers from July-mid August, and produces seed from late July-September. Flowering is staggered and prolonged if there are multiple flower heads per stem.

Population size and condition: *Pyrracoma clementis* var. *villosa* occurs in scattered clusters with numbers ranging from less than 50 plants to numbers in the 1000's (Table 4). Detailed survey and mapping are available for two occurrences (#001, #007), where total numbers approach or

surpass the 10,000 magnitude (Table 4). The difficulty of accurate estimates is compounded by the high density of plants in places (Figures 11 and 12), where numbers are apt to be seriously underestimated. Total occupied habitat is likely to be much more than 405 ha (1000+ ac).



Figure 11. *Pyrocoma clementis* var. *villosa* in high density, Granite Pass (#001). By Susan Bell.

Figure 12. *Pyrocoma clementis* var. *villosa* in high density, Granite Pass (#001). By Susan Bell.

Table 4. Size and extent of *Pyrocoma clementis* var. *villosa* populations

EO#	Numbers/Extent ha (ac)
001	Probably several thousand plants across 138 ha (340 ac)
002	Unknown
003	Unknown
004	Unknown
006	Unknown
007	Possibly thousands across 162 ha (400 ac)
013	Less than 100 in app. 6 ha (15 ac)
014	Unknown
015	Unknown
017	Unknown
018	Unknown
021	Unknown
022	Unknown

There is no evidence to suggest that *Pyrocoma clementis* var. *villosa* has lost habitat or that its habitat has declined. Disturbance frequency or successional rates might affect population trends if it is restricted to a successional habitat maintained by periodic disturbance such as fire, or favors a successional habitat.

Reproductive biology

Type of reproduction: Reproduction is sexual, by seed.

Pollination biology: *Pyrrcoma clementis* var. *villosa* has conspicuous inflorescences with pistillate ray flowers that mature first, fostering outcrossing, and bisexual disk flowers, possibly self-pollinated. Beetles have been observed feeding for nectar and getting dusted with pollen.

Seed dispersal and biology: The flower head doesn't shed seeds until it dries out, late in the growing season, sometimes after frost. The bristles on the achene aid in wind dispersal.

Population ecology

General summary: *Pyrrcoma clementis* var. *villosa* is a perennial. There are no available data on its life history, or a way to characterize the age or life history stage of individual plants, either in the field or in the herbarium. It is possible, but not proven, that the taproot diameter or vestiges of leaf sheathes reflect age.

Competition: *Pyrrcoma clementis* var. *villosa* grows in grassland plant communities that are part of a mosaic with *Artemisia tridentata* ssp. *vaseyana* (mountain big sagebrush). It is not clear what is cause and what is effect, but its absence from areas with sagebrush may be due to some intermediate variable such as gopher avoidance of sagebrush habitat, the allelopathic affects of sagebrush, or the disturbance represented by gaps in sagebrush cover.

Herbivory: Few signs of herbivory were observed on *Pyrrcoma clementis* var. *villosa* plants in the field or on herbarium specimens. The hairiness of the flowering stalk and the stiff bracts may deter herbivory.

Hybridization: No evidence.

ASSESSMENT AND MANAGEMENT RECOMMENDATIONS

Potential threats to currently known populations

Grazing: *Pyrrcoma clementis* var. *villosa* occupies habitats that are generally in the middle of primary range for livestock. No signs of grazing or browsing were observed. Evidence of trampling was not observed. Grazing can sometimes be associated with habitat degradation and associated vegetation shifts. Some of the species associated with it such as *Taraxacum officinale* (common dandelion), are exotic species that can occupy a wide range of intact and degraded habitat. There was not sufficient information collected to characterize *P. c.* var. *villosa* as a decreaser or increaser under livestock grazing.

Logging: *Pyrracoma clementis* var. *villosa* does not occupy forest stands so would not be affected by logging practices except in the construction of access roads.

Roads: Motorized vehicles are restricted to open, designated roads or motorized trails during the growing season in nearly all areas occupied by *Pyrracoma clementis* var. *villosa*, although people can drive up to 300 ft off of the road for a specific purpose such as camping. Parts of its habitat are on gentle terrain that can be affected by such practices. Roads run through the center of some of the largest populations, and occasionally plants are found in graded margins but the topographic position that *P. c.* var. *villosa* occupies appears to be the main reason for this overlap, rather than because it is associated in any way with roadwork or road use.

Weeds: There were no noxious weeds found in 2010 surveys of *Pyrracoma clementis* var. *villosa*.

Fire: There are charred remnants of scattered, old trees at some sites of *Pyrracoma clementis* var. *villosa* (Figure 13). It is sometimes found in gaps between stands of *Artemisia tridentata* ssp. *vaseyana* (mountain big sagebrush), but the vegetation borders have not been examined closely to look for signs of fire or other disturbance history.



Figure 13. *Pyrracoma clementis* var. *villosa* habitat with dead trees, Granite Pass (#001).
By Earl Jensen.



Figure 14. *Pyrracoma clementis* var. *villosa* habitat with bare soil possibly due to burrowing activity, Granite Pass. (#001).
By Earl Jensen.

Other: *Pyrracoma clementis* var. *villosa* is often found on substrates that often appear to be churned by pocket gopher activity (Figure 14). It is possible that frost action or other processes are involved rather than rodent burrowing. In any case, this natural disturbance might account for the high frequency of plants such as *Taraxacum officinale* (common dandelion) associated

with *P. c. var. villosa*. In places along gentle, headwater drainages, its local distribution might also be shaped by slight differences in erosion or snowmelt patterns (Figure 9).

Management practices and response

There have been no studies of management practices and associated responses of *Pyrrocomma clementis* var. *villosa*. It would be insightful to document before-and-after conditions for any new grazing developments implemented in occupied habitat, prescribed burn activity, or any actions affecting burrowing mammals. It would be especially insightful to set up a study with a control plot containing a portion of the population that is excluded from treatment.

Conservation recommendations

Recommendations regarding present or anticipated activities: It would be appropriate to integrate allotment information with *Pyrrocomma clementis* var. *villosa* distribution. The occurrence maps provided in electronic format with this report (Appendix A) are available for this use.

Notification of U.S. Forest Service personnel of locations on national forest: To prevent inadvertent impacts to known *Pyrrocomma clementis* var. *villosa* populations, all appropriate USFS personnel and cooperators involved in planning and on-the-ground land management activities, should have access to species information and location data. Key activities include grazing, fire management and weed control. Towards this end, the updated Forest Service species evaluation (Appendix C) and state species abstract (Appendix D) are updated, accompanied by GIS files of all currently known occurrences.

Status recommendations: All status recommendations are contingent on taxonomic treatment. Bighorn National Forest occurrences of *Pyrrocomma clementis* var. *villosa* represent the core of its global distribution. No immediate threats have been identified, but it would be useful to gather more detailed information on responses to natural disturbance regimes and land use disturbances.

Summary: *Pyrrocomma clementis* var. *villosa* is a state endemic restricted to the Bighorn Mountains. The only extant occurrences are in Big Horn and Washakie counties, and the highest number of them are on Bighorn National Forest, all documented since 2005. All extant occurrences are on public land, managed for multiple use. This species is found in montane grassland on limestone parent material. Based on the results of this project, *P. c. var. villosa* has been found to be locally common, forming extensive populations, and with limited vulnerability to most land management practices. The negative survey information has been significantly expanded *Pyrrocomma clementis* var. *villosa* remains a Wyoming plant species of concern.

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