SHAGGY FLEABANE

Erigeron pumilus Nutt.

Asteraceae – Aster family

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ORGANIZATION

NOMENCLATURE

Shaggy fleabane (*Erigeron pumilus* Nutt.) belongs to the Astereae tribe of the Asteraceae family (Semple 1985; Nesom 2006; USDA NRCS 2021).

NRCS Plant Code. ERPU2 (USDA NRCS 2021).

Subtaxa. Flora of North America recognizes two varieties of shaggy fleabane: *E. p.* var. *intermedius* (Cronquist) Cronquist and *E. p.* var. *pumilus* Nutt. (Nesom 2006; ITIS 2021). These subtaxa are referred to as subspecies by PLANTS database (USDA NRCS 2021). Utah Flora (Welsh et al. 2016) considers *E. p.* var. *concinnus* (Hook. & Arn.) Dorn to be a subtaxa of shaggy fleabane and the most common type of shaggy fleabane in Utah, but this variety is recognized as its own species by Flora of North America (Nesom 2006) and PLANTS (USDA NRCS 2021).

Synonyms. *E. p.* subsp. *concinnoides* Cronquist, *E. p.* subsp. *intermedius* Cronquist, *E. p.* subsp. *intermedius* var. *gracilior* Cronquist, *E. p.* subsp. *intermedius* var. *intermedius* (Cronquist) Cronquist, *E. p.* subsp. *pumilus* Nutt., *E. p.* subsp. *typicus* Cronquist, *E. p.* var. *concinnus* (Hook. & Arn.) Dorn, *E. p.* var. *condensatus* (D.C. Eaton) Cronquist, *E. p.* var. *euconcinnoides* Cronquist, *E. p.* var. *euintermedius* Cronquist, *E. p.* var. *gracilior* Cronq., and *E. p.* var. *subglaber* Cronquist (ITIS 2021).

Common Names. Dwarf fleabane, hairy fleabane, low daisy, shaggy daisy, and Vernal daisy (Andersen and Holmgren 1976; Weber 1976; Taylor 1992; Welsh et al. 2016; USU Ext. 2017).

Chromosome Number. Chromosome numbers are: 2n = 18, 36 according to Semple (1985) and Hickman (1993). Chromosome numbers are 2n = 18, 36 for variety *intermedius* (Nesom 2006). Welsh et al. (2016) reported chromosome numbers of 2n = 27 for the species, but this was not reported elsewhere.

Hybridization. Hybrids were not reported in the reviewed literature.

DISTRIBUTION

Shaggy fleabane occurs from southern British Columbia south through the Cascade Mountains of Washington and Oregon to central and eastern California and west to North Dakota, South Dakota, Nebraska, and Kansas (Nesom 2006; Hitchcock and Cronquist 2018; USDA NRCS 2021). According to PLANTS (USDA NRCS 2021), shaggy fleabane also occurs in Manitoba and a handful of counties in Arizona and New Mexico. Shaggy fleabane appeared in 29 of 50 local floras from throughout the Basin and Range and Colorado Plateau physiographic provinces, (McLaughlin 1986).

Variety *intermedius* is the more westerly distributed shaggy fleabane variety. It occurs from southern British Columbia south to southern California and east to Utah, Wyoming, and Montana (Nesom 2006; Hitchcock and Cronquist 2018; USDA NRCS 2021). Variety *intermedius* occurs in the San Juan River drainage of Utah but does not occur in the bordering areas of Colorado, Arizona, or New Mexico (Heil and O'Kane 2003).

Variety *pumilus* is the more easterly distributed shaggy fleabane variety, occurring primarily on the east side of the Rocky Mountains and in the Great Plains. It occurs in Alberta and Saskatchewan and south to Kansas and Colorado with a disjunct population in Washington (Hickman 1993; Nesom 2006; Hitchcock and Cronquist 2018). Shiflet (1994) and Heil and O'Kane (2003) report variety *pumilus* in Arizona and New Mexico, and PLANTS (USDA NRCS 2021) reports this variety in Manitoba as well.

Habitat and Plant Associations. Throughout its range, shaggy fleabane commonly grows in dry open sites in grassland (Fig. 1), sagebrush (*Artemisia* spp.), pinyon-juniper (*Pinus-Juniperus* spp.), and ponderosa pine (*P. ponderosa*) communities (Munz and Keck 1973; Shiflet 1994; Nesom 2006; Pavek et al. 2012; Charboneau et al. 2013; Welsh et al. 2016; USU Ext. 2017; Hitchcock and Cronquist 2018).

Grasslands. Shaggy fleabane is common in the bluebunch wheatgrass (*Pseudoroegneria spicata*) rangeland cover type, which occurs throughout the Pacific Northwest. Bluebunch wheatgrass communities average 8 to 20 inches (203-508 mm) of annual precipitation, 45 to 60% of which occurs in the winter. Summers are very dry (Shiflet 1994). In the Columbia Basin in Washington and Oregon, constancy of shaggy fleabane was 62% in bluebunch wheatgrass/Sandberg bluegrass (*Poa secunda*) grasslands (Franklin and Dyrness 1973). A bluebunch wheatgrass-Sandberg bluegrass-shaggy fleabane community occupied hot, dry sites in the Blue Mountains of southeastern Washington, northeastern Oregon, and west-central Idaho (Powell et al. 2007). In the Snake River Canyon in Idaho and adjacent Washington and Oregon, shaggy fleabane constancy was 55% in wheatgrass-plains pricklypear (*Agropyron* spp./*Opuntia polyacantha*) communities on southwest slopes, 44% in Idaho fescue (*Festuca idahoensis*)/wheatgrass grasslands on northeastern slopes, and 33% in wheatgrass-Sandberg bluegrass grasslands on western slopes and in Idaho fescue/prairie Junegrass (*Koeleria macrantha*) grasslands on northeastern slopes (Tisdale 1979). In southern Saskatchewan, shaggy fleabane occurred in rough fescue (*F. campestris*) mixed prairie (Coupland and Brayshaw 1953).

Figure 1. Shaggy fleabane (lower right) growing in a grassland community in Oregon used as a seed collection area by the Bureau of Land Management's (BLM) Seeds of Success program. Photo: BLM OR0303, SOS.

Shrublands. Shaggy fleabane is most common in low- to moderate-elevation sagebrush shrublands and occurs in salt desert and mountain brush communities (Fig. 2) (Cronquist 1947; Munz and Keck 1973; Andersen and Holmgren 1996; Welsh et al. 2016; Hitchcock and Cronquist 2018). Although it occurs throughout the sagebrush steppe, it rarely occurs in high densities (Taylor 1992).

Shaggy fleabane was reported as a common forb in several shrub-dominated rangeland cover types across the United States (Shiflet 1994). It occurs

in dry basin big sagebrush (*A. tridentata* subsp. *tridentata*) types, which occur below 7,000 feet (2,000 m) in eastern Washington, southern Idaho, Montana, Wyoming, and south to Arizona and New Mexico. It occurs in Wyoming big sagebrush (*A. t.* subsp. *wyomingensis*) communities, which occupy a range like that of basin big sagebrush communities but includes parts of Colorado, Nevada, and northeastern California. Shaggy fleabane grows in threetip sagebrush (*A. tripartita*) shrublands of relatively high-elevation sites (4,000-9,000 feet [1,200-2,700 m]) in Washington, eastern Oregon, southern Idaho, southwestern Montana, Wyoming, and northern Utah and Nevada. It occurs in black sagebrush (*A. nova*) communities found at middle elevations in southern Idaho, western Wyoming, Colorado, Utah, and Nevada (Shiflet 1994). When forb species composition was evaluated at 15 big sagebrush (*A. tridentata*)-dominated sites in Oregon, Nevada, Idaho, Utah, Colorado, Wyoming, and Montana, shaggy fleabane was sampled at 6 sites (Pennington et al. 2017).

Figure 2. Shaggy fleabane growing in a big sagebrush shrubland in Oregon. Photo: BLM OR0303, SOS.

Constancy of shaggy fleabane was 100% in big sagebrush/Idaho fescue, 42% in threetip sagebrush/Idaho fescue, and 40% in antelope bitterbrush (*Purshia tridentata*)/Idaho fescue vegetation in the Columbia River Basin of Washington and Oregon (Franklin and Dyrness 1973). In Utah, shaggy fleabane often occurs with lupines (*Lupinus* spp.) in dry, open big sagebrush sites from valleys to upper elevation foothills (USU Ext. 2017). When little sagebrush (*A. arbuscula*) and black sagebrush habitats were evaluated in northern and central Nevada, shaggy fleabane only occurred in black sagebrush communities (Beatley 1976). Constancy of shaggy fleabane was 100% in black sagebrush-beardless wheatgrass (*Pseudoroegneria spicata* subsp. *inermis*) communities in Nye County (5,900-6,900 feet [1,800-2,100 m]) and 80% in black sagebrush-needle-and-thread (*Hesperostipa comata*) communities in White Pine County (5,900-7,200 feet [2,000-2,200 m]) (Zamora and Tueller 1973). At the Nevada Test Site and in central and southern Nevada, shaggy fleabane grows with saltbush (*Atriplex* spp.), blackbrush (*Coleogyne ramosissima*), black sagebrush, and mixed sagebrush-pinyon-juniper communities (Beatley 1976).

Woodlands/Forests. Shaggy fleabane commonly occurs in pinyon-juniper, Utah juniper (*J. osteosperma*), and ponderosa pine forests throughout its range (Munz and Keck 1973; Charboneau et al. 2013; Welsh et al. 2016; USU Ext. 2017). In southeastern Wyoming's Medicine Bow National Forest, shaggy fleabane occurred in ponderosa pine-sagebrush communities from 7,880 to 9,250 feet (2,400-2,820 m) (Lukas et al. 2012).

Elevation. Shaggy fleabane occupies elevations from 2,690 to 9,700 feet (1,000-2,960 m) (Nesom 2006; Welsh et al. 2016). In Utah, the elevation range is 2,690 to 9,700 feet (820-2,960 m) (Welsh et al. 2016); in California it is 4,000 to 7,000 feet (1,200-2,100 m) (Munz and Keck 1973; Hickman 1993); and in central and southern Nevada it is 4,000 to 8,200 feet (1,200-2,500 m) (Beatley 1976). Nesom (2006) reports similar elevation ranges for variety *intermedius* (4,000-9,200 ft [1,200-2,800 m]) and variety *pumilus* (3,300-8,500 ft [1,000-2,600 m]).

Soils. Shaggy fleabane grows on a variety of substrates and commonly occurs on well-drained sandy to gravelly soil textures (Fig. 3) (Taylor 1992; Welsh et al. 2016; USU Ext. 2017).

Figure 3. Shaggy fleabane growing with grasses and other forbs on a rocky site in Utah. Photo: BLM UT080, SOS.

Texture, substrate, depth. Shaggy fleabane is a typical forb in several dry rangeland cover types with shallow to deep soils. Basin big sagebrush communities receive low levels of precipitation (8-14 inches [203-356 mm]/yr) and occupy deep permeable soils. Wyoming big sagebrush cover types occupy shallow soils, which often overlay hardpan or parent rock and receive even lower levels of precipitation (7-12 inches [178-305 mm]/yr). Black sagebrush cover types occupy droughty, coarse-textured, usually calcareous soils, which are often shallow or overlay silica hardpan but when deeper have an extremely gravelly subsoil. Black sagebrush cover types receive 8 to 16 inches (203-406 mm) annual precipitation (Shiflet 1994).

In the Snake River Canyon in Idaho and adjacent Washington and Oregon, shaggy fleabane occurs in grasslands and shrublands where soils average 21 to 33 inches (54-85 cm) deep and have 2 to 7% organic matter and 6 to 43% gravel or rock cover (Tisdale 1979). Bluebunch wheatgrass-Sandberg bluegrass-shaggy fleabane communities at 1,500 to 2,600 feet (460-790 m) in the Snake River Canyon in the Wallowa-Whitman National Forest occur on steep (average 57%) southeast to northwestern slopes. These communities occupy sandy loam to clay loam soils 30 to 43 inches (76-109 cm) deep (Johnson and Simon 1987). In the Fernow Valley in Utah's Juab County, shaggy fleabane occurs in the understory of big sagebrush communities, which occupy deep, permeable, salt-free soils with high water-holding capacities (Fautin 1946). In the House Mountain range in Utah, shaggy fleabane is common on gravelly slopes and alluvial flats at moderate elevations (Kass 1988). Shaggy fleabane occurs in sagebrush communities in the mountains of northeastern Nevada where average soil depths range from 8 inches (20 cm) in black sagebrush/bluebunch wheatgrass communities to 46 inches (117 cm) in mountain big sagebrush/basin wildrye (*A. tridentata* subsp. *vaseyana*/*Elymus cinereus*) communities (Jensen et al. 1988).

Frequency of shaggy fleabane varied more with soil type than grazing influences in an evaluation of salt-desert shrub range near Grand Junction, western Colorado. Frequency of shaggy fleabane was much greater on sandstone (18-22%) and mixed sandstone-shale (21%) soils than on shale soils (0-1%). Frequency differences between grazed and ungrazed sites were 3% or less regardless of soil type. Sites were grazed by domestic sheep and cattle from November to mid-May (Turner 1971). For a broader discussion of shaggy fleabane's response to grazing, see the Ecology section.

Moisture. Shaggy fleabane generally occurs in communities where soils have low moisture levels. In the Columbia Plateau of eastern Washington, shaggy fleabane was rare along the margins of vernal pools and labeled as flood intolerant (Björk and Dunwiddie 2004). At the base of Pike's Peak, Colorado, shaggy fleabane is a secondary forb in blue grama (*Bouteloua gracilis*) grasslands, which occupy coarse gravelly loam soils with 6 to 9% water content (Shantz 1906). Yet in basin big sagebrush vegetation on the Humboldt-Toiyabe National Forest, shaggy fleabane occurred only on wet sites when wet, intermediate, and dry sites were compared. Wet sites were 23 to 98 inches (60-250 cm) to the water table. Intermediate sites were 39 to 110 inches (100-280 cm) to the water table. Dry sites were 110 to 118 inches (280-300 cm) to the water table. Perennial grass and forb cover were higher, and basin big sagebrush cover lower in wet than dry sites (Wright and Chambers 2002).

DESCRIPTION

Shaggy fleabane is a short- to long-lived perennial from a woody taproot and caudex with short, thick branches (Nesom 2006; Welsh et al. 2016). Caudex branches are typically clothed by withered leaf bases (Welsh et al. 2016). Plants are variable, ranging from rather stout to slender, 2 to 20 inches (5-50 cm) tall. Stems and leaves are often densely covered with spreading hairs of more than 1 mm long, giving the plant a shaggy or unkempt appearance (Fig. 4) (Taylor 1992; Hitchcock and Cronquist 2018; Luna et al. 2018).

Figure 4. Shaggy fleabane plant with fuzzy stems and leaves growing in Oregon. Photo: BLM OR030, SOS.

Stems are topped with flower heads (Munz and Keck 1973; Hickman 1993; Nesom 2006;

Hitchcock and Cronquist 2018). Look alike species include threadleaf fleabane (*Erigeron filifolius*) and desert yellow fleabane (*E. linearis*) (Pavek et al. 2012).

Shaggy fleabane produces linear to narrowly oblong basal and stem leaves with smooth margins (Hitchcock and Cronquist 2018; Luna et al. 2018). Leaves are indistinctly petiolate with petioles prominently ciliate with spreading thick-based hairs (Nesom 2006; Luna et al. 2018). Basal leaves are erect, persistent, oblanceolate, and up to 3 inches (8 cm) long and 0.2 inch (0.5 cm) wide (Hickman 1993; Nesom 2006; Luna et al. 2018). Stem leaves occur on the distal half to three quarters of stems. They are linear-lanceolate and little reduced distally (Nesom 2006).

Individual plants produce up to 50 flat-topped to hemispheric flower heads, which often occur singly at the top of stems (Hickman 1993; Nesom 2006; Pavek et al. 2012; Welsh et al. 2016; Hitchcock and Cronquist 2018). Individual heads have 50 to 150 rays, which are pistillate, fertile, white to pink or lavender, and 6 to 15 mm long (Fig. 5). Ray flowers are thin, reflexed or sometimes weakly coiled, and surround yellow to orange disk flowers. Disk corollas are fertile, 3 to 5 mm tall with distinctly indurate and inflated throats (Nesom 2006; Welsh et al. 2016; Hitchcock and Cronquist 2018). Involucres are hairy, 7 to 15 mm wide, and 4 to 7 mm tall with subequal bracts in 2 to 4 series (Nesom 2006; Welsh et al. 2016; Hitchcock and Cronquist 2018; Luna et al. 2018). Bracts are covered with tiny glands, long hairs, and have orange to yellowish or brownish midribs (Nesom 2006; Welsh et al. 2016; Luna et al. 2018).

Figure 5. Small shaggy fleabane flowers. Photo: BLM ID230, SOS.

Shaggy fleabane produces cypsela fruits, hereafter referred to as seeds. Seeds are tiny (1.4-1.8 mm long) with a double pappus. The outer pappus consists of scales or bristles (0.1-0.3 mm long) and the inner pappus of 12 to 27 bristles. Seed bodies are two nerved with sparse, straight, stiff hairs on the seed faces (Nesom 2006).

Variety descriptions. Variety *intermedius* produces flower heads with usually pink but sometimes white ray flowers and relatively dull, glabrous, or slightly puberulent disk flowers. Variety *intermedius* seeds have an inner seed pappus of 12 to 20 bristles (Nesom 2006; Hitchcock and Cronquist 2018). Variety *pumilus* produces flower heads with white ray flowers and shiny, glabrous disk flowers. Variety *pumilus* produces seeds with inconspicuous outer pappi and inner pappi of 15 to 27 bristles (Nesom 2006; Hitchcock and Cronquist 2018).

Reproduction. Shaggy fleabane reproduces by seed (Fig. 6) (Marlette and Anderson 1986; Pinto et al. 2014). Seeds are generally produced 1 to 2 months after flowers (Pitt and Wikeem 1990). Flower production (abundance and timing) can vary by location and year (Tepedino and Stanton 1980).

Figure 6. Shaggy fleabane seed head. Photo: BLM CP4, SOS.

Many sources and studies have reported on shaggy fleabane's phenology, which includes a flowering range from April to November if plants flower for a second time with fall moisture (Beatley 1976; Pitt and Wikeem 1990; Andersen and

Holmgren 1996). In northeastern Utah, shaggy fleabane flowers occur from April to September (Andersen and Holmgren 1996). In central and southern Nevada, flowers are common from April to May at lower elevations and June to July at upper elevations (Beatley 1976).

After 4 years of observations near Sidney, Montana (2,182 feet [665 m]), the average flowering date or time when 10% of plants had at least one flower was June 14 (White 1979). The earliest flowering date was June 7, and the latest flowering date was June 19. In this study, the accumulation of thermal days accounted for 49% of the variation in flowering for early flowering species such as shaggy fleabane (White 1979). In two years of observations (1978-79) made near Penticton, British Columbia, shaggy fleabane began to grow from March to May (Pitt and Wikeem 1990). Flowering began in April or May, and plants were in full flower in May or June. Shaggy fleabane set and shattered seed in July and August. Fall regrowth began in September or October, and plants flowered again in October or November and were cured by December. Phenology observations likely represent 'normal' since annual precipitation and growing degree days were similar to the 30-year average (Pitt and Wikeem 1990).

At two shortgrass prairie sites in Wyoming's Laramie Basin, flower production varied by site and year (Tepedino and Stanton 1980). Shaggy fleabane produced 1.1 flower heads/ft^2 (12/m^2) at one site and 5.5/ft^2 (59/m^2) at the other site in 1975 when permanent quadrats were monitored from late May to late August. No flowers were produced in 1976. Precipitation was much heavier than normal in the spring and early summer of 1975 and was 32% below normal by the end of June in 1976 (Tepedino and Stanton 1980).

Pollination. Shaggy fleabane flowers are insect pollinated. At the Nevada Test Site, carder bees (*Anthidium dammersi*), fairy bees (*Perdita fallugiae*), and sweat bees (*Lasioglossum sisymbrium*) were collected from shaggy fleabane flowers (Allred 1969). In surveys conducted in June of1969 and 1970 in Chaffee County, Colorado, 13 recorded simius roadside skipper butterflies (*Amblyscirtes simius*) visits were to shaggy fleabane flowers in low hills with sparse cover of pinyon pine and juniper (Scott 1973).

ECOLOGY

Shaggy fleabane is a disturbance tolerant, short- to long-lived perennial that persists in open-canopy forests (Daubenmire 1975; Akinsoji 1988; Ross and Wikeem 2002; Carr and Krueger 2012; Welsh et al. 2016). Several studies report greater shaggy fleabane abundance in disturbed than undisturbed plots (McLean et al. 1971; Ross and Wikeem 2002; Metlen et al. 2006).

Seed and Seedling Ecology. The emergence of shaggy fleabane seedlings was greater in native than nonnative-dominated vegetation and greater in unburned than burned plots in the studies described in more detail below.

Shaggy fleabane emerged from soil collected from native vegetation but not from adjacent crested wheatgrass (*Agropyron cristatum*) and desert wheatgrass (*A. desertorum*) vegetation at the Idaho National Laboratory in southeastern Idaho (Marlette and Anderson 1986). Shaggy fleabane made up 0.74% of the relative number of seedlings emerging from soil collected in big sagebrush-dominated vegetation, where it makes up 0.66% of relative cover in the aboveground vegetation. Shaggy fleabane did not emerge from soils collected from crested wheatgrass-dominated stands, even though the sampling design was designed to capture seed dispersal between native and nonnative vegetation (Marlette and Anderson 1986).

In a study evaluating the effects of disturbance, water table level, and microhabitat on seedbanks in basin big sagebrush communities, more shaggy fleabane seeds occurred on unburned than burned sites and on wet than dry sites (Table 1; Wehking 2002). The study location on the Humboldt-Toiyabe National Forest, Nevada, included wet sites with a water table at 59 to 95 inches (151-242 cm) below the soil surface, and dry sites with a water table more than 118 inches (300 cm) below the soil surface. A portion of dry and wet sites were burned in October 1996, and seedbanks were evaluated 1 year following the fire and prior to reseeding and 2 years following fire and 1 year after seeding with native grasses and forbs (9 PLS/ft^2 [100 PLS/m^2]). The seed mix did not include shaggy fleabane. Soil was collected from beneath shrubs and in the shrub interspaces at three depths (litter + 0.4 in [1 cm], 0.4-2 in [1-5 cm], 2-6 in [5-15 cm]). Seedbank composition was determined using the emergence method. Soils were spread over sand and emergence monitored in a greenhouse (86 °F [30 °C] day; 37 °F [3 °C] at night). Although shaggy fleabane did not occur on dry plots, seedlings did emerge from soil collected from dry plots. Seeds of shaggy fleabane persisted after burning in the upper soil at the wet site. Rarely did shaggy fleabane emerge from soils collected deeper than 2 inches [5 cm]. Seeds were more abundant in the interspaces than beneath shrubs on burned plots and the reverse was true for unburned plots (Wehking 2002).

Table 1. Emergence of shaggy fleabane seed by water table level (Wet: water table 59-95 in. below soil surface; Dry: water table >118 in. below soil surface), disturbance, microhabitat, and soil depth from seedbanks collected from basin big sagebrush communities on the Humboldt-Toiyabe National Forest in central Nevada (Wehking 2002).

Depth (in)	Wet				Dry			
	Burned		Unburned		Burned		Unburned	
	Undershrub	Interspace	Undershrub	Interspace	Undershrub	Interspace	Undershrub	Interspace
	Number of seeds/m^2							
litter + 0.4	0	128	256	62	0	6	102	28
0.4-2	6	51	165	63	18	42	316	110
2-6	0	0	28	0	0	0	0	0

*Seed distribution in the soil profile only evaluated for year 1997 and on burned sites in 1998.

Successional Status. Shaggy fleabane occurs in early and late seral communities. In southeastern Washington, shaggy fleabane occurred in newly abandoned old fields (1, 2, and 5 years since last cultivation). It also occurred in older fields cultivated 39 to 52 years ago and in undisturbed rangeland vegetation. Cover of shaggy fleabane was low in both old fields and undisturbed vegetation (Daubenmire 1975).

In eastern Oregon's Malheur National Forest, shaggy fleabane occurred in the understory of ponderosa pine woodlands that averaged 275 pine stems/acre (679/ha) and 57% canopy cover but not in the understory of denser stands averaging 1,312 pine stems/acre (3,244/ha) and 79% canopy cover (Carr and Krueger 2012).

Disturbance Ecology. Shaggy fleabane is commonly found on cattle-grazed sites but may be less tolerant of sheep and big game grazing. In ponderosa pine-Idaho fescue communities in the Similkameen Valley of southern British Columbia, shaggy fleabane abundance increased with heavy cattle grazing when opposite sides of a fence line were compared (McLean et al. 1971). On winter range in the Rocky Mountain trench north of Cranbrook, British Columbia, an exclosure was constructed in 1951 to evaluate the impacts of large ungulate grazing (Ross and Wikeem 2002). Cattle grazing was heavy in spring and fall before construction of the exclosure, but by 1950, grazing management was altered to a lower stocking rate and later spring turnout. Shaggy fleabane was greater on grazed than ungrazed plots for the 34-year comparison of vegetation inside and outside of the exclosure that protected vegetation from cattle, deer, and elk grazing (Table 2; Ross and Wikeem 2002).

Table 2. Cover (C) and frequency (F) of shaggy fleabane in grazed and ungrazed plots over time at a site north of Cranbrook, British Columbia (Ross and Wikeem 2002).

Treatment	1960		1970		1982		1991		1994	
	C (%)	F (%)	C	F	C	F	C	F	C	F
Exclosure	0.7	8	0	0	0.2	6	0	0	0	0
Grazed	1.2	30	4	54	4	90	0.2	8	1.9	24

At the Idaho National Laboratory site near Idaho Falls, shaggy fleabane cover was 0.3% and frequency was 11% in ungrazed sagebrush, but plants did not occur in grazed sagebrush or grazed or ungrazed crested wheatgrass stands. The grazed area (540 mi^2 [1,390 km^2])supported 1,000 to 2,000 domestic sheep each spring, and the ungrazed plots were free of livestock for 25 years (Reynolds and Trost 1981). Krueger and Winward (1974) evaluated the effects of cattle and big game grazing after 14 years of protection at the Eastern Oregon Experiment Station. Shaggy fleabane frequency was 14% on plots grazed by both cattle and big game, 0% on plots grazed by big game only, and 0% on ungrazed plots. The study area was livestock grazed for more than 100 years before treatments in the Douglas fir (*Pseudotsuga menziesii*)-ponderosa pine/ Kentucky bluegrass (*Poa pratensis*) study area.

Abundance of shaggy fleabane was consistently greater on burned than unburned plots in available fire studies. In threetip sagebrush and basin big sagebrush shrublands in Power County, Idaho, shaggy fleabane cover averaged 0.24% on 1-year-old burned plots and 0.09% on unburned plots. Shaggy fleabane did not emerge from 10 soil cores collected from burned and unburned plots (Akinsoji 1988). Frequency of shaggy fleabane was much greater on burned (65%) than unburned plots (18%) 2 years following fire in bluebunch wheatgrass-Sandberg bluegrass communities in southeastern Washington. Four years following fire, frequency was greater on unburned (15%) than burned plots (2%), and by the twelfth post-

fire year, there was no difference in frequency between burned and unburned sites (Daubenmire 1975). The frequency of shaggy fleabane was greater after than before burning, thinning, or combined treatments in ponderosa pine-Douglas-fir forests at the Lubrecht Experimental Forest in Missoula County, Montana. Post-treatment monitoring occurred 3 years following thinning and 2 years following burning. Burning of all plots occurred in the spring, and fires were of low to moderate severity (Table3; Metlen et al. 2006).

Table 3. Frequency of shaggy fleabane on treated and untreated plots in ponderosa pine-Douglas-fir forests at the Lubrecht Experimental Forest in Missoula County, Montana (Metlen et al. 2006).

Treatment	Control	Burn only	Thin only	Thin + burn
	Frequency (%)			
Pretreatment	20	3	7	13
3 yrs after thin; 2 yrs after burn	30	27	23	33

Wildlife and Livestock Use. Available literature indicates that shaggy fleabane is eaten by pronghorn (*Antilocarpa americana*), domestic sheep, various small mammals, and greater sage-grouse (*Centrocercus urophasianus*). In semi-desert vegetation in western Utah, shaggy fleabane received moderate pronghorn use whenever available. Use was greater in spring and wet summers than in dry summers (Beale and Smith 1970). On the Desert Experimental Range and Awapa Plateau in Utah, maximum pronghorn use of shaggy fleabane was 2% in the spring as determined by feces and rumen analysis (Smith and Beale 1980). Pronghorn fed on shaggy fleabane in the summer in central Montana (Cole 1956; Wentland 1968). Shaggy fleabane made up 17% of the forb feeding observations made on 62 feeding sites monitored in June 1966 and a trace of observations in June 1967 (Wentland 1968). Shaggy fleabane was not used by pronghorn in July or August.

A study near Missoula, Montana, evaluated whether domestic sheep could control invasive forbs without compromising native plant restoration efforts (Masin et al. 2018). Shaggy fleabane was grazed less than 1% at the study site where its frequency was 7%. The grazing study was conducted in bluebunch wheatgrass-Sandberg bluegrass communities with a mix of native and nonnative forb species. Sheep grazed plots heavily invaded by leafy spurge for 3 weeks before grazing the study area (Masin et al. 2018).

Small mammal use of shaggy fleabane was reported in studies conducted in Washington (Richardson et al. 2013) and Idaho (Dyni and Yensen 1996). A single pocket mouse (*Perognathus parvus*) captured from native shrub steppe vegetation in the northern Columbia Basin of eastern Washington had 17 shaggy fleabane seeds in its cheek pouch. Pocket mice were trapped in fall 2003 and 2004 and the single capture with shaggy fleabane seeds represented just 0.1% of mice captured and 0.1% of total seeds recovered. Grass seeds, especially cheatgrass (*Bromus tectorum*), were collected most by pocket mice (Richardson et al. 2013). In Adams County, Idaho, Columbian and Idaho ground squirrels fed on shaggy fleabane stems and leaves. Diets of Columbian ground squirrels were 0.6% shaggy fleabane in mixed-conifer forests in early July and 0.9% in meadows in early June. Idaho ground squirrel diets were 1.2% shaggy fleabane in meadow vegetation in early June (Dyni and Yensen 1996).

Shaggy fleabane flowers are eaten by greater sage-grouse (Luna et al. 2018), and it is an important component of brood-rearing (Wik 2002) and mating habitats (Petersen 1980). Shaggy fleabane is also utilized by a variety of insects and invertebrates that are eaten by greater sage-grouse (Luna et al. 2018). In south-central Owyhee County, Idaho, shaggy fleabane grows in big sagebrush habitats used as brood-rearing habitat by greater sage-grouse (Wik 2002). In the Spring Creek area of North Park, Colorado, shaggy fleabane occurred on two of three greater sage-grouse mating sites in sagebrush vegetation. Cover of shaggy fleabane was low (0.1- 0.3% cover) in the mating area where sagebrush cover averaged 7.3% and sagebrush height averaged 2 inches (5.3 cm) (Petersen 1980).

For information on the use of shaggy fleabane by insects, see the Pollination section.

Ethnobotany. Indigenous peoples had a variety of uses for shaggy fleabane. The Okanagan-Colville used an infusion of shaggy fleabane roots as an eye tonic or wash (Turner et al. 1980, cited in Moerman 2003). The Lakota used a decoction of shaggy fleabane to treat rheumatism, lameness, and stomach issues (Munson 1981).

Horticulture. Attractive flowers, pollinator use, and tolerance of drought and early seral conditions make shaggy fleabane a useful native plant for landscaping or use in roadside, campground, or other low-maintenance plantings (Meyer et al. 2009; Tilley et al. 2013). Because shaggy fleabane attracts predatory and parasitoid insects (LBJWC 2015), it could be useful in organic gardening or crop production.

REVEGETATION USE

Shaggy fleabane is recommended for revegetation of sites receiving 6 to 17 inches (152-432 mm) of annual precipitation. The species has a rapid growth rate and is attractive to bee and butterfly pollinators (Tilley et al. 2013).

DEVELOPING A SEED SUPPLY

For restoration to be successful, the right seed needs to be planted in the right place at the right time. Coordinated planning and cooperation is required among partners to first select appropriate species and seed sources and then properly collect, grow, certify, clean, store, and distribute seed for restoration (PCA 2015).

Developing a seed supply begins with seed collection from native stands. Collection sites are determined by current or projected revegetation requirements and goals. Production of nursery stock requires less seed than large-scale seeding operations, which may require establishment of agricultural seed production fields. Regardless of the size and complexity of any revegetation effort, seed certification is essential for tracking seed origin from collection through use (UCIA 2015).

Seed Sourcing. Because empirical seed zones are not currently available for shaggy fleabane, generalized provisional seed zones developed by Bower et al. (2014), may be used to select and deploy seed sources. These provisional seed zones identify areas of climatic similarity with comparable winter minimum temperature and aridity (annual heat:moisture index). In Figure 7, Omernik Level III Ecoregions (Omernik 1987) overlay the provisional seeds zones to identify climatically similar but ecologically different areas. For site-specific disturbance regimes and restoration objectives, seed collection locations within a seed zone and ecoregion may be further limited by elevation, soil type, or other factors.

The Western Wildland Environmental Threat Assessment Center's (USFS WWETAC 2017) Threat and Resource Mapping (TRM) Seed Zone application provides links to interactive mapping features useful for seed collection and deployment planning. The Climate Smart Restoration Tool (Richardson et al. 2019) can also guide revegetation planning, seed collection, and seed deployment, particularly when addressing climate change considerations.

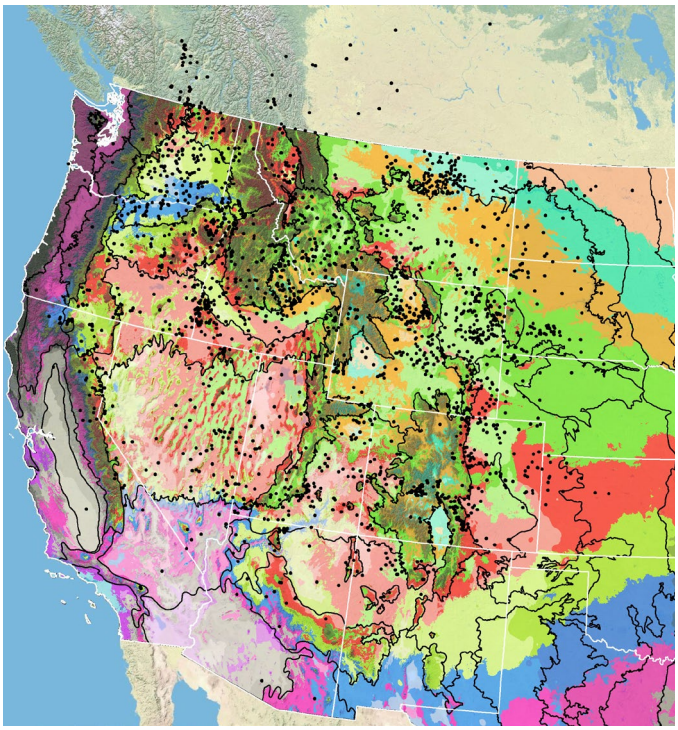

Figure 7. Distribution of shaggy fleabane (black circles) based on geo-referenced herbarium specimens and observational data from 1881-2016 (CPNWH 2020; SEINet 2020; USDI USGS 2020). Generalized provisional seed zones (colored regions) (Bower et al. 2014) are overlain by Omernik Level III Ecoregions (black outlines) (Omernik 1987; USDI EPA 2018). Interactive maps, legends, and a mobile app are available (USFS WWETAC 2017; www.fs.fed.us/wwetac/threat-map/TRMSeedZoneMapper2.php?). Map prepared by M. Fisk, USDI USGS.

Releases. As of 2021, there are no known shaggy fleabane germplasm releases.

Wildland Seed Collection. Indeterminate flowering (Fig. 8) makes monitoring and revisiting sites necessary when making shaggy fleabane seed harvests. Wildland seed collections are typically made by hand (Camp and Sanderson 2007; DeBolt 2016; USDI BLM SOS 2017).

Wildland seed certification. Wildland seed collected for either direct sale or to be used as stock seed for establishment of cultivated seed production fields or for nursery propagation should be Source-Identified. This is accomplished by following procedures established by the Association of Official Seed Certifying Agencies (AOSCA) Pre-Variety Germplasm Program that verifies species and tracks seed origin (Young et al. 2003; UCIA 2015). Wildland seed collectors should become acquainted with state certification agency procedures, regulations, and deadlines in the states where they collect.

If wildland-collected seed is to be sold for direct use in ecological restoration projects, collectors must apply for Source-Identified certification prior

to making collections. Pre-collection applications and site inspections are handled by the AOSCA member state agency where seed collections will be made (see listings at AOSCA.org).

Figure 8. Shaggy fleabane plant growing in Idaho. This plant has flowering stems with mature seed, drying flowers, and fresh flowers. Photo: BLM ID120, SOS.

If wildland seed collected by a grower is to be used as stock seed for planting cultivated seed fields or for nursery propagation (See Agricultural Seed Field Certification section), detailed information regarding collection site and collecting procedures, including photos and herbarium specimens must be provided when applying for agricultural seed field certification. Germplasm accessions acquired within established protocols of recognized public agencies, however, are normally eligible to enter the certification process as stock seed without routine certification agency site inspections. For contract grow-outs, this information must be provided to the grower to enable certification. Stock seed purchased by growers should be certified.

Collection timing. Mature shaggy fleabane seeds are small, light-colored, and easily detached from the seed head (Camp and Sanderson 2007; DeBolt 2016). Wildland seed collections are time consuming and often require multiple site visits since seed production is indeterminate. Harvests should begin as soon as seed heads begin to ripen because seed shatters rapidly and falls readily from seed heads when disturbed (Camp and Sanderson 2007). Seeds are typically harvested from mid-May to late July (Camp and Sanderson 2007; USDI BLM SOS 2017). The Bureau of Land Management (BLM) collected shaggy fleabane seed from late June to late July at 1,900-foot (580 m) sites in Douglas County, Washington (Camp and Sanderson 2007). The BLM's Seeds of Success crews made 30 shaggy fleabane seed harvests in 12 years from 2002 to 2016 in Washington, Oregon, Nevada, Idaho, Utah, and Colorado. The earliest collection was made on May 21, 2015 at 4,789 feet (1,460 m) in Uintah County, Utah. The latest collection was made on July 27, 2011 at 3,925 feet (1,196 m) in Malheur County, Oregon. Most collection sites had a lot of seed already on the ground (USDI BLM SOS 2017).

Collection methods. Wildland seeds (Fig. 9) can be collected by shaking or knocking seed heads into a container or by picking mature seeds from the seed heads (Camp and Sanderson 2007; DeBolt 2016; USDI BLM SOS 2017).

Figure 9. Collection of about 40 freshly collected seeds from shaggy fleabane plants in Idaho. Photo: BLM ID230, SOS.

Several collection guidelines and methods should be followed to maximize the genetic diversity of wildland collections: collect seed from a minimum of 50 randomly selected plants; collect from widely separated individuals throughout a population without favoring the most robust or

avoiding small stature plants; and collect from all microsites including habitat edges (Basey et al. 2015). General collecting recommendations and guidelines are provided in online manuals (e.g., ENSCONET 2009; USDI BLM SOS 2016). As is the case with wildland collection of many forbs, care must be taken to avoid inadvertent collection of weedy species, particularly those that produce seeds similar in shape and size to those of shaggy fleabane.

Post-collection management. Small wildland seed collections were air dried in paper bags at room temperature for 2 to 4 weeks before cleaning (Camp and Sanderson 2007; DeBolt 2016). DeBolt (2016) added a 1-inch^2 (6 cm^2) piece of no-pest strip in the bag for 3 days to minimize insect predation.

Seed Cleaning. Several mechanical cleaning methods have been described. The Bridger, Montana, Plant Materials Center (PMC) cleaned small quantities of fleabane seed using a blender with duct tape-wrapped blades. Blenders were filled up to 33% and pulsed at low speed. Blending was followed by sieving and winnowing over a small fanning mill (Scianna 2004). The USFS Bend Seed Extractory cleaned small seed lots (Fig. 10) using a small brush machine (mantle #32, speed 1, and medium bristle brushes) followed by hand-sieving with a #40 USGS screen and then processing with an office clipper (DeBolt 2016).

Figure 10. Shaggy fleabane seeds under magnification. Seeds were cleaned and the photo provided by USFS Bend Seed Extractory.

Seed Storage. Shaggy fleabane seed is orthodox. Viability was 93% for seed dried to equilibrium with 15% relative humidity and stored for 1 month at 68 °F (20 °C) (Kew 2017). Other researchers reported storing seed in glass jars at 40 °F (4 °C) and 35% relative humidity (Camp and Sanderson 2007) or in cool, dry, and dark locations (DeBolt 2016).

Seed Testing. There is general guidance for testing the viability and germination of fleabane species (Moore 1985).

Viability. Seed viability testing requires seeds be kept moist for 6 to 18 hours before cutting. Seeds are cut longitudinally through the mid-section of the distal half without cutting the embryonic axis at the basal end. The distal end of the seed including the tips or edges of the cotyledons is removed before staining for 6 to 24 hours. Seeds that stain completely or completely except for the distal third of the radicle are viable (Moore 1985).

Germination. Although germination testing rules were not available for shaggy fleabane, there is an AOSA rule for aspen fleabane (***Erigeron speciosus***), which says to keep seed moist, in the light at 59 °F (15 °C). First germination counts should be made at 6 days and last counts at 16 days (AOSA 2016).

Germination. Light (Young and Young 1986), warm incubation (RBG Kew 2017; Kildisheva et al. 2019b), cold stratification (Kildisheva et al. 2019a), and after ripening (Durham and Sackschewsky 2004) have all been shown to improve germination of shaggy fleabane seed.

Shaggy fleabane germinated much better at warm than cool temperatures in laboratory studies conducted by Kildisheva et al. (2019b). Seed was collected July 2015 at 4,600-foot (1,403 m) elevation in Harney County, Oregon. It was dried for 3 to 4 weeks at 60 °F (15 °C) and 15% relative humidity and stored 3 months before testing. Seed fill was 98%. Incubation temperatures of 59 to 77 °F (15-25 °C) produced significantly better germination than 41 °F (5 °C) ($P < 0.001$). At 68 °F (20 °C), it took 7.9 days to reach 50% germination. Germination was improved by 58% when seeds were incubated on karrikinolide (KAR_1) over seeds incubated on water at 77 °F (25 °C) ($P < 0.001$). Researchers classified shaggy fleabane seed as non-deep or intermediate physiologically dormant, which often requires short cold stratification durations, and seeds often lose dormancy with dry afterripening (Kildisheva et al. 2019b).

Kildisheva et al. (2019a) also found that 3 months of cold stratification maximized germination of shaggy fleabane seed. Germination of summer-collected Shaggy fleabane seed from southeastern Oregon was evaluated with chemical

stimulants (KAR_1 and gibberellic acid [GA_3]), cold stratification (37 °F [3 °C] for 1, 2, 3, or 6 months), dry afterripening (constant 77 °F [25 °C] with 12 hrs of light:12 hrs dark), and cold dry storage (dried seed stored at 0.4°F [-18 °C] for 1, 2, 3, 6, or 12 months). Cold stratification treatments improved germination most. Germination reached 49% ($P = 0.028$) after 1 month of stratification and 76% or better after 2 months of stratification at any of the three incubation temperatures tested ($P < 0.001$). Germination was improved with KAR_1 but not as much as with cold stratification. After a year of dry afterripening, germination was close to 70% for seed incubated at 77/59 °F (25/15 °C) but close to 25% at cooler incubation at 59/41 °F (15/5 °C). Germination was also improved by up to 29% with a year of cold storage. Moderate germination (up to 39%) after just a month of cold storage suggests that some late-winter or early-spring germination of shaggy fleabane may occur before the danger of freezing has passed (Kildisheva et al. 2019a).

Warm incubation temperatures and field storage of seed improved germination of shaggy fleabane seed in studies conducted by Durham and Sackschewsky (2004). Germination was compared for freshly harvested seed (July 2001) and seed kept in sealed tins in the field until later summer (Sept. 26), fall (Dec. 19), or winter (Mar. 16). Field storage sites were a remediated nuclear-waste site in sagebrush steppe vegetation near Richland, Washington. Shaggy fleabane germinated better at mid-level temperatures when incubation temperatures of 50, 68, and 86 °F (10, 20, 30 °C) were tested. Germination was also improved at low and moderate incubation temperatures with longer duration field storage (Table 4; Durham and Sackschewsky 2004).

Table 4. Seed germination (approximate percentages) of freshly harvested and field-stored (Richland, WA) shaggy fleabane seed incubated at (50, 68, and 86 °F, 12 hr light/12 hr dark) following storage treatments (Durham and Sackschewsky 2004).

Incubation temperature	50 °F	68 °F	86 °F
	Germination percentages		
Freshly harvested seed	5	65	11
Stored until 9/26	10	80	5
Stored until 12/19	35	90	15
Stored until 3/16	30	100	10

Smoke treatments had no effect on the germination of shaggy fleabane seed when germination papers were moistened with various levels of smoke water (1:10, 1:100, 1:1,000 of smoke water concentrations) (Cox 2016).

Wildland Seed Yield and Quality. Post-cleaning seed yield and quality of seed lots collected in the Intermountain region are provided in Table 5 (USFS BSE 2017). Results indicate that shaggy fleabane seed is tiny and that the purity and viability of fresh seed are highly variable. Other seed/lb values reported in the literature (1,300,000-1,800,000 seeds/lb [2,866,000-3,968,000/kg]) fall below those reported in Table 5 (Lambert 2005; Camp and Sanderson 2007).

Table 5. Seed yield and quality of shaggy fleabane seed lots collected in the Intermountain region, cleaned by the Bend Seed Extractory, and tested by the Oregon State Seed Laboratory or the USFS National Seed Laboratory (USFS BSE 2017).

Seed lot characteristic	Mean	Range	Samples (no.)
Bulk weight (lbs)	0.32	0.03-1.2	37
Clean weight (lbs)	0.04	0.002-0.18	37
Clean-out ratio	0.13	0.02-0.27	37
Purity (%)	88	40-99	37
Fill (%)[1]	95	80-99	37
Viability (%)[2]	88	52-97	27
Seeds/lb	5,014,110	2,362,500-13,341,176	37
Pure live seeds/lb	3,952,142	6,396,671-1,988,412	27

[1] 100 seed X-ray test

[2] Tetrazolium chloride test

Marketing Standards. Acceptable seed purity, viability, and germination specifications vary with revegetation plans. Purity needs are highest for precision seeding equipment used in nurseries, while some rangeland seeding equipment handles less clean seed quite well.

AGRICULTURAL SEED PRODUCTION

Growth of shaggy fleabane in an agricultural setting for seed production was not reported in the literature. Reports suggest that shaggy fleabane germinates and establishes well and grows rapidly (Pavek et al. 2013; Tilley et al. 2013), although rapid growth in not guaranteed (Pavek et al. 2013). Seed should not be planted any deeper than 0.25 inch (0.6 cm) (Pavek et al. 2013; Ogle et al. 2014). Because shaggy fleabane is insect pollinated, any growing and management practices that encourage native pollinator populations should be helpful to seed production. Indeterminate seed set will require multiple hand

harvests or other ingenious collecting techniques. See the Agricultural Seed Production section of the aspen fleabane chapter for potentially useful guidance on growing shaggy fleabane seed fields.

Agricultural Seed Certification. It is essential to maintain and track the geographic source and genetic purity of native species produced in cultivated seed fields. This means following Pre-Variety Germplasm (PVG) Certification requirements and standards as administered by state AOSCA offices. The PVG protocols track source and generation of planting stock and require field inspections for compliance. Isolation and control of prohibited weeds or other species are required. Proper seed harvesting, cleaning, sampling, testing, and labeling for commercial sales are monitored (Young et al. 2003; UCIA 2015).

Growers should apply for certification of their production fields prior to planting and plant only certified stock seed of an allowed generation. The systematic and sequential tracking through the certification process requires preplanning, knowing state regulations and deadlines, and is most smoothly navigated by working closely with state certification agency personnel. See the Wildland Seed Certification section for more on stock seed sourcing.

NURSERY PRACTICE

Shaggy fleabane nursery stock was grown successfully using the following protocols:

1) Methow Natives in Winthrop, Washington, seeded shaggy fleabane in flats filled with a 1:1:1 peat moss, perlite, and vermiculite mix, which was amended in 24 ft^3 (0.7 m^3) batches with 5 lbs (2 kg) dolomite lime, 7 lbs (3 kg) Osmocote fertilizer (18:6:12), half a cup of super phosphate, and 1 lb (0.5 kg) of micronutrient fertilizer. Flats were stratified outdoors for 4 months from November to March then brought into the greenhouse. Germination was good in the greenhouse and seedlings were transplanted into 10-$inch^3$ (0.2 m^3) cones in the summer and outplanted in the fall. Overall, shaggy fleabane grew well under nursery conditions (Camp and Sanderson 2007).

2) DeBolt (2016) sowed 3 to 10 shaggy fleabane seeds into containers (2.75 x 5.5-inch [7 x 14-cm]) filled with a 2:1:5 mix of lava fines, perlite, and Sunshine mix #4. Seeds were pressed lightly into the mix to about 0.125-0.25-inch (0.3-0.6 cm) depths and covered with thin layer of chicken grit. Containers were hand watered and put outdoors in mid-March and late-April. By early July, the germination rate was about 90%. Containers dried slightly between waterings, and a weak fish emulsion fertilizer was applied twice each month from April through June. Containers were moved to an outdoor shade house from July through September and outplanted in October. All flower stalks were removed as they appeared. Plants had healthy root development that filled the containers within 6 to 7 months of sowing seed outdoors in spring (DeBolt 2016).

Fungi (*Entyloma compositarum*, *Phyllactinia guttata*, *Puccinia stipae*, *Ramularia macrospora*, and *Septoria erigerontis*) were collected from shaggy fleabane plants growing in Oregon, Washington, Idaho, and Montana (Farr and Rossman 2017). These fungi were not reported as issues in nursery operations.

WILDLAND SEEDING AND PLANTING

Shaggy fleabane provides pollinator habitat in the revegetation and restoration of adapted sites with medium to coarse-textured soils receiving 6 to 17 inches (152-432 mm) of annual precipitation (Pavek et al. 2013; Ogle et al. 2014; Tilley et al. 2019). The recommended seeding rates range from 1 to 4 lbs/acre (1-4 kg/ha) for pure stands (Ogle et al. 2011; Tilley et al. 2013), but it is not recommended for use in pure stands (Ogle et al. 2014). Recommended seeding depths are 0.125 to 0.25 inch (0.3-0.6 cm) (Ogle et al. 2014).

Camp and Sanderson (2007) reported good establishment in one of two years of seeding in small plots in the Columbia Basin. Ten to twenty seeds were planted per plot in fall 2004 and again in fall 2005. Twenty percent of the 2004 plots had at least one plant in the following spring and 5% in the second spring. Ninety percent of the 2005 plots had at least one plant establish in the following spring (Camp and Sanderson 2007).

Irrigation (Camp and Sanderson 2007) and protection from herbivory (DeBolt 2016) can increase survival of shaggy fleabane plantings. Second season survival was greater when shaggy fleabane seedlings were irrigated than when not irrigated in the Columbia Basin. Seedlings were planted in fall 2004 (40 plants/treatment) and fall 2005 (50 plants/treatment). For the fall 2004 planting, 75% of irrigated and 65% of non-irrigated plants survived to the following spring and 18% of irrigated and 8% of non-irrigated plants survived to the second spring. For the fall

2005 planting, 50% of irrigated and 32% of non-irrigated plants survived to the following spring (Camp and Sanderson 2007). When nursery-grown shaggy fleabane plants (2.75 x 5.5-inch [7 x 14-cm] containers) were outplanted to rangeland sites in October, protection from herbivory substantially improved survival. Plants were watered at least once after planting (DeBolt 2016).

Additional field studies in establishing and managing plantings that include shaggy fleabane may provide some insight to ways to encourage establishment or manage revegetated sites. In semi-arid rough fescue and Idaho fescue-dominated grasslands in western Montana's Blackfoot River drainage, shaggy fleabane established significantly ($P < 0.05$) better on disturbed than on undisturbed plots (Maron et al. 2012). Field experiments evaluated rodent exclusion and disturbances on recruitment by adding 175 seeds to 1.5 × 1.5-foot (0.5 × 0.5-m) subplots. There were 0.2 or fewer shaggy fleabane seedlings in undisturbed, vegetated subplots and 0.7 seedlings in disturbed plots with and without rodent exclusion. Shaggy fleabane seed used in the experiments was collected from nearby. Subplot disturbances had all competitive vegetation removed and the top 4 inches (10 cm) of soil disturbed (Maron et al. 2012).

In field experiments conducted in mixed-grass prairie at the High Plains Grassland Research Station near Cheyenne, Wyoming, shaggy fleabane showed a cumulative negative response to nitrogen fertilization (Samuel and Hart 1998). The treatments applied nitrogen at rates of 20 to 30 lbs/acre (22-34 kg/ha) in late October or early March from fall 1974 through spring 1981. As the treatments began, there were several years where the frequency of shaggy fleabane was not significantly different on fertilized and control plots, but from 1983 to 1988, frequency was significantly ($P < 0.05$) greater on controls than any nitrogen-treated plots. Researchers noted that the effects could have been the result of fertilization itself or responses of associated vegetation and that effects of nitrogen fertilization on shaggy fleabane alone are unknown (Samuel and Hart 1998).

In rough fescue and Idaho fescue grasslands near Missoula in west-central Montana, shaggy fleabane typically recovered within 2 to 3 years of broadcast herbicide treatments targeting spotted knapweed (*Centaurea stoebe* subsp. *micranthos*). Picloram, clopyralid, and clopyralid + 2,4-D were applied at the recommended rates to control spotted knapweed. Herbicides were applied early when spotted knapweed was in the rosette to early bolt stage or applied late at the early to mid-flower stage (Rice and Christopher 1998).

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RESOURCES

AOSCA NATIVE PLANT CONNECTION

https://www.aosca.org/wp-content/uploads/Documents///AOSCANativePlantConnectionBrochure_AddressUpdated_27Mar2017.pdf

BLM SEED COLLECTION MANUAL

https://www.blm.gov/sites/blm.gov/files/programs_natural-resources_native-plant-communities_native-seed-development_collection_Technical%20Protocol.pdf

ENSCONET SEED COLLECTING MANUAL

https://www.publicgardens.org/resources/ensconet-seed-collecting-manual-wild-species

HOW TO BE A SEED CONNOISSEUR

http://www.utahcrop.org/wp-content/uploads/2015/08/How-to-be-a-seed-connoisseur20May2015.pdf

OMERNIK LEVEL III ECOREGIONS
https://www.epa.gov/eco-research/ecoregions

CLIMATE SMART RESTORATION TOOL
https://climaterestorationtool.org/csrt/

SEED ZONE MAPPER
https://www.fs.fed.us/wwetac/threat-map/TRMSeedZoneMapper.php

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