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Conservation Assessment of Arrowleaf Sweet Coltsfoot in the Black Hills National Forest, South Dakota and Wyoming

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Conservation Assessment

of

Arrowleaf Sweet Coltsfoot

(Petasites sagittatus (Banks ex Pursh) Gray)

in the

Black Hills National Forest,

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EXECUTIVE SUMMARY

Arrowleaf sweet coltsfoot, *Petasites sagittatus* (Banks ex Pursh) Gray, is a perennial rhizomatous forb that occurs in marshes, swamps, bogs, and other wet habitats in the northern United States and across Canada and Alaska (USDA NRCS 2001; NatureServe 2001). Disjunct, isolated occurrences of arrowleaf sweet coltsfoot in South Dakota, Wyoming, and Colorado may be relicts from the last Pleistocene glaciation. In Black Hills National Forest, arrowleaf sweet coltsfoot is known only from two locations along Rapid Creek, one in Pennington County near Solomon Gulch, the other in the Black Fox Valley Botanical Area in Lawrence County. Two other occurrences are known from private lands in Lawrence County, and one historically known population on private land from Lawrence County appears to have been lost. There may be taxonomic problems relating to the species and it may be better treated at the subspecific level. There are significant information gaps and uncertainties regarding this species' ecology and habitat needs in the Black Hills. As a result, it is only possible to speculate on the risks and effects of various management activities. The species and its potential habitat are undersurveyed in the Black Hills, but additional available habitat may exist in the Black Fox Valley.

Activities in and adjacent to known populations of arrowleaf sweet coltsfoot may impact or benefit the species. Risk factors may include climate change (i.e. warmer, drier conditions), impacts to hydrology (e.g., water table declines from physical disturbance or continued expansion of upland forests), competition from weedy species, continued low levels of beaver activity in the area, livestock and wildlife use, and recreational impacts. The basic management objectives for Black Fox Valley Botanical Area provide a good process-based conservation framework for minimizing risks to arrowleaf sweet coltsfoot in Black Hills National Forest by restricting road access, livestock grazing, and mineral development, and promoting restoration of natural disturbances such as fire and beaver activity. Conservation and enhancement of hydrologic resources throughout the watershed is essential, not only on Black Hills National Forest, but also on upstream areas, including private lands. Prescribed burnings of uplands may help to maintain or raise the water table and restore woody plants for beavers. Ultimately, enhancement of beaver populations in the drainage should be beneficial to this obligate wetland species.

Key words: Arrowleaf sweet coltsfoot, beaver ecology, Black Hills, *Petasites sagittatus*, wetland restoration.

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INTRODUCTION

The objective of this assessment is to review the status of arrowleaf sweet coltsfoot in the Black Hills and to synthesize information relevant to its management and long-term persistence. There is little information about the habitat needs of arrowleaf sweet coltsfoot and its responses to management activities in the Black Hills. The result is a fairly low state of knowledge about the local requirements of this species. In addition to published literature on arrowleaf sweet coltsfoot and its habitats, other sources of information were important in developing this assessment. The USDA, NRCS PLANTS Database is referenced frequently in this document, although the geographical basis and source of specific habitat data is often unknown and may not be directly applicable to the Black Hills in all instances. This document was developed in accordance with content and format requirements defined by Black Hills National Forest.

Arrowleaf sweet coltsfoot, *Petasites sagittatus* (Banks ex Pursh) Gray, is a perennial obligate wetland forb that occurs in Alaska, across Canada, and across the northern portion of the United States, extending south to Colorado, South Dakota, and Wyoming, (Figures 1-2) (USDA NRCS 2001; NatureServe 2001). Across the species' range, its conservation status varies from secure in northern boreal regions to imperiled or critically imperiled due to extreme rarity in southerly disjunct populations (NatureServe 2001). Arrowleaf sweet coltsfoot is a "species of special concern" with the South Dakota Natural Heritage Program (Ode pers. comm. 2001). The rare occurrences in the Black Hills and Rocky Mountains are likely relicts from the last Pleistocene glaciation 11,000 years ago (Froiland 1962; Price *et al*. 1996).

The four currently known occurrences of arrowleaf sweet coltsfoot in South Dakota are in the Black Hills, in Pennington and Lawrence counties. The largest population occurs on Black Hills National Forest in a spruce fen adjacent to Rapid Creek at Black Fox Valley Botanical Area (SDNHP 1993). Another smaller population on the Forest is known from approximately five miles downstream in the vicinity of Solomon Gulch, and two other populations occur on private land, one within one mile east of the Botanical Area, the other approximately 11 miles northeast of the Botanical Area (SDNHP 1986, 1988, 1994). The arrowleaf sweet coltsfoot population at Black Fox Valley Botanical Area is the largest in the state. At this time, it is unknown what activities are taking place at the arrowleaf sweet coltsfoot sites on private land. Black Fox Valley populations are in a gently sloping, moderately wide valley of the Rapid Creek drainage near the western edge of the central crystalline core of the Black Hills (Froiland 1999; Luhrsen 2001). Rydberg originally noted the presence of arrowleaf sweet coltsfoot in the area above Rochford along Rapid Creek (SDNHP 1994).

CURRENT MANAGEMENT SITUATION

Management Status

International

Global Heritage Status Rank: G5; secure worldwide, but possibly quite rare in parts of its range, especially at the periphery (NatureServe 2001).

Federal

Arrowleaf sweet coltsfoot has no special federal status and is not a designated "Sensitive" species in USFS Region 2 (USDA 1994) or "Special Status" plant species by the BLM (USDI BLM 1997).

Throughout its range, arrowleaf sweet coltsfoot is strongly associated with cold, wet areas such as swamps, bogs, and marshy habitats, (Van Bruggen 1976; Rydberg 1965; Hulten 1968; Welsh 1973, Scoggan 1979; McGregor 1976). Arrowleaf sweet coltsfoot is rare where suitable (i.e., cold) wetlands are less abundant or human impacts are more widespread. In addition, human activities may have directly and indirectly impacted the quality, quantity, and distribution of arrowleaf sweet coltsfoot's wetland habitats. Primarily as a result of climatic limitations, arrowleaf sweet coltsfoot is imperiled (S2) or critically imperiled due to extreme rarity (S1) toward the southern limits of its range in Wyoming and South Dakota, while populations that occur in Montana and Idaho, and the Canadian provinces of Manitoba, Alberta, Ontario, and Saskatchewan are generally more secure (NatureServe 2001).

Five occurrences of arrowleaf sweet coltsfoot have been reported from South Dakota, all in the Black Hills, in Lawrence and Pennington counties. Two of the populations are on Black Hills National Forest (BHNF) and three element occurrences are reported from private property in the Black Hills, although one of the private populations has not been relocated since it was first observed in 1928, and is presumed to have been lost (SDNHP 1986, 1988, 1993, and 1994). The site of the largest BHNF population was given administrative designation as part of the Black Fox Valley Botanical Area in 1997 (USDA Forest Service 1997). Under this direction, the Botanical Area is to be managed in such a way that the attributes for which it was established are not impaired. The primary values for which the area was designated were the botanical features, including arrowleaf sweet coltsfoot. Management directives for the Botanical Area include restrictions on roads, timber harvest, livestock grazing, and mineral development (as discussed in Sections VI.J and VII.A), to minimize impacts to existing rare plant populations. Livestock grazing within the Botanical Area continues, but off-road motorized travel is prohibited (USDA Forest Service 1997). No specific management is targeted for the other BHNF population at present. Populations of arrowleaf sweet coltsfoot in South Dakota that occur on private land are given limited consideration in this assessment. Further management related discussions are presented in REVIEW OF TECHNICAL KNOWLEDGE, Response To Habitat Changes – Management Activities and REVIEW OF CONSERVATION PRACTICES - Management Practices.

Conservation Status

State	RANK	COMMENTS	SOURCE
South Dakota	S1	Critically imperiled due to extreme rarity.	NatureServe 2001.

Conservation Status - Elsewhere

State/Province	Rank	Comments	Source
U.S.			
Colorado	SR	Reported	NatureServe 2001
Wyoming	S2	Imperiled	NatureServe 2001
Wisconsin	S2	Imperiled	NatureServe 2001
Michigan	S1S2	Critically Imperiled - Imperiled	NatureServe 2001; Michigan Natural Features Inventory 1999
Idaho	S3	Vulnerable	NatureServe 2001
Montana	S3S4	Vulnerable – Apparently Secure	NatureServe 2001
Alaska, Minnesota, North Dakota, Utah, Washington	SR	Reported	NatureServe 2001
Canada			
Manitoba	S4	Apparently Secure	NatureServe 2001
Alberta, Ontario, Saskatchewan	S5	Secure	NatureServe 2001
British Columbia, Labrador (Newfoundland), Northwest Territories, Nunavut, Quebec, Yukon Territory	SR	Reported	NatureServe 2001
New Brunswick	SU	Unrankable	NatureServe 2001

Existing Management Plans, Assessments Or Conservation Strategies

No other management documents were identified for arrowleaf sweet coltsfoot.

REVIEW OF TECHNICAL KNOWLEDGE

Systematics

Citation: (Banks ex Pursh) Gray, Bot. Geol. Surv. Calif. 1: 406-407. 1876.

Five species and three varieties of *Petasites* are presently recognized, with four of the five species represented in North America in the boreal region (USDA NRCS 2001). Arrowleaf sweet coltsfoot, *Petasites sagittatus* (Banks ex Pursh) Gray, is classified as Class Magnoliopsida (Eudicots), Subclass Asteridae, Order Asterales, Family Asteraceae (Sunflower Family), tribe Senecioneae, Genus *Petasites* (McGregor 1986; Walters and Keil 1996; NatureServe 2001). Historical taxonomic treatments include *Tussilago sagittata* Banks ex Pursh, Flora Am. Sept. 531. 1814, and *Nardosmia sagittata* (Banks ex Pursh) Hook., Flora Nor. Am. 1: 307. 1833. Synonymy includes *Petasites dentatus* Blank.; while other common names include "arrow butterbur" and "arrow-leaf sweet-colt's-foot" (ITIS 2001). According to Cherniawsky and Bayer (1998a), *Petasites* Mill. is a taxonomically difficult genus in North America mainly because of continuous morphological features across various taxa. Based on multivariate analyses of

morphological characteristics and isozymes, Cherniawsky and Bayer (1998b) concluded that North American taxa of *Petasites* are very closely related, and have experienced relatively rapid and recent morphological divergence. Cherniawsky and Bayer (1998b) concluded that all North American *Petasites* should be treated as one polymorphic species, *P. frigidus*, with infraspecific taxa at the varietal level, and one hybrid taxon. Cherniawsky and Bayer noted that *P. sagittatus* exhibits the greatest marked differentiation in leaf morphology (e.g., lack of lobes or sinuses, and number of teeth) from other North American *Petasites*, but they concluded reproductive morphology and isozymes were not sufficiently differentiated to warrant recognition at the specific level (1998b). Under Cherniawsky and Bayer's (1998b) proposed taxonomic revision, arrowleaf sweet coltsfoot would be assigned the varietal rank of *Petasites frigidus* var. *sagittatus*. The Heritage Identifier for arrowleaf sweet coltsfoot (*Petasites sagittatus* (Banks ex Pursh) Gray) is PDAST71040 (NatureServe 2001). Black Hills specimens belong to *Petasites sagittatus*.

Species Description

Non-Technical

Arrowleaf sweet coltsfoot is a rhizomatous perennial forb that typically flowers before the leaves expand in the spring. Leaf blades are cordate or sagittate, somewhat tomentose, dentate to subentire, and 2 to 35 cm long. Bracts are mostly subequal, in one series, occasionally with a few much reduced ones at the base. The receptacle is naked, and the pappus is of capillary bristles; rays are white or drying yellowish, 7 to 15 mm long, occasionally lacking; disk corollas are 6 to 10 mm long.

Technical

"Plants from elongate rhizomes; flowering stems mostly 2-6.5 dm tall, bearing few to many, alternate, scarious to subherbaceous, often brownish, tomentose to glabrate bracts, more or less white-tomentose; foliage leaves arising directly from the rhizome, the blades mostly 4-23 (to 35) cm long from sinus to apex, 2.5-21 cm broad, hastate to cordate, merely toothed with usually 20 or more teeth per side, green and glabrous or more or less tomentose above, moderately to densely tomentose beneath, the petioles 0.5-40 cm long; heads several to many, the peduncle tomentose and stipitate-glandular or glandless; involucres 7-10 mm high, 12-20 mm broad, the bracts oblong to lanceolate, pubescent basally with multicellular, glandular hairs, the cross-walls mostly colorless; rays small, white." (Welsh 1973). Morphometric analysis of *Petasites* is heavily dependent on leaf morphology, as both staminate and pistillate reproductive features tend to be continuous across North American *Petasites* (Cherniawsky and Bayer 1998a). Arrowleaf sweet coltsfoot exhibits the greatest morphological integrity (e.g., consistency of morphological features and distinction from other members of the genus) of all North American *Petasites* (Cherniawsky and Bayer 1998a).

Species Significance

Although it ranges across the northern portion of the continent, arrowleaf sweet coltsfoot is present in Region 2 only as widely scattered occurrences, as it approaches the southern limits of its range. In the Black Hills, it is restricted to four extant populations, two on BHNF and two on private land (SDNHP 1986, 1988, 1993, and 1994)). As the largest occurrence of arrowleaf

sweet coltsfoot in the state, the Black Fox population may be an important source of genetic diversity, although this has not been documented.

Due to their unique physical characteristics (i.e., acidic, peat-accumulating wetlands), fens and bogs may support assemblages of glacial relict species that have become reduced and isolated during the drying trend since the last Pleistocene glaciation 11,000 years ago (Minnesota Department of Natural Resources 2001). Arrowleaf sweet coltsfoot is also an indicator of a special habitat type (Marriott *et al*. 1999). The spruce fen vegetation provides habitat for wetland wildlife, and creates microtopographic variation that supports other rare plant species at Black Fox Valley Botanical Area, and may influence other rare or relict species (Ode pers. comm. 2001; USDA Forest Service 1997). It is possible there are species, such as butterflies or other invertebrates, mosses or other non-vascular species that are restricted to Black Fox Valley Botanical Area, and are directly or indirectly dependent upon the plant community found there, including arrowleaf sweet coltsfoot (Price *et al*. 1996). Insect pollinators and animal herbivores may utilize arrowleaf sweet coltsfoot as well.

The young flowering shoots may be eaten, and leaves reportedly may be dried and burned to provide a salt substitute (Larson and Johnson 1999). The root of *Petasites frigidus* was reportedly roasted and eaten by Siberian Eskimo (Hulten 1968), and the plant has been used as an expectorant and cough suppressant in Europe (Larson and Johnson 1999). There is no record for the use of arrowleaf sweet coltsfoot as an ornamental species, special forest product, or for other commercial purposes.

Distribution And Abundance

Distribution Recognized In Primary Literature

Arrowleaf sweet coltsfoot ranges from eastern Alaska and southern Yukon east to Labrador and south to Washington, Idaho, Montana, South Dakota, and Colorado (Welsh 1973, Rydberg 1965; Hulten 1968). The species is sympatric (i.e., it is present across the same range) with other North American *Petasites* across Canada, Alaska, and the northern tier of the coterminous United States (Cherniawsky and Bayer 1998a). Arrowleaf sweet coltsfoot is secure throughout its range with a G5 ranking, but infrequent across much of the U.S. with Region 2 state numerical rankings ranging from S1, critically imperiled; to SR, reported (NatureServe 2001). In the Black Hills, Wyoming, and Colorado, arrowleaf sweet coltsfoot approaches the southern end of its range, and generally occurs as scattered, disjunct populations, although it may be locally abundant (SDNHP 1986, 1988, 1993, 1994; Ode pers. comm. 2001; NatureServe 2001). In Montana, arrowleaf sweet coltsfoot occurs in wet places in western and central portions of the state (Dorn 1984).

The Black Hills were not glaciated during the Pleistocene era, and are known to have supported vegetation during that cooler and wetter period when coniferous forests may have linked the Hills with surrounding areas, including the Rocky Mountains to the west (Froiland 1999). The preference of arrowleaf sweet coltsfoot for spruce fens and other cold wetland communities, and its distribution across the northern portion of the continent is consistent with a species that may have ranged farther south and at lower elevations during the Pleistocene. As the climate became warmer and drier, such relict species became more restricted and isolated in their range. Arrowleaf sweet coltsfoot occurs in moist sites, usually bogs, fens, marshes, swamps, or other

wet places in wooded regions from eastern Alaska and across Canada, and south to South Dakota and Colorado, but is most common in the central Canadian provinces of Alberta, Ontario, Saskatchewan, and Manitoba (NatureServe 2001; USDA NRCS 2001; Welsh 1973). The geographic range of arrowleaf sweet coltsfoot parallels that of *P. frigidus* var. *palmatus*, although arrowleaf sweet coltsfoot extends into Alaska, but not California (Cherniawsky and Bayer 1998b). The species' distribution is presumably due to an obligate association with cold climates and wet environments. Its scattered distribution in the Rocky Mountains and Black Hills is likely the result of the geographic isolation of wetland habitats in these regions during the current inter-glacial drying trend (Froiland 1962; Price *et al*. 1996). The species was presumably more widespread historically. The species' reported habitats in the Rocky Mountains are similar to those found at Black Fox Valley Botanical Area (i.e., open or shaded, boggy, low-lying habitats along streams, often with peaty substrate) (Ackerfield 2001; SDNHP 1986, 1988, 1993, 1994). The currently known metapopulation of arrowleaf sweet coltsfoot in the Black Hills is comprised of three populations in Lawrence County and one in Pennington County. Given the relatively close proximity of the South Dakota populations, it is likely that genetic exchange occurs between populations in the state. It is not known if there is any genetic exchange with other locations in the region, but it is probably limited since the nearest populations to the Black Hills are over 100 miles distant.

Additional Information From Federal, State, And Other Records

In Wyoming, the species is no longer tracked by the state Heritage Program since a large number of populations were located in wetland habitats in the Laramie Range (Fertig pers. comm. 2001). The Atlas of the Flora of Wyoming (Figure 2) depicts arrowleaf sweet coltsfoot occurrences in the Laramie Range of Albany County near Laramie, and in the Absaroka Range in Park County (Dorn 1992; University of Wyoming 1998).

In Colorado, arrowleaf sweet coltsfoot occurs in wet areas, from 7970 to 9700 feet, in Gunnison, Jackson, Saguache, Larimer, and Summit counties (Ackerfield pers. comm. 2001). The species is not tracked by the state Heritage Program (Spackman pers. comm. 2001).

The first report of arrowleaf sweet coltsfoot in South Dakota was in 1892 by Rydberg on marshy ground along Rapid Creek above Rochford, in the vicinity of Solomon Gulch, an area that is now within the BHNF (SDNHP 1994). Another population reported in 1928 on private land has not been observed since and is believed to have been lost from the site, although the site continues to offer suitable potential habitat (SDNHP 1986). The four currently known extant occurrences of arrowleaf sweet coltsfoot in South Dakota are restricted to wetland habitats in the Black Hills, Lawrence and Pennington counties (SDNHP 1986, 1988, 1993, and 1994). Black Hills population elevations range from approximately 5150 to 5820 feet (SDNHP 1986, 1988, 1993, and 1994).

Local Abundance

There are five Element Occurrence (EO) records for southwestern showy sedge in South Dakota, three on private land, and two on the BHNF (SDNHP, 1973, 2000, 2001). These occurrences reportedly range up to 2 to 3 acres in size, with population estimates including "several clones", "common", "local patches" and, at Black Fox Valley Botanical Area, "several thousand leaves". No other information regarding reproductive status of the plants was reported. The following

table provides additional details.

Element Occurrence (EO) Summary

EO code#	EO date, Location, Comments and Habitat
PDAST71040*001*SD	First observed 7/29/1983. Last observed by Glisson 10/4/2001. BHNF. Best currently known EO for *P. sagittatus,* occurs in swampy spruce forest on SE side of Rapid Creek extending along base of NW facing slope, in moist spruce understory with *Carex disperma* and *C. leptalea.* Several thousand leaves observed, elevation 5850 feet.
PDAST71040*002*SD	First observed 7/17/1986. Last observed by Glisson 10/4/2001. Private land 11 air miles SE of Lead, previously known as Camp Paha Sapa, elevation 5275 feet. Along S side of Boxelder Creek. Several clones among scattered spruce along creek bank and in seepage area at base of N-facing slopes. In saturated organic substrate with *Equisetum, Calamagrostis, Glyceria,* and *Carex*.
PDAST71040*003*SD	First observed by McIntosh 8/20/1928 (# 113165 RM Herbarium). Occurred on private land in a mossy bog one mile north of Bulldog Ranch, elevation 5900 feet. Not relocated during 1986 field survey, presumed destroyed although habitat is still present. Previously listed as common.
PDAST71040*004*SD	First observed and collected by Rydberg in 1892 (# 821). Last observed Aug. 1994. BHNF, elevation 5413 feet. Local patches in marshy ground along Rapid Creek above Rochford (Solomon Gulch site).
PDAST71040*005*SD	First observed 8/10/1988. Black Fox Meadow, 6 miles west of Rochford, elevation 5800 feet. Located on private land along stream and in streamside wetland just below road on N side of valley. Several large clones in saturated soil and shallow water with *Calamagrostis, Agrostis,* and *Carex rostrata.* Trampled by cattle.

Surveys for additional occurrences of arrowleaf sweet coltsfoot are conducted on an ongoing basis in the South Dakota and Wyoming portions of Black Hills National Forest. The restricted occurrence of arrowleaf sweet coltsfoot in the Black Hills may be due to naturally limited habitat availability, although other apparently suitable habitat is present in Black Fox Valley (Ode pers. comm. 2001). The long-term persistence of arrowleaf sweet coltsfoot in the Black Hills is likely dependent upon a stable climate, and the continued maintenance and enhancement of existing populations, especially in the Black Fox Valley Botanical Area. The species' ability to disperse elsewhere in the Black Hills may be determined by the quality and extent of suitable wetland habitats.

Population Trend

No specific population trend monitoring data is available for arrowleaf sweet coltsfoot in Black Hills National Forest, although an occurrence first noted by Rydberg in 1892 is still extant. An occurrence in a mossy bog one mile north of Bulldog Ranch (private land), first reported by McIntosh in 1928, was not relocated during a 1986 field survey. This occurrence is presumed destroyed although habitat is still present.

Broad Scale Movement Patterns

The Black Hills populations of arrowleaf sweet coltsfoot are over a hundred miles away from the nearest populations, which are in southeast Wyoming and northern North Dakota. Arrowleaf sweet coltsfoot seeds or pollen may be expected to travel considerable distance via wind transport, but natural transfer of seed material from other arrowleaf sweet coltsfoot populations outside of the Black Hills is probably limited. Water transport is conceivable on a localized basis, but not likely as a means of long range transport, especially in the absence of direct transfer routes. Migratory birds, wind, or insects may represent likely modes of transfer under present climatic conditions. The disjunct Black Hills populations of arrowleaf sweet coltsfoot may be an important source of genetic diversity, but this is not documented. If the Black Hills populations were extirpated, it is unlikely that natural recolonization would occur.

Habitat Characteristics

Arrowleaf sweet coltsfoot is an obligate wetland species (USDI FWS 1988) that occurs predominantly in boreal regions where it occupies bogs, marshes, fens, marshy tundra, alluvial flats, roadside ditches and disturbed sites such as clearcuts, at low to high-elevations (Hulten 1968; Rydberg 1965; Scoggan 1979; Cherniawsky and Bayer 1998b). Arrowleaf sweet coltsfoot appears to require cold, wet conditions, and is currently limited in the Black Hills to open or shaded boggy, low-lying habitats along streams, often with peaty substrate. It exhibits a preference for similar conditions where it occurs in Wyoming, Montana, and Colorado (Dorn 1984; Dorn 1992; Larson and Johnson 1999; Ackerfield 2001). In Wyoming, the species usually occurs on very wet soils in shade of aspen or white spruce (Fertig pers. comm. 2001). Black Hills population elevations range from approximately 5150 to 5820 feet (SDNHP 1986, 1988, 1993, and 1994).

The BHNF arrowleaf sweet coltsfoot populations at Black Fox Valley Botanical Area and Solomon Gulch occur within the Cordeston-Marshbrook loams, 0 to 6 percent slopes (thick Mollisols), a soil map unit typical of mountain meadows in the Crystalline Core area of the Black Hills (USDA SCS 1990). These wetland environments may meet the Histic requirements, but there are no Histosol inclusions defined for the Black Hills, and neither of the locations have been sampled (Cooley pers. comm. 2002). Sediments from disturbances that expose upstream hillsides to erosional forces typically collect in valley bottoms, and more sediment deposition would likely have occurred along Rapid Creek when beaver were active in the area (Olson and Hubert 1994).

The acidic, iron-rich springs and surface water in the Black Fox Valley Botanical Area fen have contributed to a suite of boreal plant species including numerous acid-loving species including *Sphagnum* and members of the Ericaceae (Reyher pers. comm. 2001). Ericaceous species are common in acidic, nutrient depleted environments (Walters and Keil 1996). The plant

community at Black Fox Valley Botanical Area possesses an organic substrate comprised of decaying *Sphagnum* moss typical of boreal wetlands (Mitsch and Gosselink 1993; Illinois State Museum 1992). Similar wetland features are common elsewhere in the Black Fox Valley (Ode pers. comm. 2001). While some arrowleaf sweet coltsfoot populations elsewhere reportedly occur in bogs and fens, it is also reported from a variety of other wet habitats including swamps and meadows. The Black Fox area lies immediately downstream from several major springs at the contact of the Limestone Plateau and Central Core. Much of the water at Black Fox probably comes from the complicated underground systems of the Limestone Plateau (Marriott pers. comm. 2001).

The effect of fire as a disturbance factor on arrowleaf sweet coltsfoot in Black Fox Valley Botanical Area is unclear, although it may be a fire neutral species (Ode pers. comm. 2001). Many bog and fen habitats appear to be relatively constant environments and may not be routinely affected by physical disturbance such as fire or fluvial action. In the case of Black Fox Botanical Area, the fen may not be regularly affected by annual fluvial disturbance (i.e., erosion and deposition processes), although it is possible the area is periodically inundated by high stream flows during snow melt runoff or large storm events. See REVIEW OF TECHNICAL KNOWLEDGE, Response To Habitat Changes, *Management Activities* – Prescribed Fire and Fire Suppression for further discussions of fire effects.

Total annual precipitation at nearby Hill City, South Dakota, averages 20.43 in (51.89 cm), with average monthly temperatures ranging from 22.7 (-5.2 C) (January) to 63.6 F (17.5 C) (August); precipitation is concentrated in the early summer months from May (3.55 in; 9.02 cm) through July (3.43 in; 8.71 cm); first frost is in early to mid-September and last frost in early to late June; average total annual snow fall is 60.0 in (152.4 cm); and extreme temperatures from 1955-2000 ranged from minus -40 to 100 F (-40.0 to 37.8 C) (High Plains Regional Climate Center 2001). The Hill City reporting station is at an elevation of approximately 5000 feet, or 275 to 900 feet lower than occurrences of arrowleaf sweet coltsfoot, suggesting that colder, wetter conditions may exist in occupied habitat.

In the Black Hills, Colorado, and Wyoming, arrowleaf sweet coltsfoot appears to be limited to wet locations at mid to high elevations (Dorn 1984; Dorn 1992; Ackerfield 2001). Arrowleaf sweet coltsfoots' habitat requirements in this portion of its range could be due to arid conditions or other factors and may be different from its habitat needs to the north (Ode pers. comm. 2001). Unoccupied potential habitats for arrowleaf sweet coltsfoot occur in the Black Hills and in the intermediate areas between populations along the Rocky Mountains from Montana to southern Colorado. The reasons for the species absence from these habitats may be due to highly specific micro-site requirements, eradication due to human activities, dispersal limitations, the absence of beaver or other disturbance that facilitates plant establishment, or habitat needs that have yet to be discovered.

The species' limited distribution is probably at least in part due to the cumulative effects of human activities on wetlands and the resulting trend toward geographically isolated wetland habitats. Overall, it appears that the species' distribution is dependent on a combination of climatic and hydrologic conditions (e.g., cold, wet habitats).

Demography

Life History Characteristics

Arrowleaf sweet coltsfoot is a native perennial obligate wetland forb associated with bogs, marshes, fens, and other wet habitats across its range (USDA NRCS 2001). As in all North American *Petasites*, the plants are polygamodioecious (i.e., separate fertile pistillate and staminate inflorescences occur on the same plant) with flowering inflorescences emerging before the leaves (Cherniawsky and Bayer 1998b). As an obligate wetland species, it presumably exhibits a high tolerance to anaerobic conditions. The flowering period is mid spring to early summer across its range (Rydberg 1965; Hulten 1968; McGregor; Welsh), and May to June in South Dakota (Van Bruggen 1976; Larson and Johnson 1999). As a northern boreal species, it may require cold stratification for seed germination.

Arrowleaf sweet coltsfoot produces inflorescences which appear before the leaves, and separate male and female inflorescences are borne on the same plants (Cherniawsky and Bayer 1998b). Arrowleaf sweet coltsfoot's flowering time overlaps with several other *Petasites* species in its range, although no other *Petasites* are known from South Dakota (Rydberg 1965; Hulten 1968; Ode pers. comm. 2001).

Arrowleaf sweet coltsfoot reportedly has hybridized with *P. frigidus* var. *palmatus* (Cherniawsky and Bayer 1998b). The resulting intermediate species, *P. x vitifolius* Greene (pro sp.) (Rhodora 70: 548. 1968), is recognized as a hybrid (Cherniawsky and Bayer 1998b). *P. x vitifolius* frequently grows in association with its parental species, in wooded habitats with *P. frigidus* var. *palmatus*, and in wet, marshy conditions preferred by arrowleaf sweet coltsfoot (Cherniawsky and Bayer 1998b). According to Cherniawsky and Bayer (1998b) "the geographical range of the hybrid is somewhat more extensive than the zone of sympatry of its parental taxa, …, but is less extensive than either parent". The known range of the hybrid extends southward from the prairie provinces of Canada to Washington and the northern portions of Michigan, Wisconsin, and Minnesota (Cherniawsky and Bayer 1998b).

Survival And Reproduction

Separate, fertile pistillate and staminate heads typically occur in the same inflorescence (Van Bruggen 1976). As a rhizomatous species, arrowleaf sweet coltsfoot is probably able to expand or shift population locations in response to subtle changes in groundwater availability and is apparently able to withstand periodic drought conditions. The Rochford population has apparently withstood severe regional drought conditions such as the historical drought of the 1930's in the Great Plains. Presumably, prolonged drought conditions that drastically reduce water table elevations would be significant stressors to this species.

Arrowleaf sweet coltsfoot appears to tolerate full sun as well as more shaded locations in wetland forest understories (Cherniawsky and Bayer 1998b; SDNHP 1993; Larson and Johnson 1999). Disturbance driven models may be less applicable to arrowleaf sweet coltsfoot and other species adapted to relatively stable environments such as bogs, swamps, and fens. As noted earlier however, the fen at Black Fox Botanical Area may be subject to occasional inundation from overbank flooding of Rapid Creek. As an obligate wetland species, arrowleaf sweet coltsfoot requires continued access to the water table.

As with many Asteraceae, arrowleaf sweet coltsfoot may be pollinated by a variety of insects (Walters and Keil 1996). As a semi-precocious species, wind pollination may also represent a viable form of pollination in arrowleaf sweet coltsfoot since physical obstruction from fully

expanded leaves is less likely. The present geographic isolation of Black Hills' arrowleaf sweet coltsfoot populations from the nearest locations in Wyoming, Colorado, North Dakota, and Montana would appear to prohibit any interbreeding between them, although there is the limited possibility of seed or pollen transfer via birds or air masses. Arrowleaf sweet coltsfoot does not reportedly form hybrids with any other species known from the Black Hills.

Local Density Estimates

Population estimates for arrowleaf sweet coltsfoot at Black Fox Valley Botanical Area were last reported as several thousand leaves (SDNHP 1993). The other BHNF occurrence is reported to consist of local patches (SDNHP 1994). Population estimates for private land occurrences include several clones and several large clones (SDNHP 1986, 1988).

Limiting Factors

Arrowleaf sweet coltsfoot's apparent affinity for wet habitats in cold regions is undoubtedly a major limiting factor since these features are relatively rare in the Black Hills. Arrowleaf sweet coltsfoot occurs in, but is not restricted to iron rich acidic fens in this part of its range. Acidic fens are extremely limited features in the Black Hills. In addition, in this portion of arrowleaf sweet coltsfoot's range, the distribution and character of riparian and wetland habitats are strongly influenced by fire, flooding, and beaver-created disturbances (Parrish *et al*. 1996). Wetland habitats are often enhanced by the removal of encroaching conifers, increased groundwater flow from scorched uplands, and by the flooding, sediment deposit, and other disturbances created by beaver during dam building. These disturbance factors may be important to arrowleaf sweet coltsfoot's long-term persistence in the Black Hills, and to its ability to occupy potential habitats, but no specific information is available in the literature.

Long-term climate and hydrological changes since the last Pleistocene glaciation, and the more recent decline in beaver have resulted in a reduction in the amount of habitat available to wetland species throughout North America. It is possible that arrowleaf sweet coltsfoot was more widely distributed prior to European settlement, and the disjunct and isolated distribution that exists today is in part due to human impacts on the abundance and distribution of wetland habitats in North America. In the Black Hills and Rocky Mountains, the natural disturbances that benefit wetlands, such as fire and beaver activity, have been reduced or eliminated (Parrish *et al*. 1996; Price *et al*. 1996). At the same time, timber production, mining, livestock grazing, agricultural use, and extirpation of beaver since the late 1800s have resulted in a sharp downward trend in the quantity and distribution of wetland habitat (Parrish *et al*. 1996).

Metapopulation Structure

Although no specific information is available, the size and density of the overall arrowleaf sweet coltsfoot population at Black Fox Valley Botanical Area appears to have remained fairly stable in recent times (Ode pers. comm. 2001). However, the apparent loss of a population on private land since 1928 suggests that existing populations may be at risk due to land use practices or other factors.

As regional disjuncts, the Black Hills populations are inherently less secure than populations in the core range of the species, although they have likely persisted since the last glacial period. If populations in the Black Hills area were extirpated, it is unlikely that natural recruitment from

other extant stands would occur.

Propagation Or Cultivation

Petasites species have been successfully propagated from seed (Cherniawsky and Bayer 1998b) and direct planting of rhizomes may also offer an effective means of propagation.

Community Ecology

Browsers Or Grazers

Grazing and browsing can have both direct and indirect negative effects on many species (Hoffman and Alexander 1987). Browsing by deer, elk, insects, or livestock can reduce photosynthetic tissues and plant viability, particularly where the plant is already stressed. Livestock may directly impact a variety of species, and possibly arrowleaf sweet coltsfoot, by browsing or trampling plants, and indirectly by altering the microtopography and nutrient dynamics of the species' habitats (USDA Forest Service 2000). Arrowleaf sweet coltsfoot does not appear to be especially palatable to cattle (Ode pers. comm. 2001). Direct physical disturbance and transport of noxious weed propagules by livestock and large wildlife ungulates may pose an additional risk to arrowleaf sweet coltsfoot habitat. Livestock use is presently permitted in Black Fox Valley Botanical Area, as cattle from the Wolff Allotment on the Northern Hills District may access the bottomlands along Rapid Creek, since the allotment boundary along the north side of Forest Service Road 231 is not fenced (Luhrsen pers. comm. 2001).

Competitors

The literature contains no specific references to competitive interactions that would limit the distribution of arrowleaf sweet coltsfoot in any portion of its range. Because arrowleaf sweet coltsfoot prefers wet habitats, some interspecific competition with other wetland species is likely. Arrowleaf sweet coltsfoot is presumably subject to the same risks as other native wetland plants from competitive exclusion by invasive wetland weed species. Invasive wetland weeds such as purple loosestrife and Canada thistle may disrupt wetland ecosystems by rapidly overtaking native species and may out-compete woody plants as well.

Canada thistle, a noxious weed, is present across many Black Hills riparian and wetland communities, but high soil moisture levels and anaerobic conditions preferred by arrowleaf sweet coltsfoot may discourage Canada thistle advancement into arrowleaf sweet coltsfoot habitat. Canada thistle is presently known from Black Fox Botanical Area and the Solomon Gulch area. Although Canada thistle may be locally dense in these areas, it occurs on drier, upland areas, but not in the boggy areas that support arrowleaf sweet coltsfoot (Lynch pers. comm. 2002). Refer to Section REVIEW OF TECHNICAL KNOWLEDGE – Risk Factors for an additional discussion of weeds.

Parasites, Disease, And Mutualistic Interactions

No information is available.

Other Complex Interactions

Beaver may facilitate the establishment and persistence of arrowleaf sweet coltsfoot by creating flood disturbance and saturated wetland conditions (Olson and Hubert 1994), particularly in the arid western portions of the species' range. Even in more mesic, boreal regions of North America, beaver exert a strong influence on the quantity and quality of wetland habitats (Naiman *et al*. 1988). For this reason, it is likely that the metapopulation dynamics of arrowleaf sweet coltsfoot in the Black Hills are linked to the recent and historic distribution and abundance of beaver. In general, the long-term benefits beaver provide to arrowleaf sweet coltsfoot by creating and enhancing wetland habitats would appear to outweigh any potential short-term impacts to individuals or populations, with the possible exception of potential adverse effects that may result from flooding and inundation of the largest population at Black Fox Valley Botanical Area.

Both biotic and abiotic disturbances may play a significant role in the distribution and abundance of arrowleaf sweet coltsfoot. Natural disturbances such as periodic insect outbreaks and fire benefit the species by the increased groundwater flow that results from the death of upland trees. Fire also serves to maintain the open character of wetland habitats and facilitates the regeneration of hardwoods favored by beaver. By damming and flooding lowlands, beaver effectively exclude invading tree species, raise local water tables, expand wetlands and create both large and small-scale soil disturbance (Olson and Hubert 1994). These actions may directly create and/or enhance habitats for a variety of wetland species, although there is no specific information available for arrowleaf sweet coltsfoot. Where suitable habitat conditions exist, arrowleaf sweet coltsfoot may be expected to quickly recover from beaver disturbance via rhizome expansion into adjacent habitat. In general, natural disturbances that reduce upland tree densities, or facilitate hardwood regeneration (e.g., aspen) and thereby beaver activity, will likely enhance arrowleaf sweet coltsfoot's occupied and potential habitats. The successional relationships and disturbance ecology of arrowleaf sweet coltsfoot are not well understood at this time, although the species may be fire neutral (Ode pers. comm. 2001). The large arrowleaf sweet coltsfoot population in the iron fen along Rapid Creek suggests the species is adapted to peaty, acidic, high iron conditions. However, this does not appear to be an exclusive requirement in the Black Hills or other portions of the species' range.

The specific habitat preferences for arrowleaf sweet coltsfoot are unknown, but the species is known to occur under a variety of lighting conditions, from full sunlight to heavy shade. The reported occurrences of arrowleaf sweet coltsfoot populations in disturbed areas, such as along roads and in clearcuts, suggest the species may also be adapted to early seral conditions, including low canopy, high light conditions. As a result, human induced disturbances, such as road cuts, through otherwise late seral communities may potentially offer limited benefits by providing new recruitment opportunities for the species. However, reports of other occurrences in wooded settings across its range suggest that arrowleaf sweet coltsfoot may also be well adapted to low light understory conditions associated with later seral, forested wetlands such as spruce bogs or fens, including the Black Fox Botanical Area. Ode observed that arrowleaf sweet coltsfoot leaves wilted under direct sunlight in exposed locations on private land below the Botanical Area (Ode pers. comm. 2001).

Risk Factors

The primary ecological stressors (i.e., risk factors ranked from highest to lowest) to arrowleaf sweet coltsfoot in the Black Hills appear to be climate change (i.e., warmer and drier conditions),

impacts to local hydrology, competition from weedy species, and predation by wildlife. Because arrowleaf sweet coltsfoot is an obligate wetland species, factors that impact wetland hydrology, reduce or eliminate flooding and fire, or further impact beaver activity (i.e., continued dominance by later seral communities with dense spruce and limited hardwoods), may have negative effects on its long-term persistence in the Black Hills (refer to REVIEW OF TECHNICAL KNOWLEDGE, Response To Habitat Changes – Management Activities and Natural Disturbances). Potential exists for water diversion or development on land upstream from the Black Fox Valley Botanical Area, such as road realignment, pavement, and culverts, that could negatively affect the flow of water from streams, springs and seeps, lower the water table, and limit beneficial beaver activity in the drainage. In addition, short and long-term droughts may reduce water availability to the site.

Noxious weeds and other invasive species pose a serious risk to arrowleaf sweet coltsfoot on BHNF. Canada thistle (*Cirsium arvense*), a noxious weed, is present across many Black Hills riparian and wetland communities, but high soil moisture levels and anaerobic conditions preferred by arrowleaf sweet coltsfoot may discourage Canada thistle advancement into arrowleaf sweet coltsfoot habitat. Canada thistle is presently known from Black Fox Botanical Area and the Solomon Gulch area. Although Canada thistle may be locally dense in these areas, it occurs on drier, upland areas, not in the boggy areas that support arrowleaf sweet coltsfoot (Lynch pers. comm. 2002). Although purple loosestrife does not occur at in the Black Fox Valley Botanical Area, it has been documented along Rapid Creek near Rapid City, South Dakota and poses a potentially serious risk to the rare wetland species if it were somehow introduced to the Botanical Area (Ode pers. comm. 2001). If purple loosestrife were to invade Black Fox Valley Botanical Area, it has the potential to out-compete riparian natives, and could represent a significant competitive risk to the arrowleaf sweet coltsfoot populations. The occurrence of noxious weeds may also restrict the ability of arrowleaf sweet coltsfoot to disperse into other wetland habitats. Herbicides are potentially detrimental to arrowleaf sweet coltsfoot and other rare plant species in the Black Fox Valley Botanical Area, water quality, and herbaceous species, so broadcast spraying would not be appropriate at Black Fox Valley Botanical Area. Individual plant treatments, via hand-pulling or direct application of herbicides may offer viable approaches for controlling noxious weeds.

Black Fox Campground is immediately adjacent to *Petasites* habitat, and current recreational use has some, if minimal, impacts in the form of soil compaction from trails, trampling of plants, etc. (Ode pers. comm, 2001). Expansion of this campground could have negative impacts on this *Petasites* population, but the Forest Service has no plans to expand this campground or increase its usage (USDA Forest Service 1997).

Prolonged regional warming and or drying trends may pose a risk to arrowleaf sweet coltsfoot populations if site hydrology is sufficiently altered.

The apparent loss of a population on private land since 1928 suggests that existing populations may be at risk due to land use practices or other factors. Arrowleaf sweet coltsfoot's wetland habitats on private lands may be at risk from agricultural land use and development.

Response To Habitat Changes

Management Activities

Management activities that mimic natural disturbances, such as prescribed fire or thinning of upland forests, may enhance arrowleaf sweet coltsfoot habitats in the Black Hills and elsewhere. Direct disturbances from trail, road, or highway construction, mining, or off-road vehicle use are all potentially detrimental to arrowleaf sweet coltsfoot and the structure and integrity of its wetland habitats. Road construction can impact wetlands directly and/or by altering local hydrological features, such as springs and seeps. In addition, roads, trails and highways facilitate the introduction of noxious weeds into wetland habitats. Conversely, these disturbances may potentially offer limited benefits by providing opportunities for new recruitment.

Timber Harvest

Any future proposed vegetation management treatments on lands adjacent, or upgradient, to the Botanical Area could include vegetation treatments to benefit the habitat, and will be evaluated to minimize any potential adverse effects to arrowleaf sweet coltsfoot (Luhrsen pers. comm. 2001). The reported occurrences of arrowleaf sweet coltsfoot in clearcut areas in other portions of its range may suggest that the species may benefit from this form of disturbance. However, specific habitat responses, impacts, or benefits are not known for certain, and may not be applicable to Black Hills occurrences.

Recreation

Potential impacts due to recreational activities include trampling, alteration of runoff patterns, introduction of noxious weed propagules, and pollution. Off-road motor vehicle travel is prohibited in the Black Fox Valley Botanical Area, but is allowed in the vicinity of Solomon Gulch where the other BHNF occurrence of arrowleaf sweet coltsfoot is located. Recreational impacts associated with off-road vehicles and snowmobiles in the vicinity of the Solomon Gulch population are expected to be minimal given the steep topography in the area (Luhrsen pers. comm. 2001).

Livestock Grazing

Livestock may impact streamside communities through the effects of their grazing, trampling, resting, and trailing (Hoffman and Alexander 1987). Livestock and large wildlife ungulates may also introduce noxious weeds. Livestock grazing is presently permitted in Black Fox Valley Botanical Area as cattle from the Wolff Allotment on the Northern Hills District may access the bottomlands along Rapid Creek, since the allotment boundary along the north side of Forest Service Road 231 is not fenced (Luhrsen pers. comm. 2001). High populations of native ungulates, such as elk or deer, may increase the level of herbivore impacts on palatable browse species (Hoffman and Alexander 1987; Price *et al*. 1996). High numbers of elk, white-tailed, and mule deer typically over-winter in the valley bottom locations in and around the Black Fox Valley Botanical Area and Solomon Gulch (Lynch pers. comm. 2002). Although adverse impacts to arrowleaf sweet coltsfoot populations in Black Fox Valley Botanical Area or Solomon Gulch have not been documented, many meadows in these valley bottom locations are heavily browsed, especially during the winter months (Lynch pers. comm. 2002).

Mining

Mining is not permitted in Black Fox Valley Botanical Area or near Solomon Gulch, although neither area has been withdrawn from mineral entry (Luhrsen pers. comm. 2001). There are

rather extensive bog-iron deposits along the valley bottoms of upper Rapid Creek (both forks) and there has been historical mining activity in the area. DeWitt, *et al*. (1986) report that these bog-iron deposits constitute the third largest reserve of iron in the Black Hills. The ore is estimated at 500,000 tons averaging 25-26% iron. However, DeWitt, *et al*. (1986) noted that "because the environmental damage caused by mining is high in the mountain meadows, the bog-iron deposits probably will not be extensively exploited in the near future".

According to Ode (pers. comm. 2001), "Of equal or greater threat are the precious metal deposits (gold with silver & arsenic as byproducts) that underlie this portion of the Black Fox Valley (depicted as map area "C7" on Plate 2 in DeWitt, *et al*. 1986). The USGS Report maps and ranks the potential of various mineral resources in the Black Hills. For this map unit "C7" which includes the Black Fox Valley, the resource potential is rated as "High" with a "High" level of certainty.

The prospect of mining in the Black Fox Valley may be remote, but a Botanical Area designation is not a significant obstacle to mining under the 1872 Mining Act, unless the area has been specifically withdrawn from mineral entry. Furthermore, mining of private lands in or near the Black Fox Valley could have significant effects on the hydrology of the area which could in turn have deleterious effects on *Petasites"*.

Prescribed Fire

Management activities exert a strong influence on wetland hydrology throughout the Black Hills. In other wetland resource areas (e.g., McIntosh Fen Botanical Area) the lack of fire and other disturbances in the surrounding uplands has resulted in an increased density of trees, reduced groundwater flow into wetland areas, restricted the regeneration of aspen and other hardwoods, and has effectively excluded beaver from returning to the site. The same conditions are likely to occur in arrowleaf sweet coltsfoot's potential habitats in the Black Hills, where the lack of natural disturbance may have reduced or eliminated the species' ability to become established. Fire as a management tool in the Black Fox valley bottom itself may be of questionable value as it's unclear if fire was a significant disturbance factor in this wetland environment historically. No prescribed fires are planned in the vicinity of known populations of arrowleaf sweet coltsfoot (Luhrsen pers. comm. 2001).

Fire Suppression

Typically in the Black Hills, and other western riparian areas, large scale erosional disturbances may result from fires followed by significant precipitation. Wildfires on the Mystic Ranger District are generally controlled as soon as possible, and existing wildfire suppression policies are likely to continue in the future (Luhrsen pers. comm. 2001). Considering arrowleaf sweet coltsfoot's preference for wet environments and rhizomatous growth form, occasional, low intensity burns that are not capable of burning the peat substrate are not likely to kill existing plants. Fires in the vicinity of arrowleaf sweet coltsfoot populations would probably be of low intensity, except under drought conditions.

Non-Native Plant Establishment And Control

There is no specific information available on this topic for arrowleaf sweet coltsfoot, although it may not compete well with aggressive species capable of exploiting its habitat such as Canada

thistle (*Cirsium arvense*) and purple loosestrife (*Lythrum salicaria*). Canada thistle occurs as relatively minor infestations in the vicinity (Luhrsen pers. comm. 2001).

Fuelwood Harvest

Fuelwood harvest is not allowed in Black Fox Valley Botanical Area, dead and down harvest is allowed elsewhere by permit.

Road Construction

Road construction is not allowed in Black Fox Valley Botanical Area, and not likely in vicinity of Solomon Gulch (Luhrsen pers. comm. 2001).

Other

Collection of plant specimens is not likely to pose a risk. Although the species may appeal to some amateur botanists, it is not likely to be sought by the general public.

Natural Disturbance

Insect Epidemics

No information is available.

Wildfire

No information is available, but arrowleaf sweet coltsfoot is presumed to be capable of resprouting from rhizomes after low intensity fires. Indirectly, wildfires that kill upland conifers might benefit arrowleaf sweet coltsfoot through enhanced water yield, although the precise role of fire in Black Hills ecology remains a controversial topic.

Wind Events

Wind events are not expected to pose a significant risk to arrowleaf sweet coltsfoot and may actually benefit the species by toppling woody species that may encroach into potential habitat and creating new opportunities for establishment.

Flooding

Arrowleaf sweet coltsfoot is apparently adapted to and dependent on inundation and/or saturated soils. Adverse impacts due to destructive floods are unlikely due to the off-channel position and relatively high position in the watershed of much of the occupied habitat.

Other Events

Prolonged drought may adversely impact arrowleaf sweet coltsfoot.

REVIEW OF CONSERVATION PRACTICES

Management Practices

The Black Fox Valley Botanical Area was designated in 1997 and is administered by the Mystic Ranger District, Black Hills National Forest (USDA Forest Service 1997; Luhrsen pers. comm. 2001). No specific management practices have been applied in the Black Hills or elsewhere for arrowleaf sweet coltsfoot. Many potentially beneficial management practices are already incorporated in the Forest Management Plan for the Black Fox Valley Botanical Area Botanical Area, arising from a central theme to "protect unusual or special characteristics" (USDA Black Hills National Forest 1996). This includes restrictions on roads, timber harvest, livestock grazing, and mineral development (as discussed in Section J), thereby minimizing impacts to existing rare plant populations. Restoration of "fire to its natural role in the ecosystem" on surrounding uplands may improve water yield and site hydrology in the fen where arrowleaf sweet coltsfoot occurs and potentially create new recruitment sites (USDA Black Hills National Forest 1996). However, the Black Fox area lies immediately downstream from several major springs at the contact of the Limestone Plateau and Central Core, and much of the water at Black Fox probably comes from the complicated underground systems of the Limestone Plateau (Marriott pers. comm. 2001). In order to improve water yield at the site, it would be necessary to know which uplands to burn, and the area might need to be quite large to have an appreciable effect.

In general, conservation management of wetland species involves conserving water sources, potentially changing livestock management or numbers of large wild ungulates, providing open habitat for colonization, establishing seedlings or cuttings, and prescribed burning (Price *et al*. 1996). In bog or fen habitats, conservation requires the maintenance of groundwater flow, water chemistry, and the structure and integrity of the vegetation (Reed 1985). Because the sources of groundwater flow and recharge areas for fens are often difficult to determine, management activities may need to focus on adjacent land use so that sources of groundwater draw down and/or contamination may be eliminated or reduced (Reed 1985). Agricultural activities such as fertilization or drainage, and construction of impermeable surfaces (e.g., parking lots) in recharge zones may alter the quality and/or quantity of water entering the fen (Reed 1985). Ditching for drainage or utilities in the vicinity of bogs or fens can be detrimental due to direct impact on the flow and quality of groundwater (Reed 1985).

Non-administrative vehicles and off-road vehicles are restricted from the Black Fox Valley Botanical Area Botanical Area and are not expected to harm the arrowleaf sweet coltsfoot population near Solomon Gulch due to extremely limited activity in the area as a result of steep terrain (Luhrsen pers. comm. 2001).

Prescribed burning is widely recommended for the conservation of wetland vegetation (Reed 1985; SDDGFP 1992), but no prescribed burns are planned for the Black Fox Valley Botanical Area or vicinity of Solomon Gulch (Luhrsen pers. comm. 2001).

While no specific information is available regarding arrowleaf sweet coltsfoot, it is likely that burning may topkill stems and leaves, but the root crowns and rhizomes will probably resprout, and the plant may return to pre-burn numbers within several years. In the Black Hills region, historic fires occurred most often late in the growing season (Brown and Sieg 1996, 1999). Riparian and wetland habitats in the region remain moist and green throughout most of the growing season, and therefore are not likely to burn until vegetation has cured and soil moisture decreases (Sieg 1997; Sieg and Wright 1996). Although published information on the effect of fires is limited, many wetland habitats in the region most likely evolved with severe fire

disturbances in the past (Parrish *et al*. 1996; Sieg and Severson 1996; USDA FS RMRS 2001).

Arrowleaf sweet coltsfoot is a species that may respond favorably to beaver activity (Ode pers. comm. 2001). Beaver populations in the upper portion of the Rapid Creek drainage have been doing well in recent years, but available habitat and hardwood resources in the Botanical Area and downstream areas are limited due to encroachment of conifers into aspen and birch stands (Luhrsen pers. comm. 2001). It is possible that prescribed fire or removal of conifers from these areas may promote further recovery of hardwood stands and beaver populations in the valley, improve water yield, and provide recruitment opportunities for a variety of wetland species, including arrowleaf sweet coltsfoot.

The critical role of fire as a natural disturbance mechanism at the landscape scale has been clearly defined in the Black Hills and elsewhere, although the specifics in terms of intensity and return frequency remain controversial topics. However, the natural role of fire in cold, wet, otherwise stable micro-environments such as Black Fox Valley Botanical Area is less clear and prescribed fire should be approached with caution and only after other efforts such as conservation and enhancement of site hydrology have been undertaken and evaluated (Ode pers. comm. 2001). It's possible that other variables such as frost heaving or water chemistry fluctuations over periods of drought may function as disturbance factors to create available habitat or serve as environmental triggers for seed germination. Considering reports of other occurrences in wooded settings across its range, it is also quite possible that arrowleaf sweet coltsfoot is well adapted to low light understory conditions associated with forested wetlands such as spruce bogs or fens.

Models

There are no known models specific to arrowleaf sweet coltsfoot documented in the literature. Habitat level modeling with various GIS coverages may be used to assess potential habitat availability and quality, and identify high potential areas. This information can be used to prioritize future survey and management efforts. Any modeling effort would involve baseline and on-going collection of appropriate data. Microhabitat variables that may warrant tracking include elevation, aspect, soil type, precipitation, mean annual temperature, snowfall depth, frost-free days, annual maximum and minimum temperatures, geology, etc.

Survey And Inventory Approaches

In general, the Black Hills are undersurveyed in regards to rare plant species, and the recent discoveries of new populations of species of concern (some representing significant range extensions) and new records for the Black Hills show this to be true. Surveys of Black Hills vegetation have primarily been conducted at the project level and have included the use of Ranger District personnel, through agreements with The Nature Conservancy, and by contracts. If future data is collected by the Forest for this species, it is currently anticipated that it will be stored in the Forest database and the Forest GIS system. Copies of any data collected will be sent to the respective State Natural Heritage Program. Any voucher specimens collected will be sent to the designated FS herbarium for vouchers in the Rocky Mountain Region, which is currently the Rocky Mountain Herbarium in Laramie, Wyoming.

Few if any surveys directed specifically at arrowleaf sweet coltsfoot have been done on Black Hills National Forest. The Forest is beginning to use broader floristic surveys, and surveys with

expanded lists of target species (not just Sensitive). Additional unsurveyed potential habitat sites for arrowleaf sweet coltsfoot may include the numerous seeps and springs known to occur on this portion of the Forest. Known potential habitat could be identified and mapped and periodic visits (e.g., every 5 years) to resurvey the sites will determine if new recruitment has occurred.

Monitoring Approaches

No monitoring protocols specific to this species are documented in the literature, and monitoring of arrowleaf sweet coltsfoot by Black Hills National Forest has not been performed to date. Baseline monitoring might be useful to detect changes in the populations and potentially help to counter risks to the species' long-term persistence on BHNF. Monitoring protocols may include GPS positions of the end points or polygons of concentrations within the Botanical Area, a count of individuals during the blooming period, leaf tallies, documentation of any occurrence of noxious weeds and their locations, active control measures to be implemented, and periodic (e.g., seasonal) measurements from piezometers to identify any changes in the height of the water table.

ADDITIONAL INFORMATION NEEDS

Additional ongoing data collection could focus initially on comprehensive surveys and inventories to better assess the range and distribution of arrowleaf sweet coltsfoot on the Black Hills National Forest. Additional surveys of potential habitat areas could be conducted on other FS lands in the vicinity of known occurrences. Documentation of known element occurrences could include mapping via GPS (e.g., area type polygon of known population boundaries with survey grade GPS unit), estimates of colony size and density, and collection of other basic biotic and abiotic data such as geology, hydrology, associated species, and community types. Voucher specimens could be collected for any new populations of arrowleaf sweet coltsfoot to ensure identification. The monitoring approaches noted above (REVIEW OF CONSERVATION PRACTICES – Monitoring Approaches) could be applied to arrowleaf sweet coltsfoot and possibly expanded through the use of fixed photopoints and quantitative sampling of fixed sample plots to assess subtle changes in community structure (e.g., is natural recruitment occurring, are later seral species increasing, etc.,). Line intercept data and leaf or stem tallies may be appropriate to quantify changes in cover data for individual species. The data can be linked to physical location to provide a better indication of new recruitment or death of particular individuals. Pre- and post-treatment data could be collected to evaluate the effectiveness of specific restoration approaches. Information gained through these approaches could help to clarify important issues surrounding the reproductive and disturbance ecology of the target species and overall site ecology of the occurrences. This information could also be useful in adaptively managing the sites and identifying appropriate conservation and restoration measures. It may also be useful to identify remnant hardwood stands (birch and aspen) in the vicinity of occupied or potential habitat that could benefit from prescribed burns and/or removal of conifers. Monitoring of recreational impacts from the Black Fox campground may also be appropriate.

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DEFINITIONS

THE NATURE CONSERVANCY NATURAL HERITAGE RANKS

GLOBAL RANK (G): based on range-wide status of a species

-G1 Critically imperiled globally because of extreme rarity (5 or fewer occurrences, or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extinction. (Critically endangered throughout its range).

-G2 Imperiled globally because of rarity (6 to 20 occurrences) or because of other factors demonstrably making it very vulnerable to extinction throughout its range. (Endangered throughout its range).

-G3 Vulnerable throughout its range or found locally in a restricted range (21 to 100 occurrences). (Threatened throughout its range).

-G4 Apparently secure globally, though it might be quite rare in parts of its range, especially at the periphery.

-G5 Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.

-GX Presumed extinct

-GQ Indicates uncertainty about taxonomic status.

-GU Unable to assign rank due to lack of available information.

-G? Indicates uncertainty about an assigned global rank.

TRINOMIAL RANK (T): used for subspecies or varieties. These taxa are ranked on the same

criteria as G1-G5.

STATE RANK (S): based on the status of a species in an individual state. S ranks may differ between states based on the relative abundance of a species in each state.

-S1 Critically imperiled in state because of extreme rarity (5 or fewer occurrences, or very few remaining individuals, or because of some factor of its biology making it especially vulnerable to extirpation from the state. (Critically endangered in state).

-S2 Imperiled in state because of rarity (6 to 20 occurrences) or because of other factors demonstrably making it very vulnerable to extirpation from the state. (Endangered or threatened in state).

-S3 Vulnerable in state (21 to 100 occurrences).

-S? Indicates uncertainty about an assigned state rank.

-SR Reported from state or province.

-SU Unrankable based on available information.

FIGURES

Figure 1. U.S. distribution for arrowleaf sweet coltsfoot (USDA, NRCS 2001). Grey areas indicate confirmed presence.

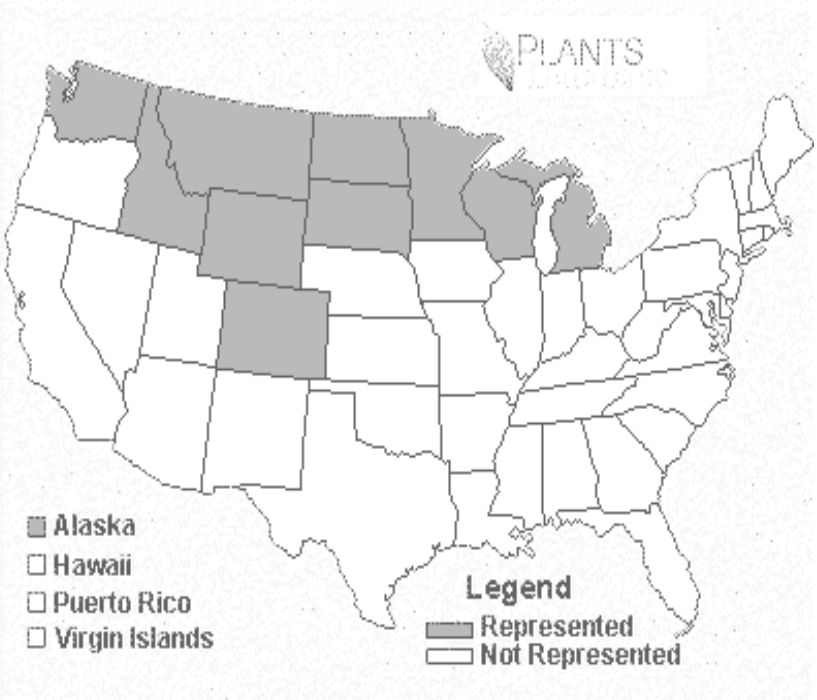

Figure 2. South Dakota distribution for arrowleaf sweet coltsfoot (USDA NRCS, 2001) with inaccuracies noted. All known EO's are from Lawrence and Pennington counties.

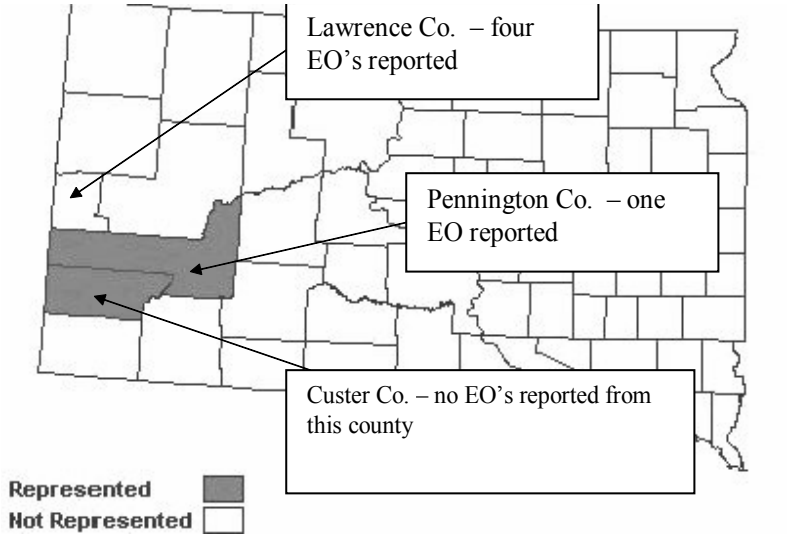

Figure 3. Wyoming distribution for arrowleaf sweet coltsfoot (University of Wyoming 1998).

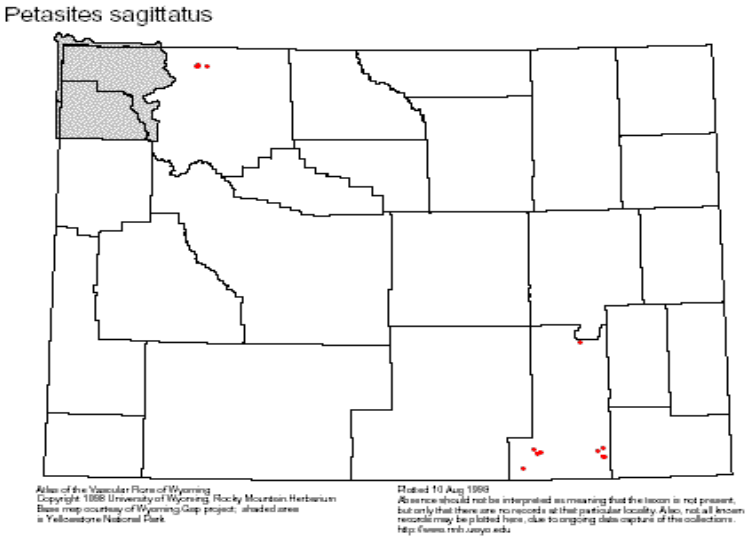

Figure 4. Photograph of arrowleaf sweet coltsfoot (USDA NRCS 2001).

Figure 5. Photograph of arrowleaf sweet coltsfoot habitat, Black Fox Valley Botanical Area (Glisson, 2001).