SHOWY MILKWEED

Asclepias speciosa Torr.

Plant Symbol = ASSP

Contributed By: USDA NRCS National Plant Data Center

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Uses

***Warning*:** Milkweed may be toxic when taken internally, without sufficient preparation.

Ethnobotanic: People have used milkweed for fiber, food, and medicine all over the United States and southern Canada. Fibers from the stems of milkweed have been identified in prehistoric textiles in the Pueblo region. Tewa-speaking people of the Rio Grande still make string and rope from these fibers. At Zuni, the silky seed fibers are spun on a hand-held wooden spindle and made into yarn and woven into fabric, especially for dancers. Pueblo people ate green milkweed pods and uncooked roots from one of the species that forms fleshy tubers underground.

Milkweeds (especially *Asclepias speciosa*) supply tough fibers for making cords and ropes, and for weaving a coarse cloth. Milkweed stems were collected after the stalks dried in late fall early winter. The dried stalks were split open to release the fibers; milkweed fibers were sometimes mixed with fibers of Indian-hemp (*Apocynum cannabinum*). The bark is removed and the fibers released by first rubbing between the hands and then drawing the fibers over a hard surface. Twisting the fiber opposite each other and twining them together formed the cord; often this was accomplished by rolling the fibers on the thigh while twisting them together.

Vast quantities of fiber plants are required for the making of nets, regalia, and cordage by California Indians. Blackburn and Anderson (1993) quote Craig Bates of the Yosemite Museum that it takes approximately five stalks of milkweed or Indian hemp to manufacture one foot of cordage. A Sierra Miwok feather skirt or cape contain about 100 feet of cordage made from approximately 500 plant stalks, while a deer net 40 feet in length contained some 7,000 feet of cordage, which would have required the harvesting of a staggering 35,000 plant stalks, (Barrett and Gifford 1933:178).

The young shoots, stems, flower buds, immature fruits, and roots of showy milkweed were boiled and eaten as a vegetable by various indigenous groups of eastern and mid-western America.

In some areas the young leaves and stems were used as greens. The flowers were also eaten raw or boiled, and the buds were boiled for soup or with meat. The most common use for these plants, recorded among almost all the tribes throughout California, was to obtain a kind of chewing gum from the sap of *Asclepias speciosa*. The sticky white sap was heated slightly until it became solid, then added to salmon fat or deer grease.

The sap of *Asclepias speciosa* was used as a cleansing and healing agent by some of the desert tribes for sores, cuts, and as a cure for warts and ringworm. The silky hairs were burned off the ripe seeds, which were then ground and made into a salve for sores. Seeds were boiled in a small amount of water and the liquid used to soak rattlesnake bites to draw out the poison. A hot tea made from the roots was given to bring out the rash in measles or as a cure for coughs. It was also employed as a wash to cure rheumatism. The mashed root, moistened with water, was used as a poultice to reduce swellings.

Insectary: Milkweed species are attractive to butterflies, bees, and other insects. Accordingly, this is a wonderful horticultural plant for beautiful floral landscaping that attracts butterflies (particularly Monarchs) and other insects.

Monarch butterflies are specific to milkweed plants. This is the only type of plant on which the eggs are laid and the larvae will feed and mature into a chrysalis. Eggs are laid on the underside of young healthy leaves. It is important to have large clumps of milkweeds for the young caterpillars; their response to predation is to drop to the ground and "play possum." They cannot find their way back to the milkweed stems, which they need to survive, unless they are fairly densely spaced.

Monarch, Queen and Viceroy butterflies are Müllerian mimics; all are toxic, and have co-evolved similar warning patterns to avoid predation. Other insects, which utilize milkweed, are the large milkweed bug, common milkweed bug, red milkweed beetle, blue milkweed beetle, and bees.

Toxicity: Milkweed sap contains a lethal brew of cardenolides (heart poison), which produces vomiting in low doses and death in higher doses. Chemicals from the milkweed plant make the monarch caterpillar's flesh distasteful to most animals. At one time, milkweed was classified as a noxious weed due to reported toxic effects on livestock, and efforts were made to eradicate it. Milkweeds are thought to be poisonous to cows and sheep.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status and wetland indicator values.

Description
General: Milkweed Family (Asclepiadaceae). *Asclepias* flowers look like crowns, with the corolla reflexed and hoods elevated above the corolla. Showy milkweed (*Asclepias speciosa*) is a hairy perennial with stems ascending to erect. The leaves are opposite, persistent, with short petioles, elliptic to ovate blades, and bases rarely cordate and clasping. The corolla is reflexed and rose-purple; the hoods are elevated above the corolla in pink, aging yellow. Horns are exerted beyond the hoods.

Distribution
For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site. Milkweed grows in clumps beside roadways and on abandoned farmlands and other open areas, reaching heights of 120 to 150 cm (4 to 5 ft) during the summer. Milkweed species grow throughout the United States. Showy milkweed occurs in many sunny, dry habitats including fields and roadsides, from 0 to 1900 m. The plant occurs in California to British Colombia and Central Canada south to Texas.

Establishment
Collect seeds after pods have ripened, but before they have split open. The seeds are wind dispersed, so be careful when gathering to place in a paper or burlap bag to avoid seed lost. Seeds can be directly sewn into the ground in the fall. The seed is very viable. Planting seed the first fall after collecting seeds maximizes revegetation success. It is not certain how long seeds can be stored.

Cold treatment for three months improves seed germination in some milkweed species from higher elevations or colder climates (where it freezes in the winter). Revegetation success with milkweeds seems to be improved by planting seeds directly in the ground. High mortality seems to occur with plants in pots and they don't overwinter well in pots. Milkweed plants naturally die back in winter, but re-emerge during the following spring unless planted in a pot

Whole Plant Collections: For milkweed species with rhizomes, propagation by cuttings of the tuberous rhizome is also easy and reliable. The cuttings should be made when the plant is dormant. Each piece of the rhizome should have at least one bud (they are about two inches apart). Timing of propagation is important. Harvest or divide plants and move them in October at the beginning of the rainy season. Place the plants in the ground by late fall so they can develop enough root growth to survive the winter. Irrigation the first year will improve survival, and by the second year the root system should be well enough established so plants will survive on their own. Both seedlings and cuttings will usually bloom in their second year, although cuttings will occasionally bloom during their first year (Kindscher 1992).

Management
When used for fiber, milkweed is collected in the autumn after the leaves have begun to senesce or dry up. Plants grow in places that have been disturbed such as road grading, construction sites, logging landing fills, and etc. Pete Bunting (pers. comm. 2-9-1999) says, "In the fall when the milkweed has dried I check to see if they will break off at the ground line. The plants are usually a yellow tan to gray depending on how long they have dried. I like the gray for softer string, but the fibers are shorter. The tan stalks have longer fibers but are also stiff and hard to work but very long. I break off as many of the plants as I can gather as they are going to resprout in the spring.

I try and let them dry some more. Then I process them. I have used plants that have over-wintered under snow and they were fine but had soft, short fiber. After 2 winters they are usually no good but you have another year's stalks to pick by then." The dried stalks are then split open and the fibers are twisted into string.

Both milkweed and dogbane were burned in the fall by California Indian tribes to eliminate dead stalks and stimulate new growth. Burning causes new growth to have taller, straighter stems with longer fibers. It also stimulates flower and seed production.

Cultivars, Improved and Selected Materials (and area of origin)

Seeds and plants of selected *Asclepias* cultivars are available from many nurseries. It is best to plant species from your local area, adapted to the specific site conditions where the plants are to be grown.

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For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

WESTERN YARROW

Achillea millefolium L. var. *occidentalis* DC.

Plant symbol = ACMIO

Contributed by: USDA, NRCS Bridger (MT) Plant Materials Center

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Alternate Name
Woolly yarrow

Key Web Sites
Extensive information about this species is linked to the PLANTS Web site. To access this information, go to the PLANTS Web site, select this plant, and utilize the links at the bottom of the Plant Profile for this species.

Uses
Conservation: Western yarrow is an early successional species that readily establishes on disturbed sites. It is recommended for adding species diversity in native seed mixtures for rehabilitation of disturbed sites such as rangelands, minelands, roadsides, park and restoration areas, prairie reconstruction projects, and farm bill program conservation plantings. Secondary use is for ornamental application in pollinator friendly, low maintenance, or naturalized landscapes.
Forage: Western yarrow is a food source for bighorn sheep, pronghorn antelope, and deer. Sage-grouse, especially chicks, and other upland birds rely heavily on the foliage of western yarrow as a food source. Sage-grouse chicks also benefit from eating the insects associated with yarrow. In Montana, domestic sheep and goats derive approximately 40 percent of their summer diet from western yarrow, while it constitutes 20 percent of cattle and horse diets (Reitz and Morris, 1939). The leaves and flowers contain volatile oils, alkaloids, and glycosides that are considered toxic, but the plant is seldom overgrazed and eaten in large enough quantities to be harmful to foraging animals.
Ethnobotanic: Native Americans used western yarrow for many purposes, such as a tea to cure stomach ailments, a poultice on infected wounds, and as a mosquito repellant.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g., threatened or endangered species, state noxious status, and wetland indicator values).

Weediness
Western yarrow is not to be confused with the introduced, invasive plant, common yarrow (*Achillea millefolium* var. *millefolium*). Common yarrow has origins in central Asia, the European continent, and the islands of Scandinavia. It is considerably different from western yarrow in that it has a much taller stature, aggressive vigor, and weedy characteristics. Common yarrow also initiates a later sequence of flowering and seed ripening (Callan, 2002).

Western yarrow is a common component of western rangelands and only under definite conditions of overgrazing and disturbance could it become locally abundant (USDA FS, 1937). Yarrow is seldom regarded as a problem weed (Whitson et al., 1991) except on heavily disturbed, arable sites with favorable environmental conditions (Kannangara and Field, 1985).

This plant may become weedy or invasive in some regions or habitats and may displace desirable vegetation if not properly managed. Please consult with your local NRCS Field Office, Cooperative Extension Service office, or state natural resource or agriculture department regarding its status and use. Weed information is also available from the PLANTS Website at http://plants.usda.gov/

Description
General: Western yarrow *Achillea millefolium* L. var. *occidentalis* DC.--synonyms *Achillea*

millefolium L. ssp. *occidentalis* (DC.) Hyl., *Achillea millefolium* L. var. *lanulosa* (Nutt.) Piper, and *Achillea millefolium* L. ssp. *lanulosa* (Nutt.) Piper--is a member of the Asteraceae family that is commonly found in natural and disturbed habitats throughout the western U.S. (Hitchcock and Cronquist, 1973). It is a self-incompatible, insect-pollinated species (Clausen et al., 1958) occurring as native forms that may differ in chromosome number (n=18 or n=27); native races originating in the western U.S. (except the Pacific coast) are mostly tetraploid and introduced races mostly hexaploid (Hitchcock et al 1955). Botanists currently acknowledge genetic and ecological differentiation among native ecotypes at the local and regional level (Lavin, 2002; Lesica, 2001).

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Taxonomic: Western yarrow is a moderately rhizomatous, long-lived, native, herbaceous perennial forb. It is 30-100 cm tall with few to many unbranched, erect, lanate stems (Cronquist et al., 2002). Leaves are alternate, sessile, pinnately dissected, semi-evergreen, and aromatic with an anthemideous scent (chamomile or dog fennel-like odor). The basal rosette foliage is up to 25 cm long, and cauline leaves are typically up to 10 cm long and 3 cm broad. Inflorescences are arranged in a compound, flat-topped corymb 6-20 cm wide, consisting of numerous, small flower heads 4-6 mm in diameter. Involucre bracts are usually pubescent and greenish, with papery, straw-colored margins (Robinson and Fernald, 1908). Outside ray flower numbers are 3-12, mostly white to cream-colored, 1-2.5 mm long and encircle the center disk flowers. The disk flowers number 10-75 each, and are yellow, tubular, perfect, and seed-producing. Fruit is a flattened, glabrous achene with compressed margins in a mostly reverse egg-shape with no pappus (USDA FS, 1966).

Distribution
For current distribution, please consult the Plant Profile page for this species on the PLANTS Website.

Habitat
Western yarrow is one of the most abundant and widely distributed wildflowers in the western United States. It is circumboreal and grows in a variety of plant communities from Alaska across Canada and into northern Mexico (Johnson and Larson, 1999). Western yarrow prefers full sun on roadsides, hills, canyons, pastures, and disturbed areas. It is scattered in sagebrush areas, open timber, and subalpine zones.

Western yarrow thrives in droughty conditions on gravelly loam and on thin or sandy soils. It is a common component of such ecological sites as shallow, silty, shallow to gravel, and silty steep (USDA SCS, 1976). Associated species include western wheatgrass, bluebunch wheatgrass, prairie Junegrass, Sandberg bluegrass, common gaillardia, big sagebrush, and prairie coneflower.

Adaptation
Western yarrow is highly variable and displays wide ecological amplitude to diurnal temperature, altitude, latitude, and climatic (Hiesey and Nobs, 1970) and edaphic conditions (Higgins and Mack, 1987). It is considered an "environmental specialist" due to the successful evolution of a number of ecotypic races (Taylor, 1992).

Establishment
Natural: Western yarrow initiates growth in early spring and blooms for an extended period of time from late spring through mid summer (Budd and Campbell, 1959).

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It reproduces by seed and vegetatively, but in undisturbed habitats the rhizomes remain attached to the parent plant and vegetative spread is relatively low (Bostock and Benton, 1979). In disturbed areas, rhizome fragments do not survive on the soil surface, and bud sprouting success in buried rhizomes is dependant on fragment length and soil depth (Bourdot, 1984). The growth performance of western yarrow is reduced under conditions of increased competition and shading (Bourdot et al., 1984 and 1985). It is rated as good in maintaining a state of evergreenness (Monsen et al., 2004) and is not highly flammable, although flames can wick up through the hollow, dry flower stalks. Late-spring burning will reduce western yarrow (Anderson et al., 1970), as will heavy fires. In certain environments yarrow populations tend to temporarily increase after less intense fires (Bartos and Mueggler, 1981). Studies conducted on the use of yarrow as a sodding technique in erosion control projects have produced satisfactory results (Airhart, 1988).

Direct Seeding: Viability of fresh western yarrow seed is generally high and seeds germinate under normal test conditions in 2 to 8 days, with 75 percent germination occurring in 5 days (Sorenson and Holden, 1974). Seed should be planted into a firm, weed-free seedbed with a drill that will ensure uniform seed placement to a depth of ⅛ to ¼ inch (3 to 6 mm) or broadcast seeded, then harrowed or raked, and firmed with a packer or roller. Field conditions during seedling emergence must be monitored for impermeable crusts, especially on sites with clayey soils. If crusting is observed, the soil crust can be fractured with a roller or periodic sprinkler irrigation

There are approximately 4.4 million seeds/lb (9.5 million seeds/kg). The full seeding rate is ¼ to ½ lb/acre (0.3 to 0.6 kg/ha) pure-live-seed (PLS), but western yarrow would seldom be seeded in a pure stand. It is recommended that western yarrow be included as a component of a native seed mixture, where the seeding rate is adjusted to the desired potential of the plant community. Spring seeding is preferred over a dormant fall planting date. Periodic mowing during the establishment year is one option for weed suppression.

Containers: Containers should be sown in fall for outside nursery production and in spring for production in the greenhouse. Pots are filled with a well-drained soilless medium and wetted prior to seeding. Seeds are placed directly on the surface and lightly covered with a thin layer of the medium, perlite, or pea gravel, and then thoroughly irrigated.

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Containers are kept moist with light irrigation or misting during the establishment phase. Germination occurs in 6 to 14 days at approximately 70° F, followed by rapid root and shoot development over the next 60 days. Supplemental nutrition is not necessary, but may be applied at the recommended rate as a controlled release, encapsulated fertilizer (Luna et al., 2004).

Potted material should be acclimated to natural spring temperatures for at least 1 month prior to lining out. The site should be prepared so that the soil is workable, but not so loose as to resist packing. Transplants are placed in a hole slightly deeper than the length of the root ball, firmly tamped to remove unwanted airspace, and watered until the soil is settled. Additional soil may be required to fill cracks as they occur around the plants. Supplemental irrigation is advised for as long as feasible, or on a regular basis during the active growing season to promote flowering and seed set. Survival is high in increase plantings receiving proper care, but lower on sites with existing vegetation (Skinner, 2003).

Management

There is a high potential for using this species to revegetate alpine and subalpine disturbances, and in other degraded areas of the western U.S (Wasser, 1982). New seedings may need protection from trampling and weeds during establishment. Clipping weeds above the seedlings is a preferred method of weed suppression as there are no herbicides selective for broadleaf plants. Western yarrow vigor, aesthetics, and stand persistence after establishment may be sustained with properly timed grazing or defoliation of associated species. Satisfactory control of western yarrow is achieved through herbicide application mixtures of dicamba and dichlorprop (Robocker, 1977). Always consult product label

prior to application and properly follow recommendations.

Pests and Potential Problems
Inflorescences that are harvested for seed production often contain small quantities of insect larvae and numerous live insects. Many beneficial and pollinating insects, such as minute pirate bug (*Orius*), big-eyed bug (*Geocoris*), hoverflies (Syrphidae), and several tachnid flies (*Archytas apicifer*, *Gymnosoma*, *Tricopoda pennipes, Cylindromia*) are known to frequent yarrow plants (Long, 2001). Pest insects include common leaf bugs (*Lygus*) and flea beetles (Chrysomelidae). Root rot and mildew may occur in poorly drained soils (Warwick and Black, 1982).

Environmental Concerns
Western yarrow is a pioneer species and considered an increaser where the forage resource has been overstocked and excessively utilized. It should be considered noninvasive when used within a diverse plant community in its anticipated area of adaptation.


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Seed Production
Production fields should be seeded at a rate of 25 PLS per linear foot of row (82 per linear meter of row). Between-row spacing is dependent on the type of planting and cultivation equipment, and ranges from 22 to 36 in. (56 to 90 cm). Adequate between-row space should be provided to perform mechanical cultivation. At 24-in. row spacing, the recommended seeding rate is 0.12 PLS lb/acre (0.14 kg/ha), and at 30- and 36-in. row spacing, the seeding rate is 0.09 and 0.08 PLS lb/acre (0.1 and 0.09 kg/ha), respectively. There are presently no herbicides specifically labeled to control weeds in seed production fields. Seed harvest can be accomplished by swathing and combining from the cured windrows, or direct combining. The indeterminate ripening may necessitate periodic mechanical stripping as seedheads mature.


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Seed is processed over a two-to three-screen fanning mill (slotted mesh screens), with final cleaning over an indent cylinder or gravity table. An acceptable seed quality testing standard is 95 percent purity and 80 percent viability (Stevens and Meyer, 1990). Seed production of 100 to 150 lb/acre (112 to 170 kg/ha) can be expected under irrigated conditions. Seed longevity is at least 5 years when stored at moderate temperatures and low humidity (USDA NRCS, 2004).

Cultivars, Improved, and Selected Materials (and area of origin)
Great Northern Germplasm is a selected class release of western yarrow originally collected in 1988 in Flathead County, Montana. This 2004 release was selected for top performance in vigor, height, seedhead production, and survival from among 29 accessions of native yarrows from Montana and Wyoming. It is adapted for use in northern Idaho, and all of Montana and Wyoming, except the Red Desert and Bighorn Basin. G_1 seed (analogous to Foundation seed) will be maintained by the USDA NRCS Bridger Plant Materials Center and is available to commercial growers through the Foundation Seed Program at Montana State University-Bozeman and the University of Wyoming Foundation Seed Service at Powell, Wyoming. Commercial production is limited to two generations beyond G_1.

Yakima Germplasm is a source-identified, composite release of western yarrow from 27 collection sites on the U.S. Army Yakima Training Center in Yakima, Washington. Yakima Germplasm western yarrow is intended for use in the rehabilitation and restoration

of western rangelands. The USDA-ARS Forage and Range Research Laboratory, Logan, Utah, will maintain G_1 seed and it will be made available to growers through the Utah Crop Improvement Association. Seed through the G_4 generation will be eligible for certification.

Control

Please contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for each control method. Trade names and control measures appear in this document only to provide specific information. USDA NRCS does not guarantee or warranty the products and control methods named, and other products may be equally effective.

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United States Department of Agriculture
Natural Resources Conservation Service

Plant Guide

BLUE FLAX
Linum perenne L.
plant symbol = LIPE2

LEWIS FLAX
Linum lewisii Pursh
PLANT SYMBOL = LILE3

Contributed By: USDA, NRCS, Idaho State Office & National Plant Data Center

Figure 1. Maple Grove Lewis flax (*Linum lewisii*)
Derek J. Tilley, USDA NRCS

Alternate Names
Prairie flax

Uses
Ethnobotanic: Cultivated flax (*Linum usitatissimum*) is grown both for fiber (flax) and seed oil (linseed). Linseed oil may cause skin irritation upon contact. Ingestion of linseed oil causes difficulty of breathing, paralysis, and convulsions (Russell et al. 1997).

Grazing/rangeland: Blue and Lewis flax are noted to have fair forage value for livestock and wildlife during spring and winter. Plants stay green throughout the growing season providing some forage value. Birds use the seed and capsules in fall and winter. All species provide diversity to the seeded plant community.

Erosion control/reclamation/greenstripping: All flax species are noted for their value in mixes for erosion control and beautification values. The six week flowering period and showy blue flowers make seeded landscapes more aesthetically pleasing and increase plant biodiversity. Due to the semi-evergreen nature of the species, flax can also be used as a fire suppressant species in green strip plantings.

Wildlife: Flax is considered desirable forage for deer, antelope, and birds, either as herbage or seed. They may also provide some cover for selected small bird species.

Status
Consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description
General: Flax Family (Linaceae). *Linum perenne* is introduced from Eurasia. *Linum lewisii* is a comparable U.S. native plant (Figure 1). In general, flax is an annual or short-lived, semi-evergreen perennial forb, sometimes semi-woody at base with attractive flowers ranging from white to blue to yellow to red in color. The flax species with yellow to red flowers can be toxic to livestock. Common in the western United States, blue flax is considered a woody sub-shrub in the PLANTS database (USDA, NRCS 2000). According to Cronquist et al. (1997), "the only significant difference between *Linum lewisii* and the Eurasian *Linum perenne* appears to be that the former is homostylic, and the latter heterostylic."

Flax plants have many narrow, small, alternate (rarely opposite), simple and entire leaves that are sessile (lacking stalks) on the stems. The perfect and regular, generally showy flowers are borne in racemes or cymes. The sepals, petals, and stamens are five, the fruit a capsule, and the seeds in most species are mucilaginous when wet.

Distribution
Lewis flax can be found from Alaska to California and east to Minnesota in mixed grass, sagebrush, shadscale, piñon-juniper, mountain brush and aspen communities and in openings in coniferous forests. Blue flax is native to Eurasia and has been planted successfully throughout the United States. For current distribution, consult the Plant Profile page for this species on the PLANTS Web site.

Adaptation
Flax species do best on well-drained soils. Most ecotypes do well on infertile, disturbed soils. They have excellent cold winter and drought tolerance. They will tolerate weakly saline to weakly acidic sites. Plants are usually found in open areas, but will tolerate semi-shaded conditions. They are fire resistant since leaves and stems stay green with relatively high moisture content during most of the fire season.

Figure 2. Test plots of 'Appar' blue flax (*Linum perenne*) . Derek J. Tilley, USDA NRCS

Establishment
Planting: Flax should be seeded with a drill or broadcast at a depth of 1/4 inch or less into a firm seedbed. The ideal seeding depth is 1/8 inch. Flax is not recommended for single species seedings. The full seeding rate (not recommended) for these forbs is 4 pounds Pure Live Seed (PLS) per acre or 24 PLS per square foot. When used as a component of a mix, adjust to percent of mix desired. For mined lands and other harsh critical areas, doubling the seeding rate component of flax is not required.

The best seeding results are obtained from seeding in late fall to very early spring (due to the grass component of mixes) on heavy to medium textured soils and in late fall on medium to light textured soils. Late summer (August - mid September) seeding is not recommended. Dormant fall seedings (preferred seeding period for flax) will pre-chill seed and reduce seed dormancy which may be present. Mulching, irrigation, and weed control all benefit stand establishment. Seedling vigor is good, but not as good as most grasses. Germination normally occurs the first growing season, but may not occur until the second growing season. Full flowering should not be expected until at least the second growing season.

Stands may require weed control measures during establishment. Because flax is a broadleaf plant, use of 2,4-D is not recommended. Mow weeds at or prior to their bloom stage. Grasshoppers and other insects may also damage new stands and pesticides may be needed.

Management
Growth of flax begins in early spring and flowers appear in mid May through early July depending on species. Weed control and removal of very competitive species may improve chance of establishment. Damage from wildlife and rodents may occur and they may need to be controlled. Disease problems are minimal with flax; however fungus problems have been noted for some native species.

Environmental Concerns
Flax species establish relatively quickly and easily via seed under favorable climatic conditions. They are not rhizomatous or considered "weedy" or invasive species, but could spread into adjoining vegetative communities under ideal climatic and environmental conditions. They coexist with other species and add biodiversity to those plant communities. 'Appar' blue flax seed normally germinates the first growing season following planting under favorable temperatures if moisture is available and it generally does not maintain a viable seed-bank. Native flax accessions tested maintain a portion of seed, which does not germinate the first growing season, as a viable seed-bank.

Seed Production
Flax should be seeded in 24 inch rows at the rate of 2.5 pounds PLS per acre or 36 inch rows at the rate of 1.5 pounds PLS per acre (25 to 30 seeds per linear

foot of row) to allow mechanical weed control. It should be seeded in early spring (April - May). Seeds that do not germinate in the year of planting will probably germinate in the following year.

Hand rouging within row and cultivation between rows may be required. Split applications of nitrogen in spring and fall and application of phosphorus in fall will enhance seed production. For optimum production, alleviate moisture stress on plants during late-bud stage, pollination and re-growth.

Seed is generally harvested in late July to mid-August by windrowing before seed shatter and combining with pickup attachment once green stems have dried. Seed is mature when capsules are dry and seed is hard and dark in color. Flowering is indeterminate with mature capsules and the possibility of some flowers present at harvest period. Some seed will shatter once capsules open. Seed

should be allowed to dry to 12% moisture or less before placing in bins or to 15% moisture or less before placing in sacks, and then stored in a cool dry area. Seed retains viability for several years under these conditions.

Seed yields of 600 to 700 pounds per acre of blue flax can be expected under irrigated conditions and 200 to 300 pounds per acre under dryland conditions.

Seed yields of Lewis flax from irrigated fields average 300 to 350 pounds per acre. Seed production of Lewis flax under dryland conditions is not recommended below 16 inches of average annual rainfall.

Cultivars, Improved and Selected Materials (and area of origin)

Foundation and registered seed is available for each variety through the appropriate state Crop Improvement Association or commercial sources.

'Appar' blue flax (*Linum perenne*) is a selected release from seed originally collected in the Black Hills of South Dakota. Appar was selected by the Forest Service Forest and Range Experiment Station and Aberdeen Plant Materials Center for outstanding vigor, beauty, and competitiveness with grasses prevalent on sites where it was collected. The Natural Resources Conservation Service, University of Idaho Agricultural Experiment Station, Utah Division of Wildlife Resources, and the Forest Service Forest and Range Experiment Station released Appar in 1980. Appar was released as native flax (*Linum lewisii*), but was later determined to be *Linum perenne*,a naturalized introduced species of European origin. Appar was named in honor of A. Perry Plumber, Forest Service (retired), who collected the original material. Appar is a hardy, relatively short-lived, introduced perennial forb, 12 to 36 inches tall, with deep blue flowers that bloom profusely for about six weeks beginning in mid May. It is well adapted to sunny open slopes, well-drained soils from moderately basic to weakly acidic, 10 to 18 inch rainfall areas, at 1,000 to 6,000 feet elevation. It has some shade tolerance, but is not tolerant of poor drainage, flooding, or high water tables. It does well seeded in mixtures with other species. Its intended uses are erosion control, reclamation, highway right-of-ways, homes, gardens, parks, diversity, and beautification. Special note: Prior to release Appar was evaluated by the ARS Poisonous Plants Laboratory (Logan, UT) for poisonous compounds toxic to mammals and was found to not have any.

Certified seed is readily available through commercial sources and breeder seed is maintained by Aberdeen Plant Materials Center.

Separating Appar Blue Flax from Maple Grove Lewis Flax

Appar: darker blue flowers and styles of two different lengths (much shorter than anthers, or somewhat longer than the anthers).

Maple Grove: pale blue flowers and styles much longer than the anthers.

Maple Grove Germplasm Lewis flax (*Linum lewisii*) is a recent (2003) Selected Class Germplasm release of a native collection from the Maple Grove, Utah area. Maple Grove was selected by the Forest Service Forest and Range Experiment Station and Aberdeen Plant Materials Center for outstanding vigor, beauty, and competitiveness with grasses prevalent on sites where it was collected. The Natural Resources

Conservation Service, University of Idaho Agricultural Experiment Station, Utah Division of Wildlife Resources, and the Forest Service Forest and Range Experiment Station released Maple Grove in 2003. Maple Grove is a hardy, relatively short-lived, native perennial forb, 12 to 36 inches tall, with light blue flowers that bloom profusely for about six weeks beginning in mid May. It is well adapted to sunny open slopes, well-drained soils from moderately basic to weakly acidic, 10 to 18 inch rainfall areas, at 1,000 to 6,000 feet elevation. It has some shade tolerance, but is not tolerant of poor drainage, flooding, or high water tables. It does well seeded in mixtures with other species. Its intended uses are erosion control, reclamation, highway right-of-ways, homes, gardens, parks, diversity, and beautification. Certified seed is available through the University of Idaho Foundation Seed Program and Utah Crop Improvement Associations and Soil Conservation Districts in Idaho, Utah and Nevada. Certification of seed shall be limited to not more than two generations from the Generation-3 seed.

There are numerous flax species native to the U.S. that may be available through native plant nurseries and seed companies. These include the following: *Linum alatum* (TX & LA), *Linum arenicola* (FL), *Linum aristatum* (UT

& AZ to TX), *Linum berlandieri* (CO to LA), *Linum catharticum* (northeast US), *Linum compactum* (MT & ND to NM & TX), *Linum intercursum* (Atlantic states), *Linum lewisii* (central & west US), *Linum medium* (east & central US), and *Linum virginianum* (east & midwest US). Please check the PLANTS database for other native flax species.

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USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Guide

FIRECRACKER PENSTEMON

Penstemon eatonii A. *Gray*

Plant Symbol = PEEA

Contributed by: USDA NRCS Idaho and Utah Plant Materials Program

Richfield Selection firecracker penstemon (Derek Tilley, Aberdeen PMC)

Alternate Names

Eaton's beardtongue, scarlet-bugler penstemon, *Penstemon eatonii* ssp. *eatonii*, *Penstemon eatonii* ssp. *exsertus*, *Penstemon eatonii* spp. *undosus*

Uses

Firecracker penstemon is chiefly used as a forb component for restoration and wildlife enhancement projects. It is not noted for having value as forage for livestock and forage use is limited by big game. Its showy flowers attract pollinators and other insects which provide a food source for birds and other animals. The fibrous root system and wide canopy cover make it a good plant for low-water use landscaping (i.e. roadsides) and other ornamental plantings.

Firecracker penstemon was used by Native Americans for the treatment of: spider bites, stomach troubles, to reduce bleeding, backache, snakebite, as a veterinary aid, and for healing of burns (Native American Ethnobotany Database).

Status

Consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g., threatened or endangered species, state noxious status, and wetland indicator values).

Description

General: Figwort Family (Scrophulariaceae). Firecracker penstemon is an erect, perennial, cool-season, short-lived forb, 40-100 cm (16-39 in) tall with scarlet (bright red) colored flowers. Leaves are cauline, 30-90mm (1.2-3.5 in), widely lanceolate to ovate, and entire. The flower calyx is 3.5-6 mm (0.1-0.2 in), lobes ovate. The corolla is 24-33 mm (0.9-1.3 in), cylindric, obscurely 2 lipped, lobes sub equal, barely spreading, glabrous (Hickman, 1993). Chromosome number is n=8 (Parfitt, et al, 1990).

There are three subspecies recognized. *P. eatonii* ssp. *eatonii*, *P. eatonii* ssp. *exsertus*, and *P. eatonii* ssp. *undosus*. Cronquist et al. (1984) provides a key separating *eatonii* from u*ndosus* and notes the key characteristics for *exsertus*. The ssp. *eatonii* is glabrous throughout and ssp. *undosus* is puberulent (covered in soft downy hairs). The ssp. *exsertus* has conspicuous exerted anthers and is also puberulent.

Distribution: Firecracker penstemon is found in North America, west to southwest from Colorado to California and south into New Mexico and Arizona. The *Penstemon* genus is common to western North America and except for one minor species, does not occur naturally outside of North America. The ssp. *eatonii* occurs in the northern portion of the species range from Idaho to California and Colorado. The ssp. *undosus* occurs from southern Utah to New Mexico, Arizona and southern California. The ssp. *exsertus* is limited in distribution, occurring in central Arizona. For additional information on distribution, consult the Plant Profile page for this species on the PLANTS Web site.

Habitat: Firecracker penstemon is found on dry slopes and flats in sagebrush, pinyon-juniper, mountain mahogany and ponderosa pine plant

communities at 3,300-8,000 feet elevation in 10-16 inch annual rainfall zones (Ogle et al. 2011).

Adaptation
Firecracker penstemon is adapted to shallow rocky, to stony loams, sandy loams, and gravelly loams that are moderately to very well-drained. It does not grow well in areas with poor drainage. It can survive in full sunlight, but may not tolerate hot, dry areas. It survives cold winter temperatures in the northern portion of its range if snow depths are adequate to cover the plant (USDA-NRCS, 2006). It is adapted to USDA Plant Hardiness Zones 4a to 8b and pH ranges of 6.6 (slightly acidic) to 8.5 (alkaline) (Dave's Garden, 2011).

Establishment
A study conducted to correlate habitat and germination response found that firecracker penstemon seed from colder winter sites had longer chill (stratification) requirements and were slower to establish than seed from warmer winter sites (Meyer,1992). Because of the seed stratification requirement, firecracker penstemon should be seeded in late fall with a drill or broadcast planted and then pressed to a depth of ⅛ to ¼ inch into a firm seedbed. Good seed to soil contact is important for germination and establishment. The full seeding rate is 3 pounds Pure Live Seed (PLS) per acre and there are approximately 315,000 seeds per pound (Ogle, et al. 2011). When used as a component of a seed mix, adjust to the percent of mix desired.

Mulching, irrigation and weed control benefit stand establishment. Some planted seed may not germinate until the second growing season. Flowering should not be expected until the second growing season.

Weed control will be required during establishment. Because penstemon is a broadleaf plant, the use of broadleaf type herbicides is not recommended. Mow weeds at or prior to bloom stage.

Management
Firecracker penstemon should be used as a minor component of seed mixtures. Management strategies should be based on the key species in the established plant community. Grazing should be deferred on seeded lands for at least two growing seasons to allow for full stand establishment.

Pests and Potential Problems
Firecracker penstemon is susceptible to soil-borne fusarium and rhizoctonia root rot which can be severe in poorly drained loam and clay textured soils (USDA-NRCS, 2006). There are no known insect problems (USDA-NRCS, 2006).

Environmental Concerns
Firecracker penstemon is a native plant species in western North America and has no known negative impacts on wild or domestic animals. It is not considered a weedy or invasive species but can spread to adjoining vegetative communities under ideal conditions. It co-exists with other native species and adds biodiversity to plant communities.

Seed and Plant Production
Fields for seed production can be established from direct seeding or from transplanting greenhouse grown containerized stock. Direct seeding should take place in late fall to allow for natural stratification of the seed. Firecracker penstemon should be seeded in 30-36 inch rows at a rate of 1.3 pounds PLS per acre (target 30 pure live seeds per linear foot of drill row) to allow for mechanical weed control. The use of weed barrier fabric is an alternative to allow closer spacing, reduce weeds and conserve soil moisture. Plant spacing of 18 inches provides for maximum growth and seed yield when using weed barrier fabric.

Richfield Selection firecracker penstemon seed production field at Aberdeen PMC utilizing weed barrier fabric. (Loren St. John, Aberdeen PMC).

Transplants grown in a greenhouse can be established by seeding into cones or flats in winter for natural stratification or by stratifying the seed for 8 to 12 weeks in cold and moist conditions prior to planting seed. Treatment of seed with gibberellic acid (GA_3) may reduce the stratification requirement (Kitchen and Meyer, 1991). Seed should be surface sown and pressed firmly into the soil surface. Flats or containers should be blocked from sunlight during the stratification period to prevent mold and fungus from establishing on the soil surface during stratification. A very thin covering of fine to medium grade perlite on the soil surface after emergence in containers or flats helps to prevent excessive moisture around the emerging seedling and limits damping-off of young seedlings. Allow seedlings to grow in the greenhouse for 8-12 weeks before transplanting to the field. Transplants can also be made from dividing the base of older plants.

Firecracker penstemon seedlings growing in greenhouse trays. (Loren St. John, Aberdeen PMC)

Seed harvest can be accomplished by hand or by mechanical means. Seed is mature when capsules are dry and seed is hard and dark in color. Flowering is indeterminate with mature capsules and flowers present at harvest. Harvest should occur when the majority of seed capsules begin to dry and open. Plants may be swathed ahead of combining to allow more uniform ripening and drying. Plants are swathed to a height above most leaves to capture flower stalks. Stalks are then allowed to sit on top of the swathed plants for 4-5 days before combining. Seed can be separated from the capsule by use of a hammer mill or debearder and processed with an air-screen cleaner. Estimated seed yield is about 100 pounds per acre. Seed will maintain viability under cool and dry storage conditions for about 7-8 years with a gradual decline in viability over time. Seed production peaks at about 3 years and then plants start to die due to the short-lived nature of the species.

Pollinators can enhance seed production and seed yield. It is generally reported that hummingbirds are the sole pollinators of firecracker penstemon (Bateman, 1980) but recent studies by Cane and Dunne (in progress) suggest that generalist bees (*Apis*, *Anthophora*) consistently generated larger seed yields of firecracker penstemon with seed yields approaching 275 pounds per acre by the placement of hives near the field and in the absence of hummingbirds.

Cultivars, Improved, and Selected Materials (and area of origin)

Richfield Selection firecracker penstemon was released by the Aberdeen, Idaho Plant Materials Center in 1994 as pre-variety germplasm. The original collection was made near Richfield, Utah in 1974 and was selected from a collection of 119 penstemon accessions. The Richfield Selection was released for its beauty, hardiness, seed production and natural range of adaptability. It had the best stand establishment and longest survival. Certified seed is available and Generation 1 (G1) seed is maintained by the Aberdeen Plant Materials Center. Growers may produce one generation each of G2 and G3 seed (USDA-NRCS, 2006).

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PALMER'S PENSTEMON

Penstemon palmeri A. Gray

Plant Symbol = PEPA8

Contributed by: USDA NRCS Idaho State Office and National Plant Data Center

Palmer's penstemon. John Hixson, Ladybird Johnson Wildflower Center.

Alternate Names

Common Alternate Names: Palmer's beardtongue, scented beardtongue, balloon flower
Scientific Alternate Names: *Penstemon palmeri* var. *palmeri*, *Penstemon palmeri* var. *macranthus*, *Penstemon palmeri* var. *eglandulosus*

Uses

Grazing/rangeland/wildlife: Palmer's penstemon produces succulent foliage during the spring and summer and is selectively used by small birds, big game and livestock. It also provides high quality forage during the winter (Stevens and Monsen, 1988).

Erosion control/reclamation: Palmer's penstemon provides good ground cover for controlling erosion and stabilizing disturbed and burned sites (Stevens and Monsen, 1988; Ogle, et. al., 2012). It has also been used for revegetation of mines and mine spoils.

Pollinators: Flowers of Palmer's penstemon attract bumblebees (*Bombus* sp.), carpenter bees (*Xylocopa* sp.) and digger bees (Anthophorini tribe) (Wilson, et. al., 2003).

Ornamental: Palmer's penstemon produces persistent foliage and abundant, aromatic flowers that are pleasing in ornamental settings.

Ethnobotany

The Kayenta Navajo prepared a poultice of the plant to apply to snakebite sores (Native American Ethnobotany Database).

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g., threatened or endangered species, state noxious status, and wetland indicator values).

Description

General: Figwort Family (Scrophulariaceae). Palmer's penstemon is a short-lived (4-5 years), evergreen, native, perennial herb to slightly woody subshrub 50-140 cm tall with a thick crown and fibrous taproot that can reach to 1m deep. The plant is glabrous and glaucous with fleshy leaves. The leaves are opposite, dentate, 6-10 cm long and 1.5-3 cm wide with the upper ones smaller and sometimes triangular. Palmer's penstemon has long flowering stalks that are up to 140 cm tall. Flower clusters are 2-4 flowered and the flowers range from white to lavender pink color with prominent red-violet colored guidelines on the lower lip and inside the strongly inflated throat. Flowers of Palmer's penstemon give off a pleasant fragrance which is unique among penstemon species. The fruit is a many-seeded capsule. Cronquist, et. al. (1984) recognizes three botanical varieties and provides a key to distinguish them based on floral and leaf characteristics as well as geographic distribution.

Distribution: Palmer's penstemon is found in the western United States from Wyoming south to New Mexico and westward to California. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Habitat: Palmer's penstemon is found in blackbrush, sagebrush, Joshua tree, pinyon-juniper and ponderosa pine communities where subsurface moisture is available for most of the growing season and elevation ranges from 2,600-8,200 feet above sea level (Cronquist et. al., 1984).

Adaptation
Palmer's penstemon is best adapted to well-drained, slightly acidic to slightly alkaline, coarse textured soils in areas receiving 10-16 inches annual precipitation and has excellent cold and drought tolerance (Ogle, et. al., 2012). Once established it can persist on sites receiving as little as 8 inches of annual precipitation (Stevens and Monsen, 1988). It has intermediate tolerance to salinity especially during periods of cool temperatures and lower light intensities (Zollinger, et. al., 2007). Palmer's penstemon is usually found in open areas but will tolerate semi-shaded conditions. It is not tolerant of fire, but is somewhat fire resistant due to leaves staying green with relatively high moisture content during wildfire season.

Establishment
Meyer and Kitchen (1992) observed cyclic seed dormancy in Palmer's penstemon. Chilling causes the seed population to diverge into spring-germinable and spring dormant fractions allowing the seed bank to persist from year to year. The general recommendation is to plant seed in the fall from 1/8 to no more than ¼ inch depth into a firm, weed-free seedbed. Good seed to soil contact is important for germination and establishment. The full seeding rate is 2 pounds Pure Live Seed (PLS) per acre (Ogle, et. al., 2012) and there are approximately 586,000 - 600,000 seeds per pound (Stevens and Monsen, 1988; USDA PLANTS database). When used as a component of a seed mix, adjust the seeding rate to the percent of mix desired. Stevens and Monsen (1988) recommend drilling Palmer's penstemon through a legume box on a drill or with a seed dilutent such as rice hulls because the seeds are small and may separate from other seeds in a mix. Vigorous seedlings appear in the spring, compete well, and usually are not eliminated by competition from other species (Monsen, et. al., 2004).

Mulching, irrigation and weed control benefit stand establishment. Some seed may not germinate until the second growing season. Plants begin growth early in the spring and flower blossoms appear in late spring and early summer. Flowering should not be expected until the second growing season.

Weed control will be required during establishment. Because penstemon is a broadleaf plant, the use of broadleaf type herbicides is not recommended. Mowing weeds when they are beginning to bloom will help reduce weed seed development.

Management
Palmer's penstemon should be used as a minor component of seed mixtures. Management strategies should be based on the key species in the established plant community. Grazing should be deferred on seeded lands for at least two growing seasons after seeding to allow for full stand establishment. Although Palmer's penstemon is short-lived, once established, it is self-perpetuating because of its abundant seed production and seed dormancy which allows it to establish readily when conditions are favorable for germination and survival (Monsen et. al., 2004).

Pests and Potential Problems
Information on pests and diseases of Palmer's penstemon is not well known. In general, penstemon is susceptible to soil-borne fusarium and rhizoctonia root rot which can be severe in poorly drained loam and clay textured soils. Stevens and Monsen (1988) mention that Palmer's penstemon irrigated seed production fields are subject to diseases associated with alfalfa and potatoes but do not specify those diseases. Colorado State University Extension (2013) has identified a penstemon weevil (*Hesperobarus ovulum,* precise species not yet identified) that has caused catastrophic damage to several species of penstemon (including Palmer's) seed production fields in southwestern Colorado. Penstemon weevil damage is difficult to control because even once damage is observed, no control methods are available. Weevils damage the plant by feeding in the taproot.

Environmental Concerns
Palmer's penstemon is a native plant species found in western North America and has no known negative impacts on wild or domestic animals. It is not considered a weedy or invasive species but can spread to adjoining vegetative communities under ideal conditions. It co-exists with other native species and adds biodiversity to plant communities.

Seed and Plant Production
There can be considerable variability in seed dormancy among collections of the same species of penstemon. A few methods can be used to overcome dormancy including the use of aged seed where after-ripening causes seed to lose dormancy, moist pre-chilling (stratification), and the use of plant hormones referred to as gibberellins (GAs). Kitchen and Meyer (1991) found one collection of Palmer's penstemon out of 3 collections tested that did not show dormancy. There were also significant differences in germination between different lengths of stratification periods. Treatment of Palmer's penstemon seed with GA_3 at a minimum concentration of 50 ppm resulted in complete germination. Abella (2009) evaluated emergence of 61 plant species where seed was subjected to liquid smoke treatments and found significant difference between non-treated seed and seed

exposed to a 10 % (vol/vol) aqueous smoke. Non-treated seed of Palmer's penstemon had 41% emergence vs. treated seed which had 81% emergence.

A standard method for propagating penstemon for transplants is to stratify the seed for 8-12 weeks in cold and moist conditions. Seed should be surface sown into plant containers and pressed into the soil surface and then containers stored under cool (36° F), dark conditions for 8-12 weeks. After stratification period, bring plants into greenhouse conditions and allow plants to grow for 8-12 weeks before transplanting in the field. Propagation of new plants from dividing older plants is also possible.

Fields for seed production can be established from direct seeding or from transplanting greenhouse grown containerized stock. Direct seeding should take place in late fall to allow for natural stratification of the seed. Palmer's penstemon should be seeded in 30-36 inch rows at a rate of 1.2 pounds PLS/ac (target 30 pure live seeds per linear foot of drill row) to allow for mechanical weed control (Cornforth, et. al., 2001). The use of weed barrier fabric is an alternative to allow closer spacing, reduce weeds and conserve soil moisture. Plant spacing of 18 inches provides for maximum growth and seed yield when using weed barrier fabric.

Seed normally ripens from mid-August to mid-September and is mature when seed capsules dry and become hard and dark in color. Seed will shatter once capsules have opened. Seed can be harvested by hand-stripping or with combine. Seed is separated from the capsule with use of a hammermill or barley debearder followed by fan cleaning. Seed yields average 100 pounds per acre (Stevens and Monsen, 1988). Storage of seed of up to 5 years has resulted in no significant loss in germination (Stevens and Jorgensen, 1994).

Cultivars, Improved, and Selected Materials (and area of origin)

'Cedar' Palmer's penstemon was released by Utah Division of Wildlife Resources and the Intermountain Research Station, Forest Service, and Soil Conservation Service, Department of Agriculture in 1985. The Agriculture Experiment Station of New Mexico State University, Colorado State University, University of Idaho, and Utah State University also participated in the release (Stevens and Monsen, 1988).

Cedar was originally collected in 1939 from a native stand near Cedar City, Utah in a mixed pinyon-juniper, big sagebrush plant community. Seed from the original site was compared with 17 other accessions at 20 locations in Utah and also in range plantings in Idaho, Montana, Wyoming, Nevada, Colorado, New Mexico, Arizona, and Oregon. Cedar was adapted to more sites, established better, was generally the most aggressive spreader, and produced as much or more forage than the other accessions tested. Certified seed is available and the Forest Service maintains Breeder seed.

Wildland collected Palmer's penstemon seed can also be obtained through commercial vendors (Native Seed Network).

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ROCKY MOUNTAIN BEEPLANT

Peritoma (*Cleome*) *serrulata* (Pursh) de Candolle

Cleomaceae – Spiderflower family

Nancy L. Shaw and Corey L. Gucker | 2020

ORGANIZATION

NOMENCLATURE

Rocky Mountain beeplant (*Peritoma serrulata* [Pursh] de Candolle) is a member of the Cleomaceae or spiderflower family (Vanderpool and Iltis 2010) but was formerly placed in family Capparaceae. The earliest specimen was collected in 1804 by Meriwether Lewis along the Missouri River near Vermillion in Clay County, South Dakota (Reveal et al. 1999). Recent molecular work leaves the taxonomic placement of the family, genus, and species in question (see Hall 2008; Iltis et al. 2011; Roalson et al. 2015).

NRCS Plant Code. PESE7, CLSE (USDA NRCS 2020).

Subtaxa. No subspecies or varieties are recognized by the Flora of North America (Vanderpool and Iltis 2010). Welsh et al. (2015), using the synonym *Cleome serrulata*, recognized two intergrading phases in Utah: *C. s.* (Pursh) var. *serrulata*, which is widespread and *C. s.* var. *angusta* (M. E. Jones) Tidestrom, which occurs only in Utah's southern counties.

Synonyms. *Cleome serrulata* Pursh, *C. serrulata* subsp. *angusta* (M. E. Jones), *Peritoma inornata* (Greene) Greene, *P. serrulata* var. *albiflora* Cockerell, *P. serrulata* var. *clavata* Lunell (Vanderpool and Iltis 2010).

Common Names. Rocky Mountain beeplant, a' pilalu (Zuni name), bee spiderflower, guaco, Navajo spinach, pink cleome, pink bee plant, skunk weed, stinkweed, stinking clover, toothed spider-flower, 'wahpe' – h'eh'e (Lakota name) (Stevenson 1915; Craighead et al. 1963; Harrington 1967; Rogers 1980; Currah 1983; Kindscher 1987; Blackwell 2006; Vanderpool and Iltis 2010; Winslow 2014; PFAF 2019). The common names derive from the many pollinators, primarily bees, attracted to the plant; its profuse nectar production; the resemblance of the long, dangling pods to the legs of a spider; the plant's slightly unpleasant odor; and its widespread use by Native Americans.

Chromosome Number. 2n = 16, 17, 32, 34, 60 (Holmgren and Cronquist 2005; Vanderpool and Iltis 2010; Rice et al. 2015; Welsh et al. 2015).

Hybridization. Holmgren and Cronquist (2005) found no evidence of hybridization. Welsh et al. (2015), however, report occasional hybrids between *C. s.* var. *angusta* and *C. lutea*.

DISTRIBUTION

Rocky Mountain beeplant is widespread in the West. It occurs in the Canadian Provinces of British Columbia, Alberta, Manitoba, Ontario, and Saskatchewan. In the United States it is found primarily east of the Cascade and Sierra Nevada Mountains from Washington to California, Arizona, New Mexico, and the northeastern portion of the Texas Panhandle (Iltis in Corell and Johnston 1979; Vanderpool and Iltis 2010; LBJWC 2019). Rocky Mountain beeplant is found in 43 of the 56 counties in Montana, 21 of Wyoming's 23 counties, and all Utah counties (Lesica et al. 2012; Winslow 2014; Welsh et al. 2015). It grows on the Colorado Plateau and in Arizona mountains and sky islands (The Xerces Society and USDA NRCS 2012). In New Mexico, it is common in the mountains but absent near the state's southern and eastern borders (Iltis 1958). Collections from the Midwest and Northeast may have escaped from gardens (Holmgren and Cronquist 2005).

Habitat and Plant Associations. Rocky Mountain beeplant grows in sun or part shade on a variety of soil types in shortgrass and mixed-grass prairies, sagebrush (*Artemisia* spp.) steppe, dry meadows, desert scrub, pastures, and pinyon pine (*Pinus* spp.) and juniper (*Juniperus* spp.) woodlands (Iltis 1958; Blackwell 2006; Vanderpool and Iltis 2010). It is common in low elevation valleys; dry, sandy plains; mountain foothills; and barren rangeland. A pioneer plant, it often occurs on disturbed sites that are sparsely vegetated (e.g., dry washes, ditch banks, banks and terraces of natural water courses, coulee edges, and along roadsides; Fig. 1), but it is not tolerant of water logging (Iltis 1957; Craighead et al. 1963; Weber 1976; Kindsher 1987; Andersen and Holmgren 1996; Spellenberg 2001; Lesica et al. 2012; Ogle et al. 2012; Winslow 2014; Welsh et al. 2015).

In Montana and Wyoming, it often grows in association with western wheatgrass (*Pascopyrum smithii*), bluebunch wheatgrass (*Pseudoroegneria spicata*), prairie June grass (*Koeleria cristata*), Sandberg's bluegrass (*Poa secunda*), blanketflower (*Gaillardia aristata*), upright prairie coneflower (*Ratibida columnifera*), and big sagebrush (*A. tridentata*) (Winslow 2014). Beatley (1976) reported it in lowland shadscale (*Atriplex confertifolia*) vegetation on basin floors in closed drainage basins at elevations of 5,000 to 5,200 feet (1,524-1,585 m) in Nevada.

Figure 1. Rocky Mountain beeplant growing in Utah along a roadside (top) and in the Owyhee mountains of Idaho (bottom). Photos: USDI BLM UT080 SOS (top); C. Shock (bottom).

Elevation. Rocky Mountain beeplant grows at elevations from (330) 980 to 8,200 (9,500) feet ([100] 300-2,500 [2,900] m) (Vanderpool and Iltis 2010). It is found at elevations of 2,625 to 9,006 feet (800-2,745 m) in Utah (Welsh et al. 2015), 4,000 to 7,200 feet (1,200-2,200 m) in Wyoming, and 2,500 to 5,200 feet (760-1,585 m) in Montana (Winslow 2014). On the Colorado Plateau, Arizona Mountains and sky Islands, it grows at 4,500 to 7,000 feet (1,400-2,100 m) (The Xerces Society and USDA NRCS 2012).

Soils. Rocky Mountain beeplant is most common on well-drained, moist to dry, medium-textured to sandy soils with pH 6 to 7.6 (Currah et al. 1983; Kindscher 1987; PFAF 2019; USDA NRCS 2020), but it also occurs on clay and gravel soils (Iltis 1958). It grows on sites with at least 70 frost free days and tolerates drought and moderate amounts of calcium carbonate (Winslow 2014;

LBJWC 2019; USDA NRCS 2020). *P. s.* subsp. *angusta* commonly occurs on sandy soils and is more drought tolerant than *P. s.* subsp. *serrulata* (R. Stevens, Utah Division of Wildlife Resources [retired], personal communication, February 2020).

DESCRIPTION

Rocky Mountain beeplant is a tall, upright, somewhat malodorous, colonizing annual plant growing 1 to 6.6 feet (0.3-2 m) tall with a 12- to 14-inch (30- to 35-cm) taproot. It produces dense racemes of purple to sometimes white flowers and elongate, spreading pod-like capsules (Fig. 2) (Currah 1983; Cane 2008; Welsh et al. 2015). Plants are erect with glabrous to glabrate stems that may branch above, creating an open, rangy structure. Leaves are alternate, glabrous or with marginal hairs when young, and palmate with three entire to slightly sinuate or serrulate leaflets 0.8 to 2.4 inches (2-6 cm) long and 0.2 to 0.6 inches (0.6-1.5 cm) wide. Leaflets range from lanceolate to elliptic or oblanceolate with mucronate to long acuminate tips (Holmgren and Cronquist 2005; Vanderpool and Iltis 2010; Welsh et al. 2015). Petioles have bristle-like stipules (Vanderpool and Iltis 2010).

Figure 2. Rocky Mountain beeplant exhibits a rangy growth structure with branches developing from the upper part of the stem, dense inflorescences, and spreading capsules. Photo: Matt Lavin, Montana State University.

Flowers develop in terminal, densely crowded, bracteate racemes (Fig. 3) that are 0.4 to 1.6 inches (1-4 cm) long, elongating to 1.6 to 11.9 inches (4-30 cm) in fruit. Bracts are simple and much smaller than the leaves (Welsh et al. 2015). Flowers are regular to irregular with green to purple pedicels. Sepals are four, broad, persistent, dentate, and connate to 1/2 to 2/3 of their length (Welsh et al. 2015). The four narrow petals are commonly purple, but range to pink or white. They are oblong to ovate and 2.8 to 4.7 inches (7-12 cm) long and 0.1 to 0.2 inch (3-6 mm) wide, narrowing abruptly near the base. Buds of Rocky Mountain beeflower are a deeper color than the open flower. The lighter color of the mature petals may be age related and does not seem to be a pollinator cue (Nozzolillo et al. 2010).

Rocky Mountain beeplant produces perfect and pistillate flowers. Perfect flowers have both stamens and a pistil. Staminate flowers begin as perfect buds, but pistil formation is incomplete, thus flowering is not andromonoecious (with staminate and perfect flowers on the same plant) because truly staminate flowers are not produced (Cane 2008). Flowers produce six long, equal, threadlike stamens with purple filaments and green anthers that are exserted as the flower opens (Fig. 4). The pistil of perfect flowers has a basal gland and unilocular ovary with two parietal placentae. The stamens and pistil arise from an androgynophore (stipe) (Blackwell 2006; Vanderpool and Iltis 2010) that is 0.04 to 0.6 inch (1-15 mm) long in fruit (Munz and Keck 1973; Holmgren and Cronquist 2005; Vanderpool and Iltis 2010; Welsh et al. 2015).

Figure 3. Densely flowered, indeterminate Rocky Mountain beeplant inflorescence with darker colored buds at the apex and flowers and capsules further down the raceme. Note the exerted stamens with green anthers and pink filaments. Photo: Matt Lavin, Montana State University.

The fruits are dehiscent, striated, glabrous, pod-like capsules 1 to 3 inches (2.5- 7.6 cm) long and 0.1 to 0.2 inch (3-6 mm) wide, terete in cross section, and pointed at both ends (Fig. 5). The capsules become more separated as the inflorescence elongates (Craighead et al. 1963; Currah et al. 1983; Kindscher 1987; Vanderpool and Iltis 2010). The pedicels are ascending and 0.4 to 0.6 inches (10-15 mm) long; the fruiting

stipes are more spreading and 0.4 to 0.9 inches (11-23 mm) long with the mature fruits pendulous. Mature viable seeds are 2.8-4 mm x 2.5 to 3 mm, dark brown to black, and spherical to ovoid or horseshoe-shaped with rough surfaces (Fig. 5) (Currah et al. 1983; Holmgren and Cronquist 2005; Vanderpool and Iltis 2010; Winslow 2014). Fruit size variation has been attributed to environmental rather than genetic causes (Iltis 1952 in Vanderpool and Iltis 2010). Seeds reportedly lack or contain only small amounts of endosperm (Iltis 1958; Sanchez-Acebo 2005). The embryo is curved and folded (Iltis 1958). Flowering dates depend on the location, but across the species' range, flowering may occur from May to October (Iltis 1958; Munz and Keck 1973; Holmgren and Cronquist 2005).

Figure 4. Perfect Rocky Mountain beeplant flower with the capsule beginning to develop. Photo: Matt Lavin, Montana State University.

Figure 5. Fruits (capsules) of Rocky Mountain beeplant (left) and horseshoe-shaped seeds with rough surfaces (right). Photos: Matt Lavin, Montana State University (left) and USFS Bend Seed Extractory (right).

Iltis (1957) described the beeplants as primitive forms in a reduction series which includes the progressively more specialized genera, *Cleomella*, *Wislizenia*, and *Oxystylis*. He suggested the specializations provided adaptation to progressively more arid environments. Characteristics considered primitive in *Cleome* included their large, elongate capsules; free-falling seeds; short, slender styles; open bracteate racemes; small stipules, extensive vegetative growth, and delayed flowering. The presumed specialized genus, *Oxystylis*, occurs primarily in arid Death Valley. Later molecular work (see Riser et al. 2013), indicated that *Peritoma* and *Cleomella* are polyphyletic, ploidy levels in these genera are complex, fruit size may have diverged from truncated few-seeded fruits of the ancestral *Cleomella*, and the timing of the evolutionary divergence of these genera does not support the proposed series.

Reproduction. Rocky Mountain beeplant reproduces entirely from seed. Although annual flowering and seed production can vary greatly, plants produce prodigious amounts of seeds in favorable years. Populations can spread rapidly in areas where competition from other species is low (Cane 2008).

Flowering and fruiting phenology. Rocky Mountain beeplant flowers over a period of several weeks from late spring to mid-summer depending on location. In southern Alberta plants emerge in May, flower buds are produced in June, flowering occurs from June to September, seeds ripen from July to September, and plants die in October (Currah et al. 1983). Flowering begins at the base of the inflorescence and inflorescence branches and proceeds upward as the inflorescence elongates. Thus, older perfect flowers are pollinated, develop capsules, and disperse seed while new flowers continue to develop (Iltis 1958; Munz and Keck 1973; Holmgren and Cronquist 2005). Dehiscence of mature capsules occurs when the two halves (valves) of the capsule separate from the loop-shaped placenta (replum), which remains on the plant and dehisces separately (Fig. 6) (Iltis 1958). Seeds then begin dispersing from the placenta.

Figure 6. Seeds dispersing from the placenta (replum) after the valves of the capsule have fallen away. Photo: Matt Lavin, Montana State University.

Racemes alternate between production of perfect and staminate flowers as has also been noted for *C. spinosa* (spiny spiderflower) and *C. lutea* (yellow beeplant) (Murneek 1927; Cane 2008). Staminate flower production increases when racemes are producing large numbers of fruits that require high resource input. Thus, flowering throughout the season alternates between the two flower types, and fruit production occurs over a prolonged period (Cane 2008).

Breeding system. Cane (2008) found Rocky Mountain beeplants were both self-fertile and outcrossing. Fruit set and number of seeds per fruit were examined in flowers of caged plants (pollinators eliminated) manually fertilized with pollen from another flower on the same plant (geitonogamy), plants cross pollinated with pollen from another plant (xenogamy) or allowed to naturally self-fertilize (autogamy). Treatments were compared to non-caged plants with flowers accessible to pollinators. Plants were found to be self-fertile, and this was facilitated by stamens that curl back late in the day after the flowers have opened. However, plants from the two manually fertilized treatments set more fruits ($P < 0.05$) and their fruits produced more seeds ($P < 0.0001$) than the naturally self-fertilized (self-or wind-pollinated plants). Neither manual cross-pollination nor open access to pollinators improved fruit or seed production ($P > 0.05$) compared to the same-plant fertilized treatment.

Self-fertilization is considered a favorable trait for early successional species. Self-fertility insures that seeds will be produced, even in areas where pollinators are scarce or absent on disturbance sites or in years when flowers are abundant and pollinator populations limited (Baker and Stebbins 1965; Lloyd 1992; Cane 2008). Spread of Rocky Mountain beeplant following prolific seed production occurred in common gardens and dense populations have been observed on disturbed sites (Cane 2008).

Pollination. Rocky Mountain beeplant is pollinated by many diurnal bees, wasps, and butterflies that gather nectar and sometimes pollen (Cane 2008). In a study conducted at Logan, Utah, new flowers began opening and nectar drops were visible about 1.5 hours after sunset (7 August), and none opened during the day. By dawn all new flowers had dehisced anthers, receptive stigmas, and large nectar droplets (Cane 2008). Nocturnal flower opening was considered a potentially ancestral trait as no moths or other nocturnal pollinators were noted. Lack of discernable odor at night and bright flower color would suggest adaptation to diurnal pollination (Faegri and van der Pijl 1979; Dafini et al. 1987; Cane 2008).

At the Grand Staircase-Escalante National Monument, Utah, *Cleome* (= *Peritoma*) was included among the 16 magnet genera that hosted 75% of all pollinators collected (Carril et al. 2018). Sixty-four generalist species (11 unidentified) were associated with Rocky Mountain beeplant, most of which also pollinated yellow beeplant. Cane (2008) suggested that the scattered populations of the two species are important to generalist pollinators throughout their range but fail to attract specialists due to their fluctuating flower production.

ECOLOGY

Rocky Mountain beeplant is a fast-growing annual that colonizes disturbed sites with medium to coarse-textured soils and may form monocultures (Currah et al. 1983; USDA NRCS 2020). Seedlings are vigorous, and healthy plants are prolific seed producers, but population size and seed production may vary considerably from year to year.

Seedling Ecology. Competitiveness of native species (including Rocky Mountain beeplant) from the Flaming Gorge National Recreation area in Wyoming with the exotic invasive annual halogeton (*Halogeton glomeratus*) was examined in a greenhouse study (Prasser and Hild 2016). Ten native species were grown separately (four seedlings per pot) or with two native and two halogeton seedlings per pot for 14 weeks. Seedling survival and growth (leaf number, height, root:shoot, canopy area and specific area) of halogeton was not reduced by the presence of Rocky Mountain beeplant. However, halogeton above-ground biomass (as a percent of total pot biomass) was reduced when grown with either of two annuals (Rocky Mountain beeplant or annual sunflower [*Helianthus annuus*]) or a perennial grass, sand dropseed [*Sporobolus cryptandrus*]); which was not the case when halogeton was grown with any of seven other native perennials. Additionally, growth and survival of Rocky Mountain beeplant was unaffected by the presence of halogeton. The authors recommended that native annuals be included in revegetation mixes on sites where halogeton is present.

Wildlife and Livestock Use. Seeds of Rocky Mountain beeplant are used by pocket mice (*Perognathus longimembris*), mourning doves (*Zenaida macroura*), and other birds (Martin et al. 1951; Winslow 2014; LBJWC 2019). Seed use by ring-necked pheasants (*Phasianus colchicus*) is reported from Utah (Martin et al. 1951). Dumroese

and Luna (2016) listed the genus *Cleome* (= *Peritoma*) as one used by greater sage-grouse (*Centrocercus urophasianus*) based on their use of golden spiderflower (*Peritoma platycarpa*) (Pyle 1992). Direct observation of Rocky Mountain beeplant use by greater sage-grouse has not been documented.

Rocky Mountain beeplant is grazed to a limited extent by livestock, but it provides little forage for large mammals and has been described as unpalatable by Hermann (1966). The plant's foul odor has been suggested as a reason for its limited use by deer (Winslow 2014; LBJWC 2019).

Insects. Rocky Mountain beeplant is a larval host for the checkered white (*Pontia protodice*) (Xerces Society for Invertebrate Conservation in LBJWC 2019).

Rocky Mountain beeplant populations found along a soil moisture gradient in the dry, short grass prairies of western Nebraska and eastern Colorado were examined for production of methyl glucosinolate and insect damage (Louda et al. 1987). At the moist end of the gradient plants were larger, developed more flowers and seeds, and produced lower concentrations of methy glucosinolate than plants at the drier end of the gradient. Insect predation (species not identified) of seed and herbage were inversely proportional to methyl glucosinolate concentration. Consequently, seed production and the potential for reseeding were greater at the drier end of the gradient (Louda et al. 1987).

Ethnobotany. Rocky Mountain beeplant was an important and widely used food plant for American Indians (Table 1) (White 1945; Coffey 1993). It was one of the most important plants used by the Pueblo people. Because of its many uses, the Hopi and Tewa included it in songs about corn, pumpkins, and cotton, the three main cultivated plants (Castetter 1935; Robbins et al. 1916). Welsh (2015) reported it was a volunteer in fields cultivated by the Pueblo people of the Colorado Plateau from 600 to 1100 AD, and its seeds were found in middens excavated in cliff dwellings from this time period. Rocky Mountain bee plant was also an important food of the Navajo and reportedly a good source of calcium and vitamin A that saved them from starvation on several occasions (Holmgren and Cronquist 2005).

Rocky Mountain beeplant may have been cultivated or occurred as volunteers that reseeded themselves annually (Harrington 1967). Plant parts and seed were harvested and used fresh. Large quantities were also harvested and dried for winter use or for preparation of a dye for pottery. Plants were boiled until thick and black, then dried as cakes that were stored until used for paint or fried for food (Robbins et al. 1916; Harrington 1967). Members of the Cikame society of the Keres and the Zuni Shiwanakwe society are prohibited by religious injunction from eating bee plant before ceremonies (Swank 1932; White 1945).

Table 1. Indian uses of Rocky Mountain beeplant for food.

Use	Preparation	Tribe/ Band	Source(s)
Bread	Seeds used as flour	Isleta	Jones 1931 Castetter 1935
Cakes	Fibrous material removed, green parts boiled, made into fried cakes	Jemez	Cook 1930
Cakes	Seeds mixed with corn, ground and baked as cakes	Navajo	Young 1938 cited in Harrington 1967
Chile	Young plants, leaves cooked with corn, chile	Zuni	Stevenson 1915 Castetter 1935
Flower buds	Eaten with salt	San Filipe	Castetter 1935
Greens, cooked	Leaves, flowers, or young shoots or plants boiled and eaten or rolled into balls and fried, eaten with or without meat	Hopi Navajo Sia Tewa Ramah Navajo	Fewkes 1896 Castetter 1935 Whiting 1939 Castetter 1935 Steggerda 1941 Elmore 1944 White 1962 Castetter 1935 Robbins et al. 1916 Vestal 1952
Greens, fresh	Leaves, shoots, or young plants	Apache Isleta Jemez Keres Keresan Navajo	Buskirk 1986 Jones 1931 Cook 1930 Swank 1932 White 1945 Steggerda 1941
Stored for winter	Leaves gathered and dried indoors	Navajo Zuni	Lynch 1986 Stevenson 1915
Stored for winter	Young shoots or plants boiled, rolled, dried as balls	Navajo Ramah Navajo	Castetter 1935 Steggerda 1941 Elmore 1944 Vestal 1952
Pods	Unspecified	Navajo	Elmore 1944
Porridge	Seeds cooked, dried, prepared as mush	Acoma Keres Laguna	Castetter 1935 Swank 1932 Castetter 1935
Spice	Unspecified	Navajo	Hocking 1956

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Plant Guide

MUNRO'S GLOBEMALLOW
Sphaeralcea munroana (Douglas) Spach
Plant Symbol = SPMU2

Contributed by: NRCS Plant Materials Center, Pullman, WA

Sphaeralcea munroana. **Pamela Pavek**

Alternate Names
Orange globemallow, desert mallow, whitestem globemallow (*S. munroana* ssp. *subrhomboidea*), *Malva munroana, Nuttallia munroana, Malvastrum munroana, Malveopsis munroana*

Uses
Pollinator habitat: Munro's globemallow attracts many species of bees, a few of which are specialists, requiring pollen and nectar only from *Sphaeralcea* and related genera. These include the ground-nesting bees *Diadasia diminuta*, *D. lutzi*, and *Colletes sphaeralcea*. The *Diadasia* are proficient and dedicated pollinators, and have been found colonizing trial plots on research farms (Cane 2011).

Forage: Plants in the *Sphaeralcea* genus are important forage sources for a number of rodents, rabbits and other lagomorphs, and ungulates such as deer and antelope (Beale and Smith 1970; Pendery and Rumbaugh 1986, Rumbaugh et al. 1993). Browsing deer will often consume all of the foliage and leave only the woody base.

Ornamental: Munro's globemallow is hardy to Zone 4 and is recommended for rock gardens, banks, desert shrub areas, and along driveways and walkways (Rugged Country Plants 2011). This plant is also suitable for container planting (Cane 2011). For an attractive appearance, High Country Gardens (2011) suggests cutting the plants to the ground level every year.

Range revegetation: This plant is one of the gems of the arid west. It can be used to add aesthetic beauty and diversity to range landscapes.

Ethnobotanical: People of the Gosiute tribe made paint with the flowers and applied it to the inside of their earthenware dishes (Native American Ethnobotany Database 2011).

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g., threatened or endangered species, state noxious status, and wetland indicator values).

Description
General: Mallow family (Malvaceae). *Sphaeralcea munroana* is a native perennial forb or subshrub. It has a taproot, an open branching form and grows to 20 to 80 cm (8 to 32 inches) tall. Leaves and stems are pale green and have a slightly rough texture due to a covering of fine white hairs. Leaves are alternate, petiolate, have round-toothed margins, three to five lobes, and are 2 to 6 cm (0.8 to 2.4 in) long. Flowers and buds are on showy clusters in leaf axils and bloom May through August. The flowers have a diameter of 2 cm (0.75 in), five pale orange to brick-red petals, and numerous stamens. Seeds are produced in dry fruits with multiple capsules that form a sphere, and there is one seed per capsule. Seeds are pubescent and average 1.5 mm (0.06 in) in length (Rydberg 1917; Lyons and Merilees 1995; Burke Museum of Natural History and Culture 2011).

The genus name *Sphaeralcea* is from the Greek word "spharia" which is a globe (referring to the spherical fruits) and the Latin word "alcea" which means a kind of mallow. The species name *munroana* refers to Dr. Donald Munro (1789 – 1853) who was the Curator of Gardens at the Horticultural Society of London, a Fellow of the Linnean Society, and gardener-in-chief for British botanist John Lindley (Charters 2011).

Cross section of *S. munroana* fruit showing individual seeds in each capsule. James Cane, ARS

Distribution: Munro's globemallow is found throughout British Columbia and the western states of Washington, Idaho, Montana, Wyoming, Colorado, Utah, Nevada, Oregon and California. The taxon is divided into two subspecies: ssp. *munroana* which is found throughout the species' entire range, and ssp. *subrhomboidea* which is found only in Oregon, Idaho, Wyoming and Utah. Subspecies *subrhomboidea* is also known by the common name whitestem globemallow. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Habitat: This plant is typically found in association with sagebrush on desert plains to low mountain slopes (Lyons and Merilees 1995; Hichcock and Cronquist 1973).

Adaptation

Munro's globemallow is adapted to dry areas with open exposure. It is often found growing in rocky, sandy soil but also grows well in heavy clay (High Country Gardens 2011). Annual precipitation requirements range from 15 to 38 cm (6 to 15 in).

Establishment

Munro's globemallow can be established by seed or seedlings. Seed should be planted with a drill into a weed-free seed bed at a rate of 4 kg PLS per ha (3.5 lbs PLS per acre) and at a depth of 0.6 cm (0.25 in) (Lambert 2005). When planted in a mix, the seeding rate should be adjusted according to the proportion of the mix. The seed has an impermeable seed coat and should be scarified using boiling water or other treatment prior to planting if a high initial germination rate is desired (see Seeds and Plant Production below).

Seedlings can be produced by sowing treated seed in containers in a greenhouse in January and hardened off for 2 to 4 weeks prior to transplanting to a prepared field site in the spring. Plants should be spaced 25 to 75 cm (10 to 30 in) apart (Rugged Country Plants 2011).

A globemallow bee (*Diadasia diminuta*) visiting a Munro's globemallow flower. James Cane, ARS

Management

For optimal production of *Sphaeralcea munroana* seed, the pollination services of bees are required. James Cane, ARS (2011) has found outcrossing of *S. munroana* increases seed production 4-fold. He also discovered in one study 37 out of 57 of the bees that visited *S. munroana* and related plant species were ground-nesting floral specialists, such as *Diadasia diminuta, D. lutzi*, and *Colletes sphaeralcea*. The other 20 species that visited were also ground-nesting but floral generalists. Honey bees will work the flowers, but their pollination efficacy is unknown. To enhance ground-nesting bee habitat, do not cultivate around or within the plot during bloom.

Turrets indicate the presence of globemallow bee (*Diadasia diminuta*) nests. Vince Tepedino, ARS

Dunne (2011) a private seed producer in Worland, WY, has found fields of *Sphaeralcea munroana* are easily established and weeds can be controlled with the proper application of herbicides. However, due to the seed's hard coat and levels of dormancy, volunteer plants are problematic during the years of production because they interfere with between-row cultivation operations and have high amounts of green growth at harvest. Furthermore, volunteer plants will emerge in succeeding crops for many years. The volunteers cannot be controlled with applications of pre-emergent herbicides or glyphosate (Dunne 2011).

Dunne (2011) and other commercial seed producers have also found the plant's indeterminance to be problematic. With summer precipitation or irrigation, Munro's globemallow will remain green and continue to flower throughout the growing season. Compounding this problem, seeds will shatter soon after ripening. Dunne (2011) states Munro's globemallow can easily be harvested with a combine, however small amounts of seed harvestable at one time causes production to be economically unviable. In areas where irrigation is the only source of summer moisture, it may be possible to manipulate the plant's determinance by shutting off irrigation early in the growing season.

Pests and Potential Problems
This species is susceptible to a fungal rust pathogen (*Puccinia sherardiana*) (Dunne 2011). Seed can be damaged by weevils of the genus *Macrorhoptus* (Cane 2011).

Environmental Concerns
None

Seeds and Plant Production
Harvested seed can be cleaned by processing with a brush machine (Barner 2009) or hammer mill and air screening equipment. There are approximately 804,760 seeds per kilogram (365,800 seeds per pound) (Barner 2009).

S. munroana and other members of the *Sphaeralcea* genus have an impermeable seed coat which causes challenges for plant production. Cold moist stratification with no other pretreatment is unlikely to result in satisfactory germination. At the Pullman Plant Materials Center, seed of three accessions was planted into containers in mid October 2009, stratified outside for 90 days and moved into a greenhouse. Seed germinated within 7 to 14 days and achieved germination rates of 6%, 14% and 25%.

Smith and Kratsch (2009) report significant germination improvements for *S. munroana* seed (84% average germination) following the combination of scarification (nicking the seed) and a 6 wk cold stratification. Kildisheva and Davis (2011) examined the effects of seed piercing with a steel blade, 6 wk cold stratification (4.6±0.02 C) and combined scarification plus stratification. Germination was significantly improved with both the scarification (35 %) and the combined scarification and stratification (44 %) treatments.

Kildisheva and Davis (2011) also compared the effects of scarification with a steel blade, submergence in a 100 ppm gibberellic acid (GA_3) solution, submergence in deionized water, and the combination of these treatments. Scarification alone and scarification followed by a 24 hour water or GA_3 soak achieved the highest germination (87%, 93 % and 88 %, respectively) at the end of the 21 day period. Seeds soaked in distilled water for 24 hrs achieved significantly higher germination than those soaked for 48 hrs. However, a similar relationship did not exist between scarified seeds soaked in GA_3.

Although mechanical scarification can be an effective dormancy treatment, many mechanized techniques can cause embryo damage, primarily a result of scarification severity. Page et al. (1966) and Roth et al. (1987) suggest seeds of *S. munroana* died following mechanical scarification in a sandpaper-lined rotating drum, irrelevant of treatment duration.

Chemical scarification treatments have been shown to be effective for some *Sphaeralcea* species (Page et al. 1966, Sabo et al. 1979, Roth et al. 1987, Smith and Kratsch 2009). For instance, submergence in 18 M sulfuric acid (H_2SO_4) for 10 min significantly increased germination of *S. coccinea* (77 %) and two accessions of *S. grossulariifolia* (69 % and 62 %, respectively) however failed to do so for *S. munroana* (8 %) (Roth et al. 1987). Improved germination of *S. munroana* (53%) was achieved with a 3-hr soak in the organic solvent diethyl dioxide ($C_4H_{10}O_2$) (Roth et al.1987).

An alternative technique, submergence in boiling water, can be effective for large-scale seed treatment. Jensen (2011) at the Forest Service Shrub Sciences Lab in Provo, Utah, has found an improvement in germination with application of boiling water prior to planting. He also found with this treatment, no stratification period is necessary. Kildisheva and Davis (2011) compared the effects of a10-sec submergence in boiling water, tumbling with aluminum oxide, burning, heat application at 80 C for 1 hr, and the combination of burning and heating. Seeds subject to the boiling water treatment reached the highest cumulative germination (49%); while seeds subject to the remaining treatments did not exceed 20% germination.

Cultivars, Improved, and Selected Materials (and area of origin)

'ARS-2892' is select-class germplasm released by the ARS in 1993. Seed was collected from plants growing on the Hyrum Lake Dam in Cache County, UT and compared to 49 other accessions of *Sphaeralcea* species. It was selected for its large shoot size, succulence, leafy growth form and seed yield potential (Rumbaugh and Pendery 1993).

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PRAIRIE CONEFLOWER

Ratibida columnifera

(Nutt.) Woot. & Standl.

Plant symbol = RACO3

Contributed By: USDA, NRCS, National Plant Data Center

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Alternate Names

Mexican hat, yellow Mexican hat, upright prairie coneflower, long-head coneflower, columnar prairie coneflower

Uses

Ethnobotanic: Tea was made from the leaves and flower heads. Cheyenne Indians boiled prairie coneflower leaves and stems to make a solution applied externally to draw the poison out of rattlesnake bites. An infusion was used to relieve the pain of headaches and to treat stomachaches and fevers (Moerman 1998). A decoction was used as a wash to relieve pain and to treat poison ivy rash (Ibid.).

Landscaping: Prairie coneflower is suggested for use in roadside plantings, parks, recreational areas and prairie restoration projects; where annual precipitation is from ten to thirty inches. This species is sometimes grown as an ornamental.

Status

Please consult the Plants Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description

General: Composite Family (Asteraceae). Prairie coneflower is a native perennial about a foot and a half tall. The rays are generally three to five centimeters long, much longer than the disk (solid part between the rays). The floral disk is somewhat globe-shaped, ovoid, or shortly ellipsoid, twelve to twenty millimeters high (Steyermark 1963). Prairie coneflower has well-developed leaves up to fifteen centimeters long and six centimeters wide, pinnatifid to partly bipinnatifid, with ultimate segments linear to oblong, often very unequal (Great Plains Flora Association 1986). This species has one to several stems twelve to forty-seven inches tall. The fruit is a small ashen.

Distribution: Prairie coneflower ranges from Alberta to Mexico, east to Manitoba, Minnesota, Illinois, Missouri, Arkansas, Oklahoma, Texas; and New England (Steyermark 1963). For current distribution, please consult the Plant profile page for this species on the PLANTS Web site.

Adaptation

Ratibida columnifera grows well on loam, sandy loam, and clayey loam soils. It prefers a sunny position and well-drained rich soil types. This species is tolerant of weakly acidic to moderately alkaline soils and weak saline soils. It has low to moderate water requirements. Prairie coneflower is found on dry plains, prairies, waste ground, and along roadsides and railroads.

Establishment

Propagation by Seed: *Ratibida columnifera* seeds are best sown in early spring in a cold frame. Cover the seeds and place the pot in a sunny location. Optimum germination temperatures are between 68 to 86ºF, or 20 to 30ºC. Germination should be achieved in two days.

Management
Prairie coneflower seeds can be planted in the fall. If they are placed in winter storage for spring planting, they should be stratified with a cold dry treatment.

Cultivars, Improved and Selected Materials (and area of origin)
Available through native plant seed sources specializing in Great Plains species.

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CURLYCUP GUMWEED

Grindelia squarrosa (Pursh) Dunal

Plant Symbol = GRSQ

Common Names: Tarweed; resinweed; rosinweed
Scientific Names: None

Figure 1. Curlycup gumweed growing in a disturbed roadside.

Description

General: Composite family (Asteraceae). Curlycup gumweed is a short-lived perennial, or biennial forb averaging 1 to 3 feet high. Numerous branching stems bear alternately arranged leaves, typically 1 to 4 inches long with entire to serrate or even somewhat lobed margins. The flower heads are radiate with 25 to 40 yellow rays and a yellow center. The involucural bracts are squarrose-reflexed, or strongly rolled back, and highly resinous. The fruit is a 2.5 to 3 mm long achene bearing 2 to 3 pappus awns (Welsh et al., 2003). Flowering occurs in mid- to late-summer, typically beginning in July and continuing through August and into September. Occasional plants will be seen with flowers persisting into November.

There are currently three varieties recognized by the PLANTS database, including var. *quasiperennis*, var. *serrulata*, and var. *squarrosa*. Variety *quasiperennis* is a true short-lived perennial with largely entire leaf margins. The other two varieties, both biennials, can be separated by their leaf width to length ratio, with var. *squarrosa* having upper stem leaves 2 to 4 times longer than broad, and oblong in outline, and var. *serrulata* having upper stem leaves much narrower, 5 to 8 times longer than broad, and narrowly oblong in outline (Welsh et al., 2003).

Distribution: Curlycup gumweed is native throughout North America with the exception of the southeastern states. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Figure 2. Close-up of curlycup gumweed flower head showing strongly reflexed involucural bracts.

Habitat: Curlycup gumweed inhabits a variety of arid plant communities including sagebrush steppe, desert grasslands, prairies and mountain shrub chaparral (Walsh, 1993). It is very commonly found in disturbed roadsides, open fields and in poorly managed pastures and rangelands.

Adaptation

Curlycup gumweed is adapted to disturbed sites receiving 10 to 20 inches mean annual precipitation. This species is most commonly found in rocky, gravelly soils of disturbed roadsides, but can be found in heavier silty clay loam soils to sandy loams. Curlycup gumweed is adapted to neutral to moderately saline conditions. It is very commonly found growing in sites occupied by non-native grasses such as cheatgrass (*Bromus tectorum*) and crested wheatgrass (*Agropyron cristatum*).

Uses

Pollinators:

This species is highly attractive to native bees. ARS Bee Research Laboratory records indicate visitations by species from over 40 genera of native bees (Ikerd, 2016). Its drought tolerance and late-season flowering make it especially valuable for CRP and other range plantings in the arid west where late-blooming forbs are limited.

Curlycup gumweed is also readily visited by European honeybees; however, honey produced from this species has an inferior flavor and can lower the grade (Dalby, 1999). The pollen is considered more valuable than the nectar, as bees visit the plants late in the season to build pollen reserves for winter (Dalby, 1999).

Wildlife:

Curlycup gumweed has been observed being consumed by sage-grouse. Twenty-eight percent of monitored sage-grouse chicks between 5 and 8 weeks of age were reported eating curlycup gumweed in central Montana. Curlycup gumweed made up 3 percent by volume of crop contents. It was used by 39 percent of 9 to 12 week old chicks and made up 4 percent of crop contents. It was not used by chicks younger than 5 weeks old (Peterson, 1970).

Livestock:

Curlycup gumweed offers little forage value and is largely unpalatable to cattle, sheep, and horses, though sheep will occasionally crop flower heads in the absence of other forage (Johnson and Nichols, 1970). Tannins, volatile oils, resins, bitter alkaloids, and glucosides give curlycup gumweed an unpleasant taste (Bare, 1979). Cattle, sheep, and goats will occasionally graze Curlycup gumweed in its rosette stage of growth.

Ethnobotany

The resin of curlycup gumweed contains many medicinally beneficial compounds. Native Americans used this species for a variety of ailments. A decoction of root was used for liver trouble. (McClintock, 1909), and a paste made from flowering tops was applied to skin diseases, scabs and sores (Hart, 1992).

Status

Threatened or Endangered: No.

Wetland Indicator: Curlycup gumweed is considered to be a Facultative Upland (FACU) species (usually occurs in non-wetlands (estimated probability 67%-99%), but occasionally found in wetlands (estimated probability 1%-33%) or Obligate Upland (UPL) species (occurs in wetlands in another region, but occur almost always (estimated probability >99%) under natural conditions in non-wetlands in the region specified).

Weedy or Invasive:

Although this species is native to North America, it can have weedy or invasive characteristics under improper management (Stubbendieck et al, 1994; Whitson et al., 1996). It has become a problematic weed in Eastern Europe (Sirbu and Oprea, 2008). Please consult with your local NRCS Field Office, Cooperative Extension Service office, state natural resource, or state agriculture department regarding its status and use.

Please consult the PLANTS Web site (http://plants.usda.gov/) and your state's Department of Natural Resources for this plant's current status (e.g., threatened or endangered species, state noxious status, and wetland indicator values).

Planting Guidelines

Tests conducted at Aberdeen Plant Materials Center indicate there are approximately 400,000 seeds/lb and 39 lbs/bushel. Based on a seeding rate of 50 pure live seeds (PLS) per foot, the full stand seeding rate is 5 lbs/ac. Seeding rate should be adjusted to match the desired percentage within a seed mixture.

McDonough (1975) showed that curlycup gumweed exhibited seed germination polymorphism. Disc achenes (those from the center of the flower) germinated more rapidly and attained higher final germination percentages than did ray achenes (those from the outer, petal-like flowers). It is believed that this allows germination and emergence to occur during different seasons, and subsequently affects the time required for completion of the growth cycle.

Management

Due to its low moisture requirements and limited palatability, curlycup gumweed increases under drought conditions in irrigated pasture as well as under poor grazing management practices, and is often associated with pastures and range that have been over grazed. Curlycup gumweed should be used as a minor component of pollinator and restoration seed mixtures.

Management strategies should be based on the key species in the established plant community. Grazing should be deferred on seeded lands for at least two growing seasons to allow for full stand establishment (Ogle et al., 2011).

Pests and Potential Problems
Curlycup gumweed has been shown to have the capacity to serve as a host plant of the Colorado red node virus of bean (Thomas, 1949). It may also have the ability to accumulate selenium from the soil and become toxic to livestock (SDSU, 2016)

Environmental Concerns
Curlycup gumweed is native to western North America. It will spread under favorable conditions but does not pose any environmental concern to native plant communities under proper management. Due to its ability to readily occupy disturbed sites, it has been associated with other rangeland weeds (Whitson et al., 1996).

Control
Early season treatments (June) with broadleaf selective herbicides such as metsulfuron, 2,4-D, or dicamba produced better than 95% control of curlycup gumweed, while later treatments (August) yielded slightly lower results (Ferrell and Whitson, 1987).

Contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for each control method. Trade names and control measures appear in this document only to provide specific information. USDA NRCS does not guarantee or warranty the products and control methods named, and other products may be equally effective.

Seeds and Plant Production
Small scale production fields and wildland collections can be made by beating the seeds off the plant into a bin or bag, or by clipping the flower heads. Seed is cleaned by running the collected material through a hammer mill followed by sieving and air-screening. Seed often contains small grubs. Placing the seed in a freezer for 24 hours may help eliminate seed eating insects.

Nuzzo (1978) used a 10 week moist stratification for propagating curlycup gumweed. She reported first germination occurred after 3 days and peak germination occurred after 14 days. Plants were ready to transplant into the field after 10 weeks.

Two similar species, *Grindelia camporum* and *G. stricta*, are grown for seed production in California. Both have very sticky vegetation like curlycup gumweed. Fields are direct combined; however the gum must be scraped off of the combine and machine parts every so often to keep it working effectively. The seeds separate from the seed head quite readily. Deer are very fond of the young vegetation and may pose a problem in production settings (Emily Allen, Hedgerow Farms Personal communication 2016).

Cultivars, Improved, and Selected Materials (and area of origin)
Limited quantities of wildland collected seed may be available from commercial sources. There are currently no commercial releases of curlycup gumweed; however multiple accessions are currently under investigation at Aberdeen Plant Materials Center for potential release. Seed sources should be selected based on the local climate, resistance to local pests, and intended use. Consult with your local land grant university, local extension or local USDA NRCS office for recommendations for use in your area.

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Natural Resources Conservation Service

Plant Guide

ANNUAL SUNFLOWER

Helianthus annuus L.

Plant Symbol = HEAN3

Contributed By: USDA NRCS National Plant Data Center

@ PLANTS

Alternative Names

common sunflower, Kansas sunflower, mirasol; *Helianthus* comes from the Greek *helios anthos*, meaning "sun flower" (Kindscher 1987). The species name *annuus* means "annual."

Uses

Ethnobotanic: The sunflower is a native domesticated crop. During the last 3,000 years, Indians increased the seed size approximately 1,000 percent. They gradually changed the genetic composition of the plant by repeatedly selecting the largest seeds (Yarnell 1978).

Originally cultivated by North American Indians, it has a long and interesting history as a food plant (Kindscher 1987). Sunflower seeds were and still are eaten raw, roasted, cooked, dried, and ground, and used as a source of oil. Flower buds were boiled. The roasted seeds have been used as a coffee substitute. The Mescalero and Chiricahua Apache made extensive use of wild sunflowers. The Hidatsa used wild verse cultivated sunflowers in the production of cooking oil because the seeds of their smaller flower heads produced superior oil (Wilson 1917). In the Northeast, sunflowers are part of the Onandaga (Iroquois) creation myth (Gilmore 1977). In the Southwest, the Hopi believe that when the sunflowers are numerous, it is a sign that there will be an abundant harvest (Whiting 1939). In the prairies, the Teton Dakota had a saying, "when the sunflowers were tall and in full bloom, the buffaloes were fat and the meat good" (Gilmore 1977).

Helianthus seeds were eaten by many California natives, and often ground up and mixed with other seeds in pinole (Strike 1994). The sunflower was used for food in Mexico and had reputed medicinal value in soothing chest pains (Heiser 1976). Francisco Hernandez, an early Spanish explorer, ascribed aphrodisiac powers to the sunflower (*Ibid*.).

Charles H. Lange, an anthropologist at the University of Texas, wrote that "among the Cochiti, a reliable 'home remedy' for cuts and other wounds is the juice of freshly crushed sunflower stems. The juice is smeared liberally over the wounds, bandaged, and invariably results in a speedy recovery, with never a case of infection" (Heiser 1976).

According to Moerman (1986) sunflowers were used in the following ways:

- The Cherokee used an infusion of sunflower leaves to treat kidneys.
- The Dakota used an infusion of sunflowers for chest pains and pulmonary troubles.
- The Gros Ventres, Rees, and Mandan used sunflowers ceremonially; oil from the seeds were used to lubricate or paint the face and body.
- The Gros Ventres, Mandan, Rees, and Hidatsa used sunflower seeds as a stimulant, taken on a war party or hunt to alleviate fatigue.
- The Hopi used the sunflower plant as a "spider medicine" and dermatological aid.
- The Navajo ate sunflower seeds to stimulate the appetite.
- The Navaho-Kayenta used the plant for the sun sand painting ceremony and as a disinfectant to prevent prenatal infections caused by the solar eclipse.
- The Navaho-Ramah used a salve of pulverized seed and root to prevent injury from a horse falling on a person and as a moxa of the pith to remove warts.
- The Paiute used a decoction of sunflower root to alleviate rheumatism.
- Pawnee women ate a dry seed concoction to protect suckling children.
- The Pima applied a poultice of warm ashes to the stomach for worms and used a decoction of leaves for high fevers and as a wash for horses' sores caused by screwworms.

- The Thompson Indians used powdered sunflower leaves alone or in an ointment on sores and swellings.
- The Zuni used a poultice of sunflower root to treat snakebite, along with much ritual and ceremony.

Purple and black dyes extracted from wild sunflowers were used to dye basketry materials. A yellow dye was also derived from the ray flowers. The Hopi Indians grew a sunflower variety with deep purple achenes, and obtained a purple dye by soaking them in water (Heiser 1976). The dye was used to color basketry or to decorate their bodies.
The Teton Dakotas boiled flower heads from which the involucral bracts had been removed as a remedy for pulmonary troubles (Gilmore 1977). Pawnee women who became pregnant while still nursing a child took a sunflower seed medicine to prevent sickness in the child (Kindscher 1992). In the southwest, Zuni medicine men cured rattlesnake bites by chewing the fresh or dried root, then sucking the snakebite wound (Camazine and Bye 1980).

The wild sunflower was worn in the hair of the Hopi Indians of Arizona during various ceremonies, and carved wooden sunflower disks found at a prehistoric site in Arizona almost certainly were employed in ceremonial rituals (Heiser 1976).

Agricultural: Early American colonists did not cultivate sunflowers. The sunflower probably went from Mexico to Spain, and from there to other parts of Europe (Heiser 1976). The Russians developed the Mammoth Russian or Russian Giant sunflower and offered these varieties as seeds, which in 1893 were reintroduced to the United States. Sunflowers are used as a source of vegetable oil. The seeds are used for snacks and for bird food.

Medicinal: Medicinal uses for the sunflower utilized by the Europeans include use as a remedy for pulmonary affections, a preparation of the seeds has been widely used for cold and coughs, in the Caucasus the seeds have served as a substitute for quinine in the treatment of malaria, and sunflower seeds are used as a diuretic and expectorant (Heiser 1976). Sunflower pith has been used by the Portuguese in making moxa, which was used in the cauterization of wounds and infections. An infusion from the flowers has been used to kill flies.

A variety of terpenoid compounds have been found in Helianthus species, primarily sesquiterpene lactones and diterpenes (Gershenzon and Mabry 1984). These substances probably offer sunflowers protection against some insects.

Horticultural: Sunflowers are cultivated as ornamentals or garden plants, where the blooms are cherished for their beauty, and the seeds can be eaten by both humans and wildlife. Game birds, songbirds, and rodents (Martin et al. 1951) eat the large, nutritious seeds of sunflowers. These attractive weedy plants are of outstanding value to wildlife in the prairies and other parts of the West. Birds eating the seeds include Wilson snipes, doves, grouse, ring-necked pheasants, quail, blackbirds, bobolinks, lazuli buntings, black-capped chickadees, cowbirds, white-winged crossbills, crows, house finches, goldfinches, purple grackles, horned larks, longspurs, meadowlarks, white-breasted nuthatches, pyrrhuloxias, ravens, sparrows, and tufted titmice. Small mammals who relish the seeds include the least chipmunk, eastern pocket gopher, ground squirrels, lemmings, meadow mice, pocket mice, white-footed mice, prairie dogs, and kangaroo rats. Muskrats eat the stems and foliage. Antelope, deer, and moose browse on the plants.

Industry: Sunflower stalks have been used as fuel, fodder for livestock, food for poultry, and ensilage (Heiser 1976). In the Soviet Union, after the dried flower stalks have been used for fuel, the ashes are returned to the soil. The seed hulls could be used for "litter" for poultry or returned to the soil or composted. A few years ago, it was found that the hulls could be used in fuels. Today the hulls are used in the Soviet Union in manufacturing ethyl alcohol and furfural, in lining plywood, and in growing yeast. The stems have been used as a source of commercial fiber. The Chinese have used this fiber for the manufacturing of fabrics. Other countries are experimenting with the use of fiber in paper.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description
General: Sunflower Family (Asteraceae). The sunflower is an erect, coarse, tap-rooted annual with rough-hairy stems 6-30 dm (2-10 ft) tall. The leaves are mostly alternate, egg-shaped to triangular, and entire or toothed. The flower heads are 7.5-15 cm (3-6 in) wide and at the ends of branches. Ray flowers are yellow and disk flowers are reddish-brown.

Distribution
The sunflower (*Helianthus annuus*) is a common and widespread roadside weed. It is common in open sites in many different habitats throughout North America, southern Canada, and Mexico at elevations below 1900 m. *Helianthus annuus* is highly variable as a species, and hybridizes with several other species. The heads and plants are very large in cultivated forms.

Establishment
Sunflowers need full sun. Irrigation is required until they become established.

Seed Propagation: When the soil has warmed up to at least 45ºF (7ºC) in the spring, sow hardy sunflower seeds where they are to flower. Seeds can also be sown in pots or seed trays and either planted out in their final positions in late fall or overwintered in a cold frame to be planted out in spring. This technique is particularly useful in gardens with clay soil that is slow to warm up in spring.

There are two main methods of sowing outdoors in situ: broadcast and in drills. For both, prepare the seedbed first. Dig over the soil to one spade's depth, then rake over and firm. Broadcast Sowing: Sprinkle seeds thinly and evenly on the surface of the prepared seedbed and rake them in lightly. Label seedbeds, then water the area gently but thoroughly with a fine spray. Sowing in Drills: Using either a trowel tip or the corner of a hoe, mark out shallow drill holes 3-6" (8-15 cm) apart, depending on the ultimate size of the plant. Sow seeds thinly and evenly by sprinkling or placing them along each drill at the appropriate depth. Carefully cover with soil and firm. Label each row and water gently but thoroughly with a fine spray.

To prevent overcrowding, the seedlings usually need to be thinned. To minimize disturbance to a seedling being retained, press the soil around it after thinning the adjacent seedlings. Water the newly establishing seedlings fairly frequently until the roots have developed. Support is required for the sunflower stems. Stakes help support the stem and protect the seedlings from rodent or bird damage. Birds and small mammals love both the sunflower seeds and the tender young seedlings. A scarecrow or netting may be necessary to protect the plants from herbivores.

Management
In pre-European settlement times, the Hidatsa cultivated sunflowers in the following ways (Wilson 1917):

1) Garden plots were created from wooded and brushy areas in river bottomlands.
2) Brush cleared for planting was spread over the plots and burned, for it was conventional wisdom that burning trees and brush "softened the soil and left it loose and mellow for planting". Burning also added nutrients to the soil.
Before setting fire to the fields, the dry grass, leaves, and brush were removed from the edges of the fields so the fire wouldn't spread.
3) Plots were allowed to lay fallow, and were taken out of production for two years to let them rejuvenate.
4) Sunflowers were the first seeds planted in the spring. Planting was done using a hoe. Three seeds were planted in a hill, at the depth of the second joint of a woman's finger. The three seeds were planted together, pressed into the loose soil by a single motion, with the thumb and first two fingers. The hill was heaped up and patted firm. Sunflowers were planted only around the edges of a field. The hills were placed eight or nine paces apart.
There were several varieties of sunflowers; black, white, red, and striped colors occurred in the seeds.
5) Seeds were harvested by spreading sunflower heads on the roof to dry. The heads were laid face downward, with the backs to the sun. After the heads had dried for four days, the heads were threshed by laying them on the floor face downwards and beating them as a stick. An average threshing filled a good-sized basket, with enough seed left over to make a small package.
6) Parched sunflower seeds were pounded in the corn mortar to make meal. Sunflower meal was used in a dish called four-vegetables-mixed; it included beans, dried squash, pounded parched sunflower seed, and pounded parched corn.
7) Sunflower seed balls were made of sunflower seed meal. In the olden times, every warrior carried a bag of soft skin with a sunflower-seed ball, wrapped in a piece of buffalo-heart skin. When worn with fatigue or overcome with sleep and weariness, the warrior took out his sunflower-seed ball, and nibbled at it to refresh himself.
Each garden plot was "owned" and tended by a woman who cleared it. It was kept cleared of weeds and birds were chased off.

Cultivars, Improved and Selected Materials (and area of origin)
Cultivars: Apache Brown Striped, Autumn Beauty Hybrids, Aztec Gold, Bellezza d'Autuno, Big Smile, Black Oil, Color Fashion Hybrids, Confection, Daisetsuzan, Discovery, Evening Sun, Floristan, Full Sun, Fun Sun, Gloriosa Polyheaded, Gold & Silver, Gray-Stripe, Hallo, Happy Face, Havasupai Striped,

Henry Wilde, Holiday, Hopi Dye, Inca Jewels, Incredible, Italian White, Lion's Mane, Lemon Queen, Luna, Mammoth Russian, Monster, Moonwalker, Music Box, Orange Sun, Park's Velvet Tapestry, Paul Bunyan, Peredovik, Piccolo, Provance Hybrids, Silverleaf, Sonja, Sun Hybrids, Sunbeam, Sunbright, Sunburst Hybrids, Sunrise, Sunset, Sunspot, Taiyo, Tangina, Teddy Bear, Tarahumara White, Valentine, Vanilla Ice, Velvet Queen, and Zebulon.
HEAN3 is widely available through local nurseries and seed companies.

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Plant Guide

WOODS' ROSE

Rosa woodsii Lindl.

Plant Symbol = ROWO

Contributed by: USDA NRCS National Plant Data Center & the Biota of North America Program

Alternate Names
Common wild rose, wild rose, mountain rose

Uses
Wildlife: Fruits of Woods' rose are a good source of energy and protein and are eaten by many animals, including squirrels, deer, coyotes, and bears. Many birds and mammals are sustained by the persistent dry hips when the ground is covered with snow. The plants are browsed by livestock and big game from spring through fall, but the young spring leaves are especially palatable. Porcupines and beavers also browse the leaves. Thickets formed by Woods' rose provide nesting and escape cover for many birds and small mammals.

Conservation: The rhizome system makes Woods' rose effective in erosion control, and the species has been used to revegetate disturbed sites along road cuts, streambanks, and seeps. Plants are used as ornamentals near homes to attract birds and other wildlife.

Ethnobotanic: Native Americans used the roots, stems, leaves, flowers, and fruits of Woods' rose for foods and therapeutic materials. The hips are a source of vitamin C and are dried for use in flavoring teas, jellies, fruitcakes, and puddings. The inner bark and roots were boiled to treat diarrhea and stomach aliments and a tea was made from the bark to treat muscles.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description
Rose family (Rosaceae). Native subshrubs or shrubs growing 0.2-2(-3) m high, rhizomatous, with shallow, frequently branching fibrous roots, sometimes forming nearly impenetrable thickets; stems reddish-brown to gray, with straight or slightly curved prickles. Leaves are deciduous, alternate, odd-pinnately compound, leaflets 5-7(-11), obovate to ovate or elliptic, ca. 1.5-3(-4) cm long, finely toothed toward the tip. Flowers occur on branches lateral from the old wood, 10-20 cm long, few in a cluster at the stem tip, less commonly solitary; petals 5, (10-)15-25 mm long, pink to lilac-pink, or lavender; sepals lanceolate, 1-2 cm long, erect and usually persistent, tomentose on the margins and inner surface. Fruit is a fleshy, red, globose to ellipsoid "hip" 5-12 mm wide, derived from the base of the sepals and petals; nutlets 15-35, 3-4 mm long. Named for Joseph Woods, 1776-1864, an early English student of roses.

Variation within the species: many variants have been described, and the species now includes many roses previously described as species. The following varieties are sometimes now recognized (Cronquist & Holmgren 1997) but they are combined as a single variable species by others (e.g., Ertter 1993 in The Jepson Manual).
Rosa woodsii var. *glabrata* (Parish) Cole – CA
Rosa woodsii var. *gratissima* (Greene) Cole – CA and NV
Rosa woodsii var. *ultramontana* (S. Wats.) Jepson
Rosa woodsii var. *woodsii*

Woods' rose forms natural hybrids with *R. acicularis* Lindl., *R. arkansana* Porter, *R. blanda* Ait., and probably others.

Woods' rose is recognized among many similar species of rose by its combination of shrubby, thicket-forming habit, stems with straight prickles, and leaves and sepals without glands.

Distribution
Widely distributed over western North America, from Ontario and Manitoba, Wisconsin, Minnesota, and Iowa, south to Texas and northern Mexico, west to California and Alaska through every other western state and province. Var. *woodsii* (see below) occurs in Alaska and Yukon but no other provinces or states bordering the Pacific; var. *ultamontana* is the far-western entity, sometimes regarded as including var. *glabrata* (California endemic) and var. *gratissima* (California and Nevada). For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Adaptation
Woods' rose is commonly a dominant species on riparian and wetland sites, but it is adapted to a broad range of moisture conditions. It is common in various regions as a pioneer on disturbed sites, especially along roadsides and south-facing cutbanks. It occurs on bluffs, dry grassy slopes, prairie sandhills, and in clearings in boreal and subalpine forests or sometimes as an understory species in stands dominated by cottonwood, ponderosa pine, and Douglas fir. Moderate shade-tolerance allows it to persist as an understory species in mid-seral to climax communities; at elevations of 800-3500 meters. Flowering June-August; fruiting August and into the fall, the hips remaining on the plant through the winter.

Establishment
Woods' rose produces flowers and fruits at about 2-5 years of age. Good crops are usually produced every 2 years. Birds and mammals eat the fruits and disperse the seeds in droppings. The seeds remain viable for 2-5 years, and after warm or cold stratification, they germinate within 30 to 40 days. Woods' rose also reproduces through rhizomes, root crown sprouts, and layering. Establishment for ornament or rehabilitation is from transplants, hardwood cuttings, and direct seeding.

Management
Fire of low- to moderate-severity typically top-kills Woods' rose, but sprouts from root crowns and rhizomes enable it to persist or even increase. The shallow root crowns are injured by severe fire and populations consequently may decrease in vitality and abundance. Reproduction from seed is rarely observed after fire, and seedling growth rate in a burned area may be slow.

Cultivars, Improved and Selected Materials (and area of origin)
These plant materials are readily available from commercial sources. Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under "United States Government." The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

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Plant Guide

GOLDEN CURRANT

Ribes aureum Pursh var. *villosum* DC.

plant symbol = RIAUV

Contributed By: USDA, NRCS, National Plant Data Center & the Biota of North America Program

Alternate common names

Buffalo currant, fragrant golden currant, golden flowering currant, clove currant, spicebush

Botany Dept., NMNH, Smithsonian Institution @ PLANTS

Uses

Fruits of *Ribes* species, including the golden currant, are a valuable food source for songbirds, chipmunks, ground squirrels, as well as numerous wildlife species and other animals. The sweet and flavorful fruits are full of seeds but are popular for making jam, jelly, pie, and even ice cream. Some western Indian tribes used currants (*Ribes* species) for making pemmican. The Kiowa Indians believed that snakes were afraid of the currant bush and used it as a snakebite remedy. Other tribes have used the fruits to color clay pots.

The fragrant (clove odor), golden-yellow flowers of spring, yellowish to red fall foliage, edible fruits, and wide ecological range make golden currant a valued ornamental shrub for a variety of natural landscapes. Golden currant is easily cultivated from seed or cuttings.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description

General: Currant family (Grossulariaceae). A native shrub 1-3 m tall, spineless, with numerous, erect-arching branches forming an irregular crown up to 6 meters tall or more; bark gray to red-brown; rhizomatous. Leaves deciduous, light green and glossy, alternate or clustered, orbicular or cuneate-ovate with 3-5 rounded lobes, (0.6-)1-2.5(4.7) cm long and wide, cuneate to subcordate at base, glabrous or sometimes lightly hairy beneath. Flowers in short racemes of 5-10(-15), with the fragrance of cloves; long-tubed (from fused sepals) and trumpet-shaped, with 5 yellow sepal lobes spreading at the top, with 5, short, reddish petals inserted at the top of the tube. Fruit a berry 6-10 mm diameter, globose to ellipsoid, ripening from green to yellow to red and finally black to dark purple, with numerous seeds. The common name pertains to the conspicuous, golden flowers; "currant" is the general name for *Ribes* fruit.

Variation within the species: Ribes odoratum, often considered a distinct species, recognized by its considerably larger flowers, has been placed (re-placed, as var. *villosum*) as the eastern segment of the broader species.

Var. *aureum* – (golden currant)
Var. *gracillimum* (Coville & Britt.) Jepson – (golden currant)
Var. *villosum* DC. – (fragrant golden currant, buffalo currant, clove currant)
synonym: *Ribes odoratum* H. Wendl.

Distribution: Var. *aureum* is widespread in the western US and southeastern Canada, with populations in Ontario and perhaps Quebec, as far south in the US as trans-Pecos Texas. Var. *gracillimum* is endemic to California. Var. *villosum* in the central US, from western Texas to Montana and eastward to New York and Vermont; it is absent

from the Atlantic seaboard. The species is naturalized in Europe from garden escapes. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Adaptation
Golden currant grows in grasslands, coniferous forests and woodlands, and riparian and mountain shrub communities. It occurs on floodplains, along streams, in ravines and washes, by springs, and on mountain slopes, at elevations of about 800–2600 meters. It is generally an early to mid-seral species in western coniferous forests. Var. *villosum* occurs on cliffs, rocky slopes, ravines, bluffs, open hillside, and thicket margins, often in sandy habitats. Golden currant is somewhat shade tolerant and may grow in open, scattered, and dense pine stands, but it is usually suppressed by a denser canopy.

Flowering (March–)April–June, just after appearance of the leaves; fruiting (May–)June–August.

Establishment
Plants of *Ribes* generally begin fruiting after 3 years. Seeds may remain viable in the soil and duff for many years. Germination is enhanced by scarification, but relatively good germination of golden currant seeds was obtained by stratification at -2.2–2.2 degrees C for 60 days without scarification.

Golden currant transplants well and forms suckers. Plants can also be grown from cuttings. It reproduces vegetatively by rhizomes, sprouting after cutting and fire.

Management
Golden currant can be used to re-vegetate roadsides and disturbed areas, such as mine spoils and rangeland. It is rated mostly good in initial establishment, growth rate. persistence, germination, seed production, ease of planting, and natural spread. It tolerates shearing and may be used on dry, exposed sites in a range of soil types, and it is a good soil stabilizer.

Golden currant is an alternate host for white pine blister rust (*Cronartium ribicola*); this and other species of *Ribes* have been targets of various eradication efforts where white pine is of commercial interest.

Fire top-kills golden currant, but it can survive low- to moderate-severity fire by sprouting from rhizomes. Such fires also scarify soil-stored seed and enhance germination. Severe fire probably kills golden currant and may destroy soil-stored seeds.

Cultivars, Improved and Selected Materials (and area of origin)
Please check the Vendor Database, expected to be on-line through the PLANTS Web site in 2001 by clicking on Plant Materials. These plant materials are readily available from commercial sources. One cultivar (‘Crandall’) has been referred to as "the North Country's answer to *Forsythia*." Other horticultural selections have been made for hardiness, flower color and density, and fruit taste and size.

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For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS <http://plants.usda.gov> and Plant Materials Program Web sites <http://Plant-Materials.nrcs.usda.gov>.

United States Department of Agriculture
NRCS Natural Resources Conservation Service
Plant Guide

REDOSIER DOGWOOD

Cornus sericea L.

Plant symbol = COSE16

Contributed By: USDA, NRCS, National Plant Data Center & Carlinville (IL) Field Office

Robert H. Mohlenbrook
USDA, NRCS, Wetland Science Institute
@ PLANTS

Alternative Names

American dogwood, red willow, redstem dogwood, *Cornus sericea* ssp. *sericea*; *Cornus stolonifera* var. *nevadensis* Jepson and *Cornus stolonifera* Michaux (Hickman 1993). A subspecies, *Cornus sericia* spp. *occidentalis* (Torr. & Gray) Fosberg is known as western dogwood.

Use

Ethnobotanic: Native Americans smoke the inner bark of redosier dogwood in tobacco mixtures used in the sacred pipe ceremony. Dreamcatchers, originating with the Potawotami, are made with the stems of the sacred redosier dogwood. Some tribes ate the white, sour berries, while others used the branches for arrow-making, stakes, or other tools. In California, peeled twigs were used as toothbrushes for their whitening effect on teeth (Strike 1994). Bows and arrows were made from *Cornus* shoots. The inner bark is used for tanning or drying animal hides.

The Apache, Cheyenne, Dakota, Montana Indians, Ojibwa, Potawatomi, Omaha, Ponca, and Thompson Indians all use the inner bark in a tobacco mixture for smoking the sacred pipe (Moerman 1986). The leaves and/or inner bark of redosier dogwood are also used as a smoking mixture by the Okanagan-Colville, the Flathead, the Kootenay, and the Blackfeet peoples in the western United States and Canada (Hellson 1974, Hart 1976, Turner 1978, Turner et al. 1980, Johnston 1987). The Navaho-Kayentaf and Navaho-Ramah used the plant ceremonially as a Mountain-top-way emetic (Moerman 1986). An infusion of redosier dogwood bark was used as an anti-diarrheal by the Chippewa and the Potawatomi, an antidote for weak kidneys by the Shuswap, and a pediatric aid for children who wet the bed by the Shuswap. The Chippewa used an infusion of the bark for eruptions caused by poison ivy. The Chippewa and the Micmac used a decoction of redosier dogwood root for sore eyes and catarrh. The Okanagan and the Thompson Indians took a decoction of the leaves. Other remedies treated by redosier dogwood included headaches, sore throats, a wash for ulcers, a substitute for "larb", and a decoction of bark was taken as an antidote for weakness.

The Maidu of Northern California used redosier dogwood as a tonic, a laxative, emetic, and cathartic (Strike 1994). Maidu women took a dogwood decoction after childbirth.

The Indians of the Missouri region (Densmore 1974) ate the fruits. The berries are known to be tart and bitter, but were nonetheless eaten by all of the southern Interior peoples of British Columbia, including the Nlaka'pamux, Lillooet, Okanagan-Colville, Shuswap, Kootenay, Blackfeet, and the Flathead of Alberta and Montana (Kuhnlein and Turner 1991). The fruits were gathered from August to October and eaten fresh, a few at a time, or, more commonly, were pounded and mixed with other fruits, such as chokecherries (*Prunus virginiana*) or Saskatoons (*Amelanchier almifolia*). Some people mashed the berries and dried them in cakes; others dried and stored them. Eating a few raw fruits was considered to be a good tonic among the Nlaka'pamux and the Okanagan-Colville, who ate them raw as a kind of "relish" (Turner 1978; Turner et al. 1990).

Redosier dogwood is used for basketweaving. Sometimes called red willow, both *Salix* species and *Cornus sericea* are used interchangeably. Differences in stem color create a multi-hued design element. Indian people from the mid-Columbia River used redosier dogwood to make "ribbons" for

basket decorations (Schlick 1994). If gathered in the early spring, the bark will retain its deep red color when dried and could be mistaken for cherry. The Hidatsa, Arikara, and Mandan made twill plaited burden baskets with two-toned dark and light designs; these baskets were made of willow (*Salix nigra*), redosier dogwood, and boxelder (*Acer negundo*) splints (Turnbaugh et al. 1986, Hart 1976). Willow and redosier dogwood were used by the Cheyenne, Arapaho, Kiowa, Pawnee, and Teton Sioux to make a coarsely coiled gambling basket for dice.

The Ojibwa and the Chippewa used redosier dogwood bark as a dye. The inner bark was mixed with other plants or minerals and used to make a red dye, a light red dye, a black dye, and an ecru or "khaki" colored dye (Densmore 1974).

Wildlife: The fleshy fruits of dogwoods are very valuable to wildlife, particularly in the Northeast (Martin et al. 1951). The fruit ripens in late summer, and besides being available through the fall, some of the berries may persist on the plants into the winter months. Wildlife browse the twigs, foliage, and fruits. Birds known to eat the fruit include: wood ducks, eastern bluebirds, cardinals, catbirds, long-tailed chats, crows, purple finches, yellow-shafted flickers, crested flycatchers, grosbeaks, kingbirds, American magpies, mockingbirds, crested mynah birds, orioles, robins, yellow-bellied sapsuckers, European starlings, tree swallows, scarlet tanagers, brown thrashers, thrushes, vireos, pine warblers, cedar waxwings, and woodpeckers. Game birds who eat both the fruits and buds include grouse, ring-necked pheasants, band-tailed pigeons, greater prairie chickens, bobwhite quail, and wild turkeys. The shrubs provide excellent nesting habitat for songbirds. Mammals that eat the fruit and foliage include black bear, beaver, mountain beaver, cottontail rabbits, raccoons, eastern skunks, squirrels, chipmunks, mice, and rats. Deer, elk, Mountain goat, and moose browse the twigs and foliage.

Landscaping & ornamental: Redosier dogwood is often planted as an ornamental, both to beautify the landscape and to attract birds. Dogwood is often used for landscaping and as a secondary plant in windbreaks.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status, and wetland indicator values.

Description

General: Dogwood Family (Cornaceae). Redosier dogwood is a woody deciduous shrub generally 1.4-6 m (4.6-20 ft) tall. The bark and twigs are reddish to purple and fairly smooth from autumn to late spring; after the leaves have fallen, the deep burgundy branches add color to the winter landscape. The bark, twigs, and leaves are bright green in spring through summer. The simple, opposite leaves are 5-10 cm (2-4 in) long, dark green above and hairy and lighter-colored below, with smooth margins, rounded bases, pointed tips, and falsely parallel veins. Flowering occurs from June to August. The inflorescence is a cyme, with 2-3 mm (0.08-0.12 in) white to cream-colored flowers. The white berries are smooth on the faces, furrowed on the sides.

Distribution

For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site. Redosier dogwood has a wide distribution from California north to Alaska and throughout the country to the eastern United States south to Mexico. It generally grows at elevations below 2500 m.

Establishment

Adaptation: Redosier dogwood grows in soils that are saturated for at least a portion of the growing season. Redosier dogwood is common on the edges of lakes, ponds, within wetlands, and along streams. Not as tolerant of long-term root saturation as are some other shrubs, dogwood seems to prefer wetland margins where soils are nitrogen-rich, saturated, and shallowly inundated in the spring, and may be completely dry by late summer. It is tolerant of fluctuating water tables. The "osier" in redosier dogwood is derived from French, meaning "willow-like"; it is often called red willow because of its red stems.

Propagation from cuttings: Redosier dogwood can be started easily by division, french layering, and hardwood cuttings. To propagate suckers by division:

- Lift a root with suckers on it without disturbing the parent plant. Check that there are fibrous roots at the base of the suckers.
- Remove the suckering roots by cutting it off close to the parent plant. Firm the soil around the parent plant.
- Cut the main root back to the fibrous roots, then divide the suckers so that each has its own roots. Cut back the top-growth by about half.
- Treat each sucker or hardwood cutting at the base with IBA at 20,000 ppm liquid formulation to promote rooting. Alternatively, treatment

with 2 percent IBA talc; this will promote rooting on both suckers and stem cuttings.
- Replant the suckers in open ground in prepared holes with good potting soil. Firm the soil around the suckers and water.
- Before growth starts in the spring, lift the plant. Break the clump into sections, retaining those with vigorous shoots and well-developed roots.
- Prune any damaged roots, and cut back the top-growth by one-third to a half to reduce water loss. Replant the divisions in the open and water in dry weather.
- Ultimately, simply lift a suckering root, sever it from the parent plant, and then replant it in the open.

To ensure survival of cuttings or suckers through the following winter in cold climates, the potted cuttings should be kept in heated cold frames or poly-houses to hold the temperature between 0-7°C (32-45°F). Rooted cuttings that had shoot growth in the fall, but were not given nitrogen, had the best over-winter survival in a cold frame with microfoam.

French layering: Layering is a method where a stem is encouraged to develop roots before being removed from the parent plant.
- In spring, plant a rooted layer or young plant, label it, and grow it for a season. Then, in the dormant season, cut back the stem to within 3 inches (8 cm) of the ground.
- In the following spring, apply a balanced fertilizer at the rate of 2-4-oz/sq yd (60-110 g/sq m). Space the stems evenly again; dropping each into a 2-inch (5-cm) deep trench. Peg down each stem and cover with soil, leaving the shoot tips exposed. Hill up all but 2-3 inches (5-8 cm) of the new shoots as they develop, until the mound is 6 inches (15 cm) high. Water as needed.
- After leaf fall, carefully fork away the soil from around the new shoots until the stems that were laid horizontally are exposed. Cut these flush with the basal area of the stems. Then cut the stems to separate the rooted sections. Pot these or plant them out in the open garden, and label them. The same redosier dogwood basal area may be used to propagate further layers.

Propagation by seed: Redosier dogwood is established easily from seed. The best germination is obtained if the seeds are gathered as soon as the fruit starts to color or ripen, from August to October. If the seeds are allowed to dry out, it is best to remove seeds from the fruit and soak in water.

The best results are obtained from fall sowing of freshly harvested seeds. Fruits collected too late to sow in the fall should be stored, pre-chilled until the next season, and sown outdoors the following fall. To effectively condition the seed for germination, store for two months in moist sand at 5ºC for 90 days. After pre-chilling, expose the seeds to fluctuating temperatures from 12/72ºC for 10 days (Young and Young 1992). With some species, the warm stratification period may be replaced by mechanical scarification or soaking in sulfuric acid. Seeds sown in nursery beds should be covered with 0.25-0.5 in (0.6-1.25 cm) of soil. Fall-sown beds should be mulched during the winter.

Management

Redosier dogwood is often coppiced in late fall after the leaves turn brown and fall off the stem. Cut all stems to approximately 2-3 in (5-8 cm) from the base before growth begins in spring. Apply fertilizer around the shrub to promote new growth, then apply mulch around the base. Coppicing stimulates the growth of new, vigorous stems whose deep burgundy color is especially vivid.

Traditional resource management: Redosier dogwood was traditionally tended by pruning or burning to produce long straight stems.
- Often basket weavers will prune many redosier dogwood stems, sometimes replanting the stems, so there will be nice straight basketry material the following year.
- Before gathering, offerings of thanks and prayers for permission to gather are given. Often tobacco or sage or other offerings are given before beginning to gather.
- Basket weavers process materials with their hands and mouths. Herbicides sprayed along streams have a much higher health risk for humans when they are processed and used for traditional materials.

Overgrazing, especially by livestock and big game, frequently changes plant species composition and growth form, density of stands, vigor, seed production of plants, and insect production. Livestock grazing can cause the replacement of bird and mammal species requiring the vertical vegetation structure of riparian habitat to species, which are ubiquitous in their habitat preferences. Previous heavy cattle grazing changed the bird and small mammal community composition in riparian areas through reduction of shrub and herbaceous cover.

Cultivars, Improved and Selected Materials (and area of origin)

Cultivars: 'Alman's Compacta', 'Allamans', 'Bailey', 'Cardinal', 'Coloradensis', 'Flaviromea', 'Isanti', 'Kelseyi', 'Lutea', 'Ruby', 'Silver' and 'Gold', and 'White Gold' have been planted in the growing range of redosier dogwood.

Consult your local nurseries to choose the right cultivar for your specific landscape. Please check the Vendor Database, expected to be on-line through the PLANTS Web site in 2001 by clicking on Plant Materials.

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Plant Guide

BLACK HAWTHORN
Crataegus douglasii Lindl.
Plant Symbol = CRDO2

Contributed By: USDA NRCS National Plant Data Center

J.E. & Bonnie McClellan
© California Academy of Sciences
@ CalPhotos

Alternative Name
Douglas hawthorn

Uses
Erosion Control: Because it tolerates a wide variety of sites, black hawthorn can be planted to stabilize banks, for shelterbelts, and for erosion control along ditches and highways.

Timber: Although the wood is hard and strong, it has no commercial value except for tool handles and other small items.

Wildlife: It provides abundant food and cover for game birds such as the blue and sharp-tailed grouse. The mule deer, small mammals and other wildlife species feed on the leaves and twigs of young seedlings or trees. Livestock readily eats its leaves if accessible.

Beautification: Ideal for biological barriers between recreational areas and physical structures.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description
It is a large shrub or small tree that can grow to thirty-five feet tall, with straight, strong but few thorns ranging from 0.5 to 1 inch long. Stems are usually clustered from the base or from a point just above the ground surface. Leaves are smooth, long, broad, dark green, shiny, and serrated at the tip. Flowers are globe-shaped and in small clusters produced in the spring. Its fruits are dark reddish-purple to black.

Distribution: *Crataegus douglasii*, black hawthorn, is widespread in the Pacific Northwest, from southeastern Alaska south through British Columbia to northern California.

Adaptation
Black hawthorn generally occurs on deep, moist, fine-textured soils, at lower elevations ranging from 2,200–5,400 ft. Although it will succeed in partial shade and different soil types, it grows best in full sunlight with sufficient moisture levels. It is predominantly an understory species and seldom found in pure stands. It is fire tolerant and will re-sprout and produce suckers following fire disturbance.

Establishment
Propagation from Seed or Grafting: Black hawthorn can be propagated by either seeds or grafting. To increase percent germination, seeds require acid scarification for 0.5 to 3 hours, followed by 84 to 112 days of cold treatment. Seeds are planted early in the fall, in drill rows 8 to 12 inches apart and covered with 1/4 inch of soil. Seedlings must not be kept in the nursery longer than a year. Approximate seed per pound: 22,600.

Containerized trees should be planted when they are no more than eight feet tall, in the fall or spring. Balled and burlapped trees should be planted in early spring.

Grafting on seedling stock of *Crataegus oxyacantha* or *Crataegus monogyna* is best carried out in the winter to early spring.

Management
Because it develops long taproot, it should not be kept in seedbeds more than one year. Pruning should be done in the winter or early spring in order to maintain a clear shoot leader on young trees and/or

remove the weakest branches to allow more light to pass through. Suckers or stems arising from the roots should be removed when they become noticeable. Limited agriculture/livestock can help maintain and protect black hawthorn thickets as important source of food and cover for wildlife.

Pest and Potential Problems
Although pests and diseases seldom affect it, it is susceptible to fireblight, cedar-hawthorn rust, cedar-quince rust, leaf blight, fruit rot, and leaf spot.

Cultivars, Improved and Selected Materials (and area of origin)
Consult you local nurseries to choose the right cultivar for your specific landscape. Seeds and seedlings are commercially available at forest seed companies. Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under "United States Government." The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

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For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

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Natural Resources Conservation Service

Plant Guide

UTAH SERVICEBERRY

Amelanchier utahensis Koehne

Plant Symbol = AMUT

Contributed by: Upper Colorado Environmental Plant Center, Meeker, Colorado

Steve Parr, Upper Colorado Environmental Plant Center

Alternate Names
Serviceberry, Juneberry, shadbush, and sarvis**.**

Uses
Utah serviceberry can be used for food and cover to improve wildlife habitat. Leaves and small branches are used by big game and livestock and berries are consumed by birds and small animals. It also provides nesting and cover for birds. Utah serviceberry can be used for reseeding big sagebrush and pinyon-juniper sites and is also beneficial for conservation plantings on rangelands and mined land. The plant can be used for landscaping and as a component of windbreaks and shelterbelts. It also can be used for roadside beautification. Native Americans used the berries as a source of food that was prepared in several ways (Dunmire and Tierney, 1997). Berries persist longer on the bush than on Saskatoon serviceberry and provide a food source over a longer period of time, especially when the ground may be covered with snow.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicat values).

Description
General: Considerable variation occurs in the native shrubs or small trees that are generally 2 to 4 meters tall. Deciduous leaves are simple, alternate generally serrate-dentate from the middle to the tip. Flowers form clusters in early May with five showy white petals and the ovary is 2 to 5 celled. The persistent purplish – black pome can remain dry and pulpy. Considerable variation occurs when it is found on sites with Saskatoon serviceberry where natural hybrids are sometimes found. It generally occupies drier sites than Saskatoon serviceberry.

Distribution: Utah serviceberry is generally found at elevations of 5000 to 9000 feet from Montana to Oregon, south to New Mexico, and California (Harrington, 1954).

Habitat: The plant is found on dry ridges and slopes in big sagebrush, pinyon-juniper, and aspen communities. It is abundant in the southern portion of the Great Basin (Wasser, 1982).

Adaptation
The plant is found on rocky slopes, canyons and stream banks with 12 to 20 inches of annual precipitation. It has a deep spreading root system and occupies soils that are coarse to medium textured and well drained. It is not tolerant of high water tables or saline soils. It is adapted to drier sites than Saskatoon serviceberry. Utah serviceberry grows with a variety of other plants but grows slowly and seedlings can be suppressed by dense stands of grasses and forbs.

Establishment
Utah serviceberry can be established with seed planted about ¼ of an inch deep in fall months or container grown plants set in the ground in early spring when soil moisture is present. Sprouting does occur but is not as common as the occurrence in the more northern ecotypes of Saskatoon serviceberry. Establishment can be slow, especially if soil moisture is low, but the plant can survive on drier sites than Saskatoon serviceberry. New plantings can require several years (8 to 10) for flowering and seed production. Protection from browsing and plant competition along with the use of mulch will reduce the time required for establishment. Shade also will be beneficial for establishing live plants.

Management

After seeding or planting live plants, controlled browsing will be important for maintaining vigorous growth. Reducing plant competition is also necessary for rapid plant growth. Controlled browsing will be important for berry production. After the plant is established, it can withstand moderate to heavy browsing in years with average to above average precipitation. Browsing should not exceed more than 50 percent of the current season's growth to maintain good plant vigor and growth.

Pests and Potential Problems
The plant is host of Apple-cedar rust when growing in close proximity to Junipers. The rust affects leaves and berries. No other serious diseases or pests are known (Wasser, 1982).

Environmental Concerns
The plant is not known to be aggressive, invasive, or difficult to control when used in areas where adapted.

Seeds and Plant Production
Utah serviceberry has about 25,800 seeds per pound. In years with good moisture, large quantities of berries are produced and can be hand harvested. Controlled browsing is also important for berry production. Seedlings can exhibit good vigor but slow growth. Fresh seed may require cold stratification.

Cultivars, Improved, and Selected Materials (and area of origin)
Long Ridge Germplasm Utah serviceberry is the only release of the species. Seed and plants of Long Ridge Germplasm are available form Upper Colorado Environmental Plant Center (UCEPC) Meeker, Colorado.

Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under "United States Government." The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

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Edited: 080826 jsp

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United States Department of Agriculture
NRCS Natural Resources Conservation Service
Plant Guide

SKUNKBUSH

Rhus trilobata Nutt.

plant symbol = RHTR

Contributed By: USDA, NRCS, National Plant Data Center & the Biota of North America Program

Alternate common names

Botany Dept., NMNH, Smithsonian Institution @ PLANTS

Skunkbrush, polecat bush, stinking sumac, ill-scented sumac, quailbush, squawbush, squawberry, basketbush, lemonade sumac, three-lobed sumac, three-leaved sumac, lemita

Uses

Skunkbush fruits were used by Native Americans in foods, beverages, and medicines. Pliable young stems were woven with grass stems into durable baskets that would hold water. The leaves are said to have been smoked by the Comanches.

Livestock in some locations use skunkbush, but it is not a preferred species. It has been planted in some locations as a deterrent to grazing animals. It provides some browse for deer, elk, and pronghorn when more preferred forage is unavailable. Skunkbush fruits, which persist through fall and winter, provide a food for birds and small mammals when other foods are scarce or unavailable. Skunkbush also may form dense thickets that provide good hiding and nesting cover for small birds and mammals.

Skunkbush has been used as an ornamental (the fall leaves turn bright yellow, orange, and red to reddish-purple), and it has been widely planted at recreation sites, rest areas, and roadsides. It is useful for windbreaks, shelterbelts, and because of the strong root development, for erosion control. Var. *trilobata* has been successfully transplanted onto phosphate mine spoils in Idaho. 'Bighorn,' a cultivar from Wyoming, has been widely planted on pinyon-juniper sites, and the species has been successfully transplanted in aspen-maple, pinyon-juniper, and mountain-brush zones.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description

General: Sumac family (Anacardiaceae). Upright arching native shrubs 0.5-2.5 meters tall, forming rounded, moundlike, or upright thickets, crown diameter often greater than the plant height; roots deep and extensively branched, with woody, shallow, and spreading rhizomes, sometimes connecting shrubs more than 9 m apart; sprouts arising from rhizomes and root crown. Leaves: deciduous, alternate, compound with 3 leaflets, variable in size, shape, lobing, and margin, the leaflets unstalked, ovate to rhomboid, more or less wedge-shaped at the base, coarsely-toothed, usually shiny-glabrous above, the terminal leaflet 3-6.5 cm long; summer foliage green, becoming orange or reddish in the fall. Flowers: yellowish to whitish, in small, dense clusters on short lateral shoots, opening before the leaves, bisexual and unisexual, both types borne on the same plant (the species polygamodioecious); male (staminate) flowers in yellowish catkins, female (pistillate) flowers in bright yellow, short clusters at the ends of branches. Fruits: 5-7 mm in diameter, red at maturity and sparsely hairy, each containing a single nutlet. *Rhus trilobata* closely resembles *R. aromatica* and is often treated as part of the latter. The common name is derived from the odor of the leaves, especially when bruised.

Variation within the species: a number of ecotypes are known to occur in skunkbush. Growth form and height vary geographically – plants are more branched and compact in the Southwest and taller in the north part of the range. Current practice recognizes six formal varieties, distinguished by morphological characteristics such as growth form, height, leaf shape and size, fruit shape and pubescence, commonly intergrading where they occur together.

Var. *anisophylla* (Greene) Jepson - OR, CA, NV, UT, AZ, and NM, south into Mexico.
Var. *pilosissima* Engelm. - CA to TX, south into Mexico.
Var. *quinata* (Greene) Jepson – OR, CA, NV, AZ, and NM.
Var. *racemulosa* (Greene) Barkl. - AZ and NM, south into Mexico.
Var. *simplicifolia* (Greene) Barkl. – OK, CO, and NM, to CA and OR, south to AZ and Mexico.
Var. *trilobata* – covers the range of the whole species.

Distribution: Broadly distributed throughout the western North America, from Saskatchewan and Alberta south to Texas and California and into Mexico; not in Washington or British Columbia. See details below for distribution of varieties. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Adaptation
Skunkbush grows in prairies to shrublands and oak woodlands at elevations of about 1000-3000 meters and in a variety of sites including dry rocky slopes, streamsides, seasonal drainages, and canyon bottoms, sand dunes and sandhills, pastures, roadsides, and waste places -- in sun or partial shade and over a wide range of soils from nearly bare rock to sand and heavy clay. It is intolerant of flooding and high water tables. Skunkbush is a prominent species in many early seral communities, especially after fire, but it also is an indicator of climax in various shrub and grassland communities. Flowering: April-July; fruiting: June-October, then persisting through the winter if not eaten.

Establishment
Skunkbush produces seed nearly every year, but the number of flowers that produce fruit is relatively low. Branches 6-10 years of age produce the most viable fruit. Mostly birds and mammals disperse seeds. Roadside colonies frequently originate from germination of seed in caches of mice and squirrels. Skunkbush, like other species of *Rhus*, may be an effective seedbank former, with long-lived seeds stored in the humus layer. The seeds have dormancy broken by cold treatment. Seedlings are intolerant of crowding, even under optimal conditions. Growth of skunkbush is most rapid during the first 3-5 years, and plantings have remained healthy and vigorous for more than 20 years; healthy rhizomes have been aged at more than 30 years.

Management
Skunkbush sprouts vigorously from woody rhizomes or from adventitious buds at the root crown after top-kill by fire. Crown width and overall coverage often increase in response to fire. Skunkbush also may have the ability to delay sprouting for up to a year following fire.

Skunkbush can be propagated from root and softwood cuttings – most effectively done well before freezing weather. Best seed germination is from fall and winter planting. The presence of seeded grasses has reduced the survival of skunkbush at some sites, and although the plants are generally drought-tolerant, water-stressed seedlings may be stunted for several years and sometimes fail to recover. Skunkbush is generally reported to be tolerant of heavy grazing.

Cultivars, Improved and Selected Materials (and area of origin)
Please check the Vendor Database, expected to be on-line through the PLANTS Web site in 2001 by clicking on Plant Materials. These plant materials are readily available from commercial sources.

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USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Guide

BIG SAGEBRUSH

Artemisia tridentata Nuttall

Plant Symbol = ARTR2

Including:

ssp. *parishii* (Gray) Hall & Clements

Plant Symbol = ARTRP2

ssp. *spiciformis* (Ousterhout) Kartesz & Gandhi

Plant Symbol = ARTRS2

ssp. *tridentata*

Plant Symbol = ARTRT

ssp. *vaseyana* (Rydb.) Beetle

Plant Symbol = ARTRV

ssp. *wyomingensis* Beetle & Young

Plant Symbol = ARTRW8

ssp. *xericensis* Winward ex R. Rosentreter & R. Kelsey

Plant Symbol = ARTRX

Contributed by: USDA NRCS Idaho State Office

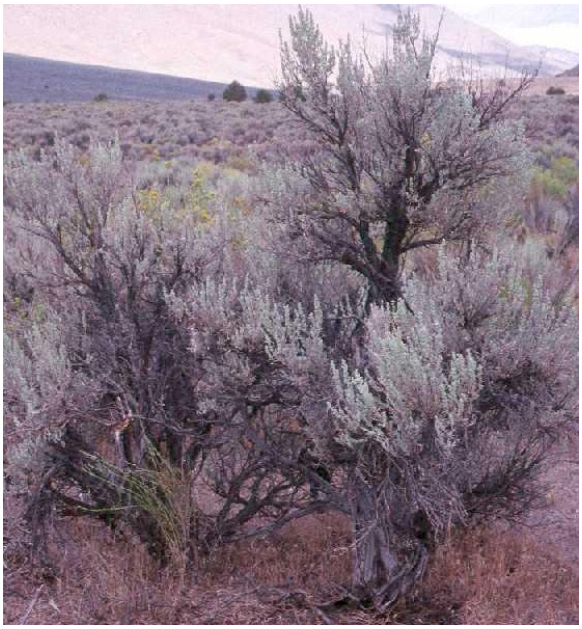

Figure 1. Basin big sagebrush *(Artemisia tridentata* ssp. *tridentata).* Photo courtesy of the PLANTS database.

Alternate Names

A. tridentata ssp. *parishii* = Parish's big sagebrush
A. tridentata ssp. *spiciformis* = subalpine or spicate big sagebrush
A. tridentata ssp. *tridentata* = basin big sagebrush
A. tridentata ssp. *vaseyana* = mountain big sagebrush
A. tridentata ssp. *wyomingensis* = Wyoming big sagebrush
A. tridentata ssp. *xericensis* = xeric or foothills big sagebrush

Uses

Forage/Wildlife: Big sagebrush is perhaps the most important shrub on western rangelands. Evergreen leaves and abundant seed production provide an excellent winter food source to numerous species of large mammals including mule deer, black-tailed deer, white-tailed deer, elk, pronghorn antelope, bighorn sheep and jack rabbits. Nearly 100 bird species depend on sagebrush ecosystems for their habitat needs. Additionally, there are several animal species having an obligate relationship with big sagebrush including sage grouse, sharp tailed grouse, pygmy rabbits, sage thrashers, sage sparrows and Brewer's sparrow. Sagebrush also provide habitat and food for hosts of invertebrates which in turn support birds, reptiles and small mammals. In addition to the numerous species of animals that depend on sagebrush for food and cover, there are several plant species having close relationships with sagebrush as well.

Sagebrush plants maintain high levels of most nutrients including crude protein (see table 1). This high forage value makes it especially useful for wildlife, and in some areas livestock, winter grazing. Separate studies indicated that sagebrush made up 78% of the annual diet for antelope in Wyoming and 59% of the winter diet of deer and elk near Gardiner, Montana. Sagebrush also makes up close to 100% of the winter diet of sage grouse and over 60% of their total annual diet. Use of sagebrush by livestock is limited and variable.

Animal preference of sagebrush varies with subspecies, populations and even individual plants due to chemical variation found in the foliage. Deer and elk tend to prefer mountain big sagebrush followed by Wyoming big sagebrush and finally basin big sagebrush. Although many range managers believe that deer and other large mammals prefer to browse shrubby members of the *Rosaceae* such as mountain mahogany (*Cercocarpus*), bitterbrush (*Purshia*) and cliffrose (*Cowania*) over big

sagebrush, studies show sagebrush significantly more readily browsed.

Sagebrush's value as thermal or security cover is also very high for wildlife. This includes nesting cover and escape cover for sage grouse, sharp tailed grouse, pheasants, chukar and other upland birds.

Table 1. Nutritive values as percent dry matter and percent in-vitro dry matter digestibility (IVDMD).

	Crude Protein	IVDMD
Spring	12.6	58.1
Summer	13.2	-
Winter	11.7	57.8

(Adapted from Welch, 2005)

Revegetation/reclamation: Because of its wide range of adaptation and ease of establishment, big sagebrush can be a very important species for use in revegetation efforts. Seedlings are able to compete with grasses and forbs as well as other shrubs allowing it to be used as a component of a wide range of seed mixes. Seedlings are very easy to establish when planted correctly (see "Establishment" section) and can be drill seeded or broadcast with near equal levels of success. Because sagebrush plants spread readily by seed, it can be seeded at relatively low rates and allowed to spread by natural recruitment.

Big sagebrush plants provide many additional benefits to the plant community. The dense canopy protects understory herbaceous plants from grazing. Healthy sagebrush communities provide a multi-tiered ecosystem with high levels of biodiversity. Big sagebrush plants also have a two-part root system with a deep tap root and a shallow, diffuse root system. Numerous studies have shown sagebrush plants create "hydraulic lift" where deep soil moisture is brought to near the soil surface by the tap root system during the day and then released into the upper soil at night. This water is then available to the diffuse root system of big sagebrush as well as to the roots of other understory plants. Sagebrush plants also increase water retention by trapping and holding windblown snow.

Big sagebrush subspecies are often useful indicators of soil characteristics. Generally, a subspecies indicates the soils at a site, thus proper identification of big sagebrush at a subspecific level can provide useful information on soils and ecological site characteristics. In some areas, however, such as those with glacial deposits, a separation based on soil characteristics is considerably more complex.

Status

Consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description

General: Although big sagebrush plants generally have a similar growth form, the species does have considerable morphological variation with several subspecies and ecotypes. Big sagebrush are evergreen shrubs ranging in size from less than 0.6 m (2 ft) tall to as large as 4 m (13 ft) tall. Branches are spreading, arising from numerous main stems in the lower growing subspecies or from one main trunk in the larger forms. Leaves are blue-gray to blue-green in color due to dense gray hairs. They are typically cuneate (wedge-shaped, triangular and gradually tapering to the base) or flabelliform (bell shaped) depending on subspecies, and have three lobes at the apex on the majority of the persistent foliage. Leaves vary in length from 0.5 to 5 cm (0.2 to 2.0 in), and can be 0.2 to 2.0 cm (0.08 to 0.8 in) wide. Leaves are spirally arranged with internodes short in young vegetative stems making the leaves very dense. Panicles overtop plants of mountain and spicate big sagebrush, or can grow throughout the crown in basin and Wyoming big sagebrush. Floral heads contain from three to 18 perfect (both male and female parts present) flowers per head. Achenes are typically glabrous but are hairy in the California endemic Parish's big sagebrush. Big sagebrush plants are very aromatic with the smell being described as bitter pungent to pleasant, the odor varying by subspecies. Ploidy levels often differ among subspecies and may differ among populations.

Taxonomy

Currently there are six subspecies of *Artemisia tridentata* recognized by the National Plant Data Center: basin (ssp. *tridentata*), Wyoming (ssp. *wyomingensis* Beetle & Young), mountain (ssp. *vaseyana* [Rydb.] Beetle), subalpine (ssp. *spiciformis* [Ousterhout] Kartesz & Gandhi), xeric (ssp. *xericensis* Winward ex R. Rosentreter & R. Kelsey) and Parish's (ssp. *parishii* [Gray] Hall & Clements). Each is highly variable with multiple ecotypes, but can generally be separated using a number of morphological, geographical and topographical characters.

All chromosome number information was obtained from McArthur and Sanderson (1999) as updated in McArthur (2005). Appendix 1 contains a general summary of characteristics useful to separate subspecies. See McArthur and Stevens (2004) for a

detailed review of the characters for the subspecies occurring in the Intermountain West.

Figure 2. Leafy stem of basin big sagebrush. Photo courtesy of the PLANTS database.

Basin big sagebrush usually occurs at the lowest elevational range of the species, being most abundant in the valley bottoms to mountain foothills. Plants typically have a single main trunk and may grow to a height of 4 m (13 ft) under proper conditions, making basin the largest subspecies. Basin big sagebrush plants are generally uneven-topped with loosely branching flowering stems distributed throughout the crown (see figure 1). Floral heads typically contain 3 to 6 small flowers per head. Leaves of the vegetative stems are narrowly cuneate averaging 2 cm (0.8 in) or more and can be as long as 5 cm (2 in) being many times longer than wide (see figure 2). Ultraviolet visible coumarins in leaf extracts are minimal; leaf UV color is none to light blue in water and a rusty red-brown color in alcohol. 2n = 18 or sometimes 36.

Figure 3. Wyoming big sagebrush.
Derek Tilley, USDA NRCS Idaho PMC

Wyoming big sagebrush overlaps in range and elevation with basin big sagebrush. Plants are considerably smaller than those of basin big sagebrush, usually less than 0.9 m (3 ft) tall, and have main stems branching from the ground (see figure 3). Flowering stems are not as widely branching as those of basin, but otherwise closely resemble that subspecies. Leaves are typically shorter, from 1 to 1.5 cm (0.4 to 0.6 in) long, and flabelliform. UV extract color in water is none to light blue and rusty in alcohol. 2n = 36.

The vegetative stems of mountain big sagebrush create a characteristic even topped crown with the panicles rising distinctly and relatively uniformly above the foliage (see figure 3). Plants are normally smaller than those of basin big sagebrush, averaging about 0.9 m (3 ft) tall. Inflorescences are narrow and spicate bearing flower heads containing 4 to 8 flowers per head. Leaves are characteristically wider than those of basin or Wyoming big sagebrush. In extracts, ultraviolet visible coumarins are abundant. Leaf extracts fluoresce blue in water and blue-cream in alcohol. 2n = 18 or sometimes 36.

Figure 4. Even topped mountain big sagebrush.
Derek Tilley, USDA NRCS Idaho PMC

Originally considered a xeric form of mountain big sagebrush, xeric big sagebrush shares similarities with both basin and mountain big sagebrush and may be the result of hybridization between the two subspecies. Xeric big sagebrush plants are large and

have an uneven topped crown like those of basin big sagebrush, but in leaf UV color and cytological characters it resembles mountain big sagebrush. Ultraviolet visible coumarins are blue in water, blue-cream in alcohol. 2n = 36.

A new variation of big sagebrush being recognized by some is Bonneville big sagebrush. This as yet undescribed taxon may represent hybridization between Wyoming and mountain big sagebrush. It is reported to have the general growth form of Wyoming plants but bears the leaves and fluorescing characteristics of the mountain subspecies. It has been reported from the bench areas of Lake Bonneville and other ancient lakes of the Intermountain West in Utah and Nevada. Reports of Bonneville big sagebrush have also come from western Wyoming and western Colorado. Of particular importance is this sagebrush's reported high palatability to wild ungulates and sage grouse.

Subalpine, or spicate big sagebrush, is believed to be a stabilized hybrid between mountain big sagebrush and silver sagebrush (*Artemisia cana* Pursh ssp. *viscidula* [Osterhout] Beetle). Plants are similar to those of mountain big sagebrush except that leaves and floral heads are larger, the floral heads having 10 to 18 flowers per head. Ultraviolet visible coumarins in leaf extracts fluoresce blue in water and blue-cream in alcohol. 2n = 18 or 36.

Parish's big sagebrush is an uncommon taxon restricted to dry, sandy soils in the hills of southern California. It is nearest in appearance and relationship to basin big sagebrush, but differs from basin in having drooping flowering branches and the achenes are hairy. 2n = 36.

One additional taxon that should be mentioned is Lahontan sagebrush (*Artemisia arbuscula* ssp. *longicaulis* Winward and McArthur). It is thought to be a stable hybrid between low sagebrush (*A. arbuscula*) and Wyoming big sagebrush. It bears the flowers of low sagebrush but has the vegetative characteristics of its big sagebrush parent. This subspecies forms dominant communities in northwestern Nevada and adjacent portions of California and Oregon in shallow or clayey soils above and around the shoreline of the Pleistocene Lake Lahontan.

The following key should provide some assistance in separating the subspecies of big sagebrush.

1. plants larger, usually >0.9 m (3 ft) tall, with a single main trunk; crown uneven with floral stems throughout
   2. achenes hairy; floral stems drooping; plants endemic to sandy soils in southern California…….....ssp. *parishii*
   2. achenes glabrous; floral stems erect; plants widely distributed throughout western U.S, including southern California
      3. plants occurring in valley bottoms and low foothills, occupying deep fertile soils; leaves narrowly cuneate, 2-5 cm (0.8-2.0 in) long, UV leaf color in water=none, in alcohol=red to brown …….....…...ssp. *tridentata*
      3. UV in water=blue, in alcohol=blue-cream; plants restricted to well-drained basaltic soils in western Idaho….....ssp. *xericensis*
1. plants smaller, averaging 0.9 m (3 ft) or less, with trunks branching at or near ground level; crowns various
   4. crowns uneven-topped, plants of low valleys and foothills;
      5. UV color in water=none, in alcohol=rust ……..ssp. *wyomingensis*
      5. UV color in water=blue, in alcohol=blue-cream……..(Bonneville)
   4. crowns even-topped, floral stems rising uniformly above the vegetative stems; plants of higher elevations
      6. flowers 4 to 8; leaf tips lobed …….ssp. *vaseyana*
      6. flowers 10 to 18; leaf tips often pointed ……..……...……..ssp. *spiciformis*

Additional taxonomic information can be found in the Flora of North America, Volume 19 (FNA Editorial Committee 2006) and the Intermountain Flora, Volume 5 (Cronquist et al. 1994).

Distribution

Fossil records and records from early pioneers indicate that sagebrush was widespread and existed in nearly the same general distribution for the past several thousand years as it does in the present day. Densities of sagebrush communities, however, have been reduced historically due to range management practices. Big sagebrush presently covers a vast ecological range from British Columbia to Baja California eastward to the Dakotas. Mahalovich and McArthur (2004) provide distribution as well as seed and plant transfer guidelines for *Artemisia* subgenus *Tridentatae*. For current distribution for each subspecies, please consult the Plant Profile page for this species on the PLANTS Web site.

Habitat

The big sagebrush complex is adapted to a wide range of precipitation zones and soil conditions.

Plants are well adapted to the arid plains, valleys, foothills and mountains of the West where annual precipitation ranges from as little as 200 to as much as 750 or more mm (8 to 30 in). It is often found growing in loamy to sandy loam soils, but plants are found on all 12 soil textural classes in five soil orders: Alfisols, Aridisols, Entisols, Inceptisols and Mollisols. Tolerance to alkalinity or acidity varies by subspecies. In general big sagebrush will grow in soils with a pH of 5.9 to 10.0 and with organic matter content of 0.62 to 4.14 percent.

Basin big sagebrush is commonly found at low to mid elevations from 600 to 2,100 m (1,900 to 6,900 ft) in valleys and mountain foothills, occupying sites with deep fertile loamy to sandy soil, 0.9 m (3 ft) or deeper. It is often the dominant shrub species of the plant community, but is also found in association with juniper, piñon pine and rabbitbrush communities. Basin big sagebrush has a deep penetrating root system that allows it to occupy deeper soils in areas receiving little precipitation. Plants are often found growing in valleys, plains, alluvial fans and in seasonal or perennial stream channels. Basin big sagebrush prefers soils which are non-alkaline, non-saline and non-calcareous. The deep root system does not allow plants to grow in soils with a soil depth limiting hardpan or caliche layer. Depending on soil infiltration and water storage capacity, plants will grow in areas receiving less than 200 to more than 400 mm (8 to 16 in) annual precipitation. This subspecies also does not tolerate soils saturated for more than a few weeks in a season.

Wyoming big sagebrush grows at low to intermediate elevations between basin and mountain big sagebrush, but also commonly overlaps in range with the other two subspecies. When found in proximity with basin big sagebrush, Wyoming sagebrush will occupy the shallower, better-drained soils. Like basin big sagebrush, Wyoming is typically found in large stands covering many acres. Plants are also found in juniper, rabbitbrush, bitterbrush and mountain mahogany communities. At lower precipitation areas it is sometimes intermixed with shadscale and other *Atriplex* species. Wyoming big sagebrush commonly occurs from 800 to 2,200 m (2600 to 7,200 ft) in elevation. Wyoming big sagebrush is the most drought tolerant of the big sagebrush subspecies and is commonly found growing on low valley slopes and foothills receiving between 200 and 300 mm (8 to 12 in) annual precipitation. It occupies loamy soils with high clay content and a depth of 25 to 75 cm (10 to 30 in). Soils may be quite rocky or gravelly, but in these cases plants will be smaller. Wyoming big sagebrush will be found growing in soils underlain by a caliche or silica layer if the available soil is deep enough. Plants are typically found in soils with a low water holding capacity where excess water may run off into channels more suitable to basin big sagebrush.

Mountain big sagebrush grows in mountain and mountain foothill plant communities such as rabbitbrush, piñon pine, juniper, mountain shrub, aspen, Douglas fir, ponderosa pine and spruce-fir habitats from 800 to 3,100 m (2,600 to 10,000 ft). Plants prefer moderately deep to deep, well-drained soils providing summer moisture. Mountain big sagebrush occurs at higher elevations and in higher annual precipitation zones than either Wyoming big sagebrush or basin big sagebrush. Soils are typically 45 to 90 centimeters (18 to 36 in) deep or more, and are most often loamy to gravelly but can contain greater amounts of clay. Plants commonly grow in areas receiving over 350 mm (14 in) annual precipitation, but may be found in lower elevations and precipitation zones under certain conditions such as snow drift accumulation areas and shaded north facing slopes.

Xeric big sagebrush is limited to basaltic and granitic soils of western and west central Idaho and is often associated with bluebunch wheatgrass. Plants grow in the foothills from 800 to 1,500 meters (2,600 to 4,900 ft). Precipitation ranges from 300 to 400 mm (12 to 16 in) annually.

Spicate big sagebrush grows at high elevation ridge lines and snow accumulation areas from 2,000 to 3,300 m (6,500 to 10,800 ft) in annual precipitation zones of over 750 mm (30 in). It is normally found near Douglas fir, spruce-fir, and aspen communities.

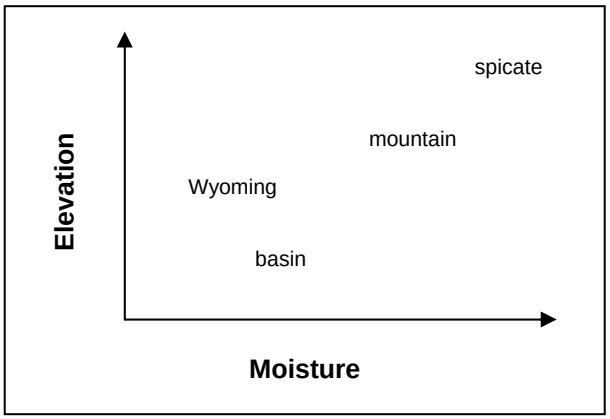

Figure 5. Adaptation of Intermountain big sagebrush subspecies based on elevational and moisture gradients (Mahalovich and McArthur, 2004).

Parish's big sagebrush is adapted to the dry sandy soils of California's Inner South Coast Ranges, South Coast, Western Transverse Ranges, White and Inyo Mountains and the desert mountains of the Mojave Desert.

Establishment

Seed of big sagebrush are best adapted to germinate in habitats with ecological conditions approximating those of the seed collection site. Seed source and subspecies should always be seriously considered prior to seeding. It may be necessary to use seed from more than one subspecies in a given revegetation project to ensure adequate establishment in all habitats.

Seed should be sown in the late fall or early winter and allowed to naturally stratify. It should be noted that big sagebrush seed has special seed storage requirements (See "Seed and Plant Production" section). If stored in conditions with relative humidity above 30 percent, seeds lose vigor and germinability after two or three years. To ensure a greater chance of establishment success, check the viability of seed lots before planting.

Seed should be planted into a firm, weed-free seedbed at a depth of no more than 1/8 inch. Seed covered too deeply with soil will generally fail to establish. Best results come from surface broadcast seed that has been pressed into the soil to provide for good seed-soil contact. Seed can also be broadcast directly onto snow with good results. Pressing broadcast seed into the soil surface with a land imprinter has provided very good establishment success. Land imprinters create good contact between the seed and soil as well as provide microhabitats that optimize temperature and water requirements. Broadcast seeding has also yielded good results when followed by a cultipacker or drag chain.

Drill seeding can be successful, but strict attention must be paid to seeding depth. Optimal drilling depth is 0 to 1/8 inch.

Sagebrush seed lots range in purity from approximately 8 to 30 percent or greater pure seed. Seed lots with high purity levels (20 percent or greater) can be difficult to seed due to limitations of the seeding equipment. Because sagebrush seed is very small and is metered through seeding equipment with difficulty, seed can be diluted with rice hulls or another inert carrier to improve flow.

Post-fire aerial seeding of big sagebrush has been done with limited success. Studies suggest that best results come from aerial seeding followed by land imprinting, cultipacking or chaining, or after allowing native perennial grasses to establish for a season following fire. It is believed that native grasses would suppress exotic annual grass species while allowing the establishment of sagebrush. Further study of this option is indicated.

Big sagebrush is not recommended for pure seedings. Seed should be a small component of a seed mix. Drill seeding 0.025 lbs PLS per acre (approximately 1 viable seed/ft^2) provides approximately 400 plants per acre for optimal wildlife habitat. For broadcast seeding increase to 0.05 to 0.075 lbs PLS (approximately 2-3 viable seeds/ft^2). With adequate soil moisture seedlings develop quickly and compete well with other shrubs and most herbaceous plants. However, to enhance establishment, sagebrush should not be sown in the same drill row with more aggressive forbs and grasses.

Sagebrush seedlings require sufficient soil moisture to germinate and survive. Young plants do not do well in open, unprotected locations. Best establishment results occur in sites where soil moisture is at or near field capacity, or in areas where snow accumulates. Existing shrubs, downed trees and litter can create microhabitats which also provide very good germination conditions.

Containerized stock or bareroot seedlings can also be used with high establishment success (50% or greater). This method, however, is quite costly, and is rarely used except in small critical area plantings. Plants can be taken from nursery stock or field harvested wildings. Wildings should be collected and transplanted during dormancy in fall or very early spring when soil moisture conditions are best. For best cost efficiency, "mother plants" should be placed in key locations throughout the revegetation site to allow for natural seed dispersal and recruitment over time.

Management

Historically, sagebrush communities have been poorly managed, mostly in attempts to reduce or eliminate sagebrush stands to increase forage production for livestock. Recently, however, the value of sagebrush to the western rangelands is being recognized, and practices are evolving to better manage healthy and productive sagebrush communities.

Contrary to long standing beliefs, studies show that complete sagebrush removal negatively affects biodiversity and has little long term affect on perennial grass production. Indeed, several studies indicate that forage production may actually decline when sagebrush is completely removed or controlled.

Overgrazing of the understory decreases plant biodiversity, especially the forb component of the plant community and increases the density of weeds. Annual weeds, such as cheatgrass (*Bromus tectorum* L.) and medusahead (*Taeniatherum caput-medusae* [L.] Nevski) often out-compete young sagebrush seedlings and create undesirable monocultures. Annual weed infestations also increase the frequency of wildfires which result in eliminating sagebrush stands therefore not allowing stand re-establishment.

Despite the many valuable benefits of sagebrush to rangelands, there may be cases when it is desirable to thin and rejuvenate sagebrush stands. In these instances it is not necessary to remove the entire stand, and control treatments in mosaic patterns are recommended. Several methods exist for partial removal of the shrubby over story.

Herbicide use is an effective means of thinning sagebrush stands. Contact your local agricultural extension specialist or county weed specialist to determine what works best in your area and how to use it safely.

Probably the simplest and most cost effective means of stand reduction is through prescribed burning. If there is sufficient fuel, a burn can completely eliminate a sagebrush community. For this reason niche burning is recommended when possible. In situations where cheatgrass is a dominant part of the understory, burning should take place when ripe cheatgrass seeds are still on the plants and will be consumed in the fire.

Methods of mechanical removal for sagebrush include anchor chaining, pipe harrowing, land imprinting offset disking and brush beating with brush hogs or mowers. Of these, chaining and land imprinting are the least expensive and do an excellent job of reducing sagebrush stands while still leaving enough plants for diversity and browsing. Brush beating does a good job, but it is expensive. Disking and harrowing also do a good job of shrub removal, but are more expensive and more destructive to under-story plant populations.

Pests and Potential Problems

Perhaps the greatest danger to sagebrush stands comes from fire. Big sagebrush plants have no fire resistance and many acres are destroyed annually because of increased fire frequency resulting from infestations of exotic annual weeds such as cheatgrass and medusahead.

Another minor cause of sagebrush mortality is winter injury. This occurs when temperatures drop quickly below freezing before plants have entered dormancy, or when a warm spell promotes winter growth followed by a return to typical winter temperatures. Extended periods of winter and summer drought (normally more than 2 years) can also cause dehydration and death.

Big sagebrush is occasionally susceptible to limited outbreaks of the sagebrush defoliator moth, or webworm, (*Aroga websteri*). Although the moths can cause extensive damage, they too are subject to insect predators, and it is rare that entire stands will be lost.

Additionally, there are a number of other microbial and fungal pathogens known to attack big sagebrush. Although these may inflict serious damage locally, they have not been viewed as a great threat to sagebrush populations.

Seed and Plant Production

The vast majority of big sagebrush seed used in revegetation is wildland collected material. Seed collection occurs in late fall to early winter (early October through the end of December) depending on the subspecies. Collections are commonly made by hand stripping, beating or clipping seed heads into containers or by using a reel type harvester. Seed can be cleaned with a hammermill, debearder, air-screen or gravity table with varying results. Most sagebrush seed lots used for rangeland seeding are only cleaned to a purity of 15 to 20 percent due to the small nature of the seeds (achenes). This practice requires less time for cleaning and also allows for easier seed flow and metering in seeding equipment. Pure seed yields approximately 1.7 to 2.5 million seeds per pound. The NRCS Plant Materials Center in Bridger, MT reported four hours collecting time and 5.5 hours cleaning yielded 200g (0.45 lb) cleaned material, or 21g (0.04 lb) per hour.

Sagebrush seed that has been dried to a minimum of 9 percent moisture content will remain viable for many years when stored under cool, dry conditions. Welch et al (1996) reported seed viabilities above 90% for seed stored at 10 ºC (50 ºF) and relative humidity (RH) of 20 percent after nine years of

storage. Seed stored at higher RH levels are susceptible to germination or damage by insects or microorganisms.

Because sagebrush seed can readily be collected from wild stands, sagebrush is rarely grown in commercial production fields. However, in very droughty periods, very little sagebrush seed can be collected from wild stands. Increasing seed demands and decreasing sagebrush stands lost to weeds and fire are growing concerns. Recent studies suggest protecting wildland seed-producing stands for optimum harvesting. The greatest factor in seed production for sagebrush is protection against grazing animals. Surrounding plants with a wire fence has shown an increase in seed stalk number of as much as 3 to 5 times the amount of unprotected plants. Studies also show significantly higher seed yields from plants grown on reclaimed mine lands when compared with those on adjacent non-mined areas. The reason for this correlation is unclear, but it may be a result of increased available soil moisture due to lower competing plant frequencies on the mined lands.

Seed production varies greatly between years and between stands due to differences in climate, stand density and maturity, soil and genetics. It has been estimated that an average stand of big sagebrush could potentially produce 100 to 300 lbs PLS per acre annually. Seed production declines as plants and stands mature creating larger amounts of woody biomass. Greater seed yields can be achieved by thinning decadent stands to encourage new flower stalk production

For nursery plantings, pre-stratified seed can be planted in greenhouse conditions, or seed can be allowed to naturally stratify after being planted in containers outdoors. Keep soil medium slightly moist during germination. Greenhouse sprayers or misters are commonly used during daylight hours at a rate of 10 seconds every 15 minutes. Uniform germination occurs after two weeks of temperatures over 20º C (70º F). Seedlings are ready for field transplanting approximately 5 months after germination.

Cultivars, Improved, and Selected Materials (and area of origin)

‘**Hobble Creek**’ mountain big sagebrush was released by the Utah Agricultural Experiment Station, Utah State University and the USDA Forest Service Rocky Mountain Research Station in 1987. Seed was originally collected in 1968 by A. Perry Plummer at the Hobble Creek drainage east of Springville, UT. ‘Hobble Creek’ was chosen for its high vegetative production and for its high palatability to mule deer and wintering domestic sheep. It is adapted to sites with deep, well-drained soils receiving more than 350 mm (14 in) of annual precipitation and having a growing season of 90 days or longer. Soils should be no finer than a clay loam, containing 40% or less clay and have a pH between 6.6 and 8.6. Breeder seed is maintained at a breeder block at the USDA Forest Service Rocky Mountain Research Station, Shrub Sciences Laboratory, Provo, UT.

‘**Gordon Creek**’ Wyoming big sagebrush was originally collected near Helper, Carbon County, UT. It was released in 1992 by the USDA Forest Service Rocky Mountain Research Station to fill the need for a low precipitation ecotype of big sagebrush to improve winter diets of mule deer and sage grouse and for rangeland restoration. Gordon Creek was chosen for its high growth rate, nutrient levels and mule deer preference. It is widely adapted to dry regions of the west receiving 250 or more mm (10 in) mean annual precipitation. It prefers deep to shallow, well-drained soils with up to 55% clay content with a pH of 6.6 to 8.8.

Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under ”United States Government.” The Natural Resources Conservation Service will be listed under the subheading “Department of Agriculture.”

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For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

Appendix 1. Summary of characteristics of big sagebrush subspecies.

	Basin	Wyoming	Mountain	Xeric	Subalpine	Parish's
Height	3 to 6' (13)	2 to 3'	2 to 3'	3 to 6'	2 to 5'	See basin
Stem	Single main trunk	Branching at or slightly above ground	Branching at or slightly above ground	Branching at or slightly above ground	Branching at or slightly above ground	See basin
Evergreen Leaves on vegetative stems	Narrowly cuneate, up to 5 cm long, many times longer than wide 	Flabelliform, 1-1.5 cm long, ca. 3X longer than wide 	Cuneate, 1-2.5 cm long; usually wider than basin or Wyoming 		Cuneate, 1-2.5 cm long; lobes often pointed	See basin
Crown shape	Uneven-topped, floral stems growing throughout crown	Uneven-topped, floral stems growing throughout crown	Even-topped, floral stems rising above crown	Uneven-topped, floral stems growing throughout crown	Even-topped, floral stems rising above crown	Uneven-topped, floral stems growing throughout and **drooping**
Flrs/head	3 to 6	3 to 8	4 to 8		10 to 18	3-6; **achenes hairy**
UV color: water/alcohol	None to light blue/ rust	None to light blue/rust	Intense blue/ blue-cream	Blue/ blue-cream	Blue/blue-cream	
Elevational range	600-2100m	800-2200m	800-3000m	800-1500m	2000-3000+m	300-?m
Soil	Sandy to loamy; deep & fertile (36"+)	Loamy to silt loam; often very gravelly; dry & shallow (10 to 30"), caliche possible	Loamy to clay loam; often gravelly (18 to 36")	Basalt or granite derived (12 to 22")		Sandy, well drained
Soil chemistry	Non-alkaline, non-saline and non-calcareous	Can be mildly alkaline	Non-alkaline, non-saline and non-calcareous			
Precipitation range	8 to 16"+	8 to 12"	14"+	12 to 16"	30"+	
Topography	Valleys, low foothills, seasonal stream channels	Mid-elevation valleys, foothills	Foothills and mountains, plateaus and ridges	Basalt flows and granite outcrops	High mountain ridges and plateaus	Deep soils in Southern California

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Fact Sheet

RUBBER RABBITBRUSH

Ericameria nauseosa (Pallas ex Pursh) G.L. Nesom & Baird

Plant Symbol = ERNA10

Contributed by: USDA NRCS Plant Materials Center, Pullman Washington

Sally and Andy Wasowski, Lady Bird Johnson Wildflower Center, www.wildflower.org

Alternate Names

Grey rabbitbrush, golden rabbitbrush, chamiso blanco, *Chrysothamnus nauseosus* (Pallas ex Pursh) Britton, *Chrysocoma nauseosa* Pallas ex Pursh, *Bigelovia nauseosa* Gray

Uses

Forage: Rubber rabbitbrush has marginal value for livestock but is an important browse species for wildlife during the winter months.

Wildlife habitat: Small mammals and birds such as jackrabbits and sage grouse utilize rubber rabbitbrush for cover.

Pollinator habitat: Rubber rabbitbrush attracts a wide array of native insects, including butterflies and small bees. It is one the few native plant species in the Intermountain West that provides habitat for pollinators during the late summer and fall months.

Range revegetation, erosion control and mine reclamation: Rubber rabbitbrush produces deep roots, heavy litter and abundant seed. It grows rapidly and is able to establish on severe sites.

Ethnobotanical: Native Americans used rubber rabbitbrush for baskets, yellow dye, chewing gum, tea, cough syrup, and to treat chest pains. During World War II the plant was studied as a substitute for commercial rubber, and currently it is a small commercial rubber source.

Ornamental: Rubber rabbitbrush is a desirable plant for low maintenance and sustainable landscaping.

Status

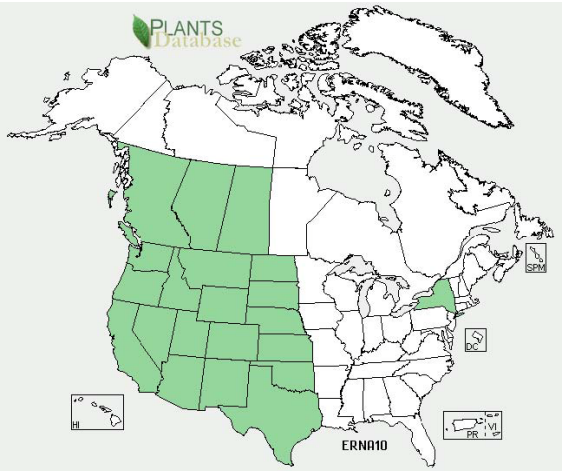
Consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g., threatened or endangered species, state noxious status, and wetland indicator values).

Description and Adaptation

General: Composite family (Asteraceae). Rubber rabbitbrush is a native, perennial, warm-season shrub that grows to 1 to 8 feet tall. It has a rounded crown with stems originating from its base. Stems and leaves are covered with dense white hairs. Leaves are 0.75 to 2.75 inches long, 0.02 to 0.12 inches wide, alternate, linear to spatula shaped with entire margins. Flowers are yellow, tubular, 0.25 to 0.4 inch long, arranged in terminal, rounded clusters. Flowers begin bloom late July – October. Inflorescences and seed bracts often persist through winter. Seeds are achenes with pappus and are wind disseminated. Reproduction is primarily by seeds and epicormic buds.

The species is taxonomically complex, and is divided into two subspecies and 22 varieties (ecotypes). The 22 ecotypes exhibit a great deal of variability in morphological characteristics and chemical composition.

Distribution: *Ericameria naseosa* is present in New York and all Great Plains and western states in the United States, and in the Canadian provinces of Alberta, Saskatchewan, and British Columbia. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.



Rubber rabbitbrush distribution from USDA-NRCS PLANTS Database.

Habitat: Rubber rabbitbrush inhabits dry, open areas on plains, valley bottoms, foothills and mountains. It is associated with many habitat types (Tirmenstein 1999).

Establishment
Rubber rabbitbrush can be established by transplanting seedlings, or drilling or broadcasting seed. Planting can be done in spring or fall, on prepared or unprepared seedbeds (Tirmenstein 1999). Rubber rabbitbrush should be seeded in a mixture with forbs and grasses at a rate of 0.025 lb Pure Live Seed (PLS) per acre. This rate should be doubled if the seed is broadcast.

Management
To control invasive weeds while minimizing damage to rubber rabbitbrush, an application of chlosulfuron can be effective (Enloe et al. 2009).

Environmental Concerns
Although rubber rabbitbrush may appear to dominate a plant community soon after disturbance, it is not overly competitive (McArthur 1979) and is eventually replaced with other vegetation as the community matures.

Cultivars, Improved, and Selected Materials (and area of origin)
None

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Plant Guide

WHITE SAGE

Artemisia ludoviciana Nutt.

Plant symbol = ARLU

Contributed By: USDA, NRCS, National Plant Data Center & University of California-Davis Arboretum

Alfred Brousseau

Alternative Names

Silver wormwood, white sagebrush, wild sage, prairie sage, wormwood, white mugwort, western mugwort, Louisiana sage, darkleaf mugwort, Mexican sagewort, Chihuahua sagewort, Garfield tea, lobed cudweed, man sage

Use

Ethnobotanic: Burning white sage and "smudge sticks" (the process of harvesting sage stems and tying the stem together into a "smudge stick"), was and is used for cleansing and purification (Gilmore 1977, Kindscher 1992). White sage or "man sage" was perhaps the most important ceremonial plant of the Cheyenne (Hart 1976). The sage was spread along the borders and on the altar in almost every ceremonial lodge (including the stone peoples lodge or sweat lodge) with the flowering end toward the fire. The leaves were burned as an incense to cleanse and drive away bad spirits, evil influences, bad dreams, bad thoughts, and sickness. A small pinch of baneberry (*Actea rubra)* was often mixed with it for this purpose. The smoke was used to purify people, spaces, implements, utensils, horses, and rifles in various ceremonies. The Lakota also make bracelets for the Sun Dance from white sage (Rogers 1980). The Cheyenne use the white sage in their Sun Dance and Standing Against Thunder ceremonies (Hart 1976). Other tribes who used white sage include the Arapaho, Comanche, Gros Ventre, Creek, Navaho, Tewa, and Ute (Nickerson 1966, Carlson and Jones 1939, Hart 1976, Thwaites 1905, Denig 1855, Elmore 1944, Robbins et al. 1916, Chamberlin 1909).

The Dakota and other tribes used white sage tea for stomach troubles and many other ailments (Gilmore 1977). The Cheyenne used the crushed leaves as snuff for sinus attacks, nosebleeds, and headaches (Hart 1976). The Crow made a salve for use on sores by mixing white sage with neck-muscle fat (probably from buffalo) (Hart 1976). They used a strong tea as an astringent for eczema and as a deodorant and an antiperspirant for underarms and feet. The Kiowa made a bitter drink from white sage, which they used to reduce phlegm and to relieve a variety of lung and stomach complaints (Vestal and Shultes 1939). Usually, they chewed the stem and leaves and swallowed the juice.

The Kiowa-Apaches used a thin, sharp-pointed section of the stem as a moxa to relieve headaches or other pain (Jordan 1965). The Chinese also use an *Artemisia* species as a moxa to relieve pain such as arthritis. The Kiowa also used an infusion of white sage plants for the lungs, to cut phlegm, and for stomach trouble. The Mesquakie used the leaves as a poultice to "cure sores of long standing" (Smith 1928). They also made a tea of the leaves to treat tonsillitis and sore throat and a smudge of the leaves to drive away mosquitoes. The Omaha used the leaves in a tea for bathing and used the powdered leaves to stop nosebleeds (Gilmore 1913).

Both the Pawnee and the Bannock women drank *Artemisia ludoviciana* tea during their moon time, or menstrual periods (Dunbar 1880). During the time that women lived away from their lodges in a menstrual hut, they drank the bitter tea made from either the leaves of white sage or the root of *A. frigida* (Gilmore 1930).

The Blackfeet use the white sage in sweat-lodge rituals and as an ingredient in a stream vapor inhaled for respiratory problems. The "Giver of Breath" heals the ability to breathe with this powerful plant medicine.

According to Moerman (1986) *Artemisia ludoviciana* was used for the following:

- The Fox used a poultice of leaves to heal old sores, a burning smudge to drive away mosquitoes and to "smoke ponies when they have the distemper", and an infusion of leaves to heal tonsillitis and sore throats.
- The Omaha used the leaves as a bath for fevers and to prevent nosebleeds.
- The Paiute used a decoction of the plant as a soaking bath to relieve aching feet, to heal stomachaches, as a poultice for rheumatism or other aches, as a poultice or compress for headaches, to stop diarrhea, in a sweatbath for rheumatism, and to relieve the itching and discomfort of rashes and skin eruptions.
- The Shoshone took white sage for colds, coughs, headaches, stomachaches, as a compress for fevers, to stop diarrhea, as a physic, as a regulator of menstrual disorders, and for influenza.
- The Washoe used white sage as a cooling, aromatic wash for headaches, colds, and coughs.

The lactone glycosides, santonin and artemisin, are probably found in all *Artemisia* species and account for their anthelmintic properties (Moore 1979). Thujone, a terpene-like ketone and essential oil, is also found in the plant and may be responsible for some of its medicinal effects (Kinscher 1992). However, it is poisonous in large doses. The Food and Drug Administration classifies *Artemisia* as an unsafe herb containing "a volatile oil which is an active narcotic poison" (Duke 1985).

Wildlife & Livestock: Sagebrush furnishes essential cover for many of the smaller desert animals (Martin et al. 1951). Its foliage and flower clusters constitute most of the diet of the sage grouse, and these parts together with the twigs bearing them are the primary source of food for antelope and mule deer. Range cattle also make good use of sagebrush as forage. Other mammals which browse the foliage and stems include jack rabbits, black-tailed rabbits, white-tailed rabbits, cottontails, chipmunks, gophers, ground squirrels, various species of mice, prairie dogs, kangaroo rats, and white-throated wood rats. Elk and mountain sheep also browse on the foliage and twigs.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description

General: Sunflower Family (Asteraceae). White sage is a white-woolly, perennial herb 3-7 dm (1-2 1/4 ft) tall, with a strong odor of sagebrush. The stems are erect and often clustered from creeping rhizomes. The leaves are alternate, entire to irregularly toothed or lobed, 3-11 cm (1.25-4.5 in) long, up to 1.5 cm (9/16 in) wide. Flower heads are small tight greenish clusters among the leaves near the ends of the stems. White sage flowers from August through September. The fruits are dry, smooth, broadly cylindrical achenes. There are four subspecies of *Artemisia ludoviciana* (Hickman 1993).

Distribution

White sage occurs from east of the Cascade Mountains in Washington and Oregon, in California, north to eastern Canada, south to Texas and northern Mexico, and in Montana, Utah, Colorado, and in the Great Plains states. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Establishment

Adaptation: White sage grows in riparian areas along both perennial and intermittent streams, in the sagebrush steppe, in both shortgrass and tallgrass prairies, and in semi-disturbed sites. It grows on dry, sandy to rocky soils below 3500 m.

Most of the wild sages are abundant in their natural habitats. White sage and other *Artemisia* species can be propagated by seeds, by division of the rootstock, or by cuttings taken in the early summer (Kindscher 1992).

Propagation from Cuttings: *Artemisia ludoviciana* spreads vigorously from rhizomes. Plants can easily be divided and replanted.

- In greenhouse conditions, it is best to dig up and separate plants in late fall or winter. This is the "quiescent" period that follows seed maturation, and leaves are senescent (dried up and brown colored).
- Split the plant clump into pieces by hand, then cut the plant into sections, each with one or more buds.
- For dividing the whole plant, gently loosen the soil around the plant, taking care to not damage

the roots, and then lift the plant gently with a pitchfork; shake off as much soil from the roots as possible.

- Divide the plant into smaller pieces by hand, retaining only healthy, vigorous sections, each with new buds.
- Replant the divisions as soon as possible. It is important the plants don't dry out, so if replanting is delayed a couple of hours, dip the plants briefly in water and keep them in a sealed plastic bag in a cool, shady place until you are ready to plant them.
- Cut back the old top-growth and replant the divided plant sections to the same depth as before.
- When replanting, ensure that the roots are well spread out in the planting hole and the plant firmed in. Water newly planted divisions thoroughly; take care not to expose the roots by washing away soil when watering.
- Plants should be planted in the full sun in a light, loose soil. Plants should be planted on 12-18" centers.
- As plants are becoming established, the rooting zone needs to be kept moist.

Propagation by Seed: When the soil has warmed to at least 45ºF (7ºC) in the spring, sow hardy *Artemisia* species where they are to flowers.

- Seeds can also be sown in pots or seed trays and either out-planted in their final positions in late fall or over-wintered in a cold frame to be out-planted in spring. This technique is particularly useful in gardens with clay soil that is slow to warm up in spring.
- The two main methods of sowing outdoors are broadcast and drills. For both, prepare the seedbed first by digging over the soil to one spade depth, then rake over and firm.
- Broadcast Sowing: Sprinkle seeds thinly and evenly on the surface of the prepared seedbed and rake them in lightly. Label the seedbeds, then water the area gently but thoroughly with a fine spray.
- Sowing in drills: Use either a trowel tip or the corner of a hoe, mark out shallow drill holes 3-6" (8-15 cm) apart, depending on the ultimate size of the plant. Sow seeds thinly and evenly by sprinkling or placing them along each drill at the appropriate depth. Carefully cover with soil and pack firmly. Label each row and water gently but thoroughly with a fine spray.
- To prevent overcrowding, the seedlings usually need to be thinned; to minimize disturbance to a seedling being retained, press the soil around it after thinning the adjacent seedlings.
- Water the newly establishing seedlings fairly frequently until the roots have developed.

Cultivars, Improved and Selected Materials (and area of origin)

'Silver Bouquet', 'Silver Frost', 'Silver King', 'Silver Queen', and 'Valerie Finnis' are several cultivars that have been used in varies planting throughout the range of *Artemisia ludoviciana*. Consult your local nurseries to choose the right cultivar for your specific landscape. ARLU is available through your regional native plant nursuries within the species range. Please check the Vendor Database, expected to be on-line through the PLANTS Web site in 2001 by clicking on Plant Materials.

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For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS <http://plants.usda.gov> and Plant Materials Program Web sites <http://Plant-Materials.nrcs.usda.gov>.

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Plant Fact Sheet

WESTERN WHEATGRASS

Pascopyrum smithii (Rydb.) A. Love

Plant Symbol = PASM

Contributed by: USDA NRCS Plant Materials Program

Robert H. Mohlenbrock
USDA NRCS 1989.
Midwestern Wetland Flora
@ USDA NRCS PLANTS

Alternate Names
Agropyron smithii Rydb.

Uses
Erosion control: Western wheatgrass is an excellent erosion control plant because of its spreading rhizomes. It is widely used in seed mixtures for range seeding, revegetation of saline and alkaline areas, and in critical areas for erosion control in the central and northern Great Plains region. This grass protected watershed dams in Kansas from damage when they were overtopped during a 14-inch rainfall event.

Reclamation: Western wheatgrass is frequently used in the northern Great Plains for surface mine revegetation. Because of its strong rhizomes and adaptation to a variety of soils, it performs well as part of a reclamation mixture.

Livestock: Forage quality is high for pasture or range seedings.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description
Pascopyrum smithii (Rydb.) A. Love, western wheatgrass, is perhaps one of the best known and most commonly used native grasses. It is a long-lived, cool season species that has coarse blue- green leaves with prominent veins. Because of this bluish appearance it has sometimes been called bluestem wheatgrass or bluejoint. It is a sod former with very strong, spreading rhizomes. Stems arise singly or in clusters of a few and reach heights of 1 to 3 feet. The sheaths are hairy and the purplish auricles typically clasp the stem. The seed spike is erect and about 2 to 6 inches long.

Adaptation and Distribution
Western wheatgrass is adapted to fine and very fine soils and is replaced by thickspike wheatgrass on coarser soils. Although it is able to grow on a wide variety of soils it prefers the heavier but well drained soils. It requires moderate to high soil moisture content and is most common in the 10 to 14 inch annual precipitation zones. Above 20 inches per year it behaves as an increaser on rangelands, below 20 inches it is a decreaser. Its elevational range is 1,000 to 9,000 feet.

Western wheatgrass tolerates saline and saline-sodic soils, poor drainage and moderately severe drought. It will tolerate spring flooding, high water tables, and considerable silt deposition. It is very cold hardy and can grow in partial shade. It is grazing resistant and can survive fires if in the dormant stage; recovery from fire, however, is slow.

Western wheatgrass grows in association with many species, the more common being blue grama, buffalograss, needlegrasses, bluebunch wheatgrass, rough fescue, Idaho fescue, and prairie junegrass. It begins growth about 2 to 3 weeks before blue grama

and does not mature until much later in the growing season.

Western wheatgrass performs poorly in the East and is not recommended for any use in the region.

Western wheatgrass is distributed throughout the west and midwest portions of the United States. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment
Seed of western wheatgrass should be planted 1/2 to 1 inch deep in fine to medium soil. Seeding rates should be 5 to 15 pounds PLS per acre drilled or 20 to 25 PLS per row foot. If seed is broadcast or used on harsh sites, the rate should be doubled. This species should be seeded in early spring, late fall or in the period of late summer, early fall. It can be sodded.

Seedling vigor is fair and stands may be slow to establish. It has stronger rooting abilities than does thickspike wheatgrass but spreads more slowly and may take several years to become firmly established. Once established, it is very hardy and enduring. It is moderately compatible with other species and is moderately aggressive.

Management
Western wheatgrass greens up in March or early April and matures in August. If moisture is adequate, it will make fair summer or fall regrowth. If nitrogen is applied it will compete with warm season grasses.

Western wheatgrass is moderately palatable to elk and cattle all year although this quality diminishes in late summer. It is palatable to deer only in spring. It is preferred by cattle more than by sheep. It can be grazed if 50 to 60 percent of the annual growth is allowed to remain (3 or 4 inch stubble). Rest rotation of western wheatgrass is advised. In areas where it is dense, it makes an excellent hay as well as pasture.

Irrigation will improve western wheatgrass stands and aid establishment. Weed control and fertilization will also help. Pitting, chiseling, disking, and interseeding can be used to stimulate stands of western wheatgrass.

Pests and Potential Problems
The primary pests to western wheatgrass are grasshoppers, ergot, and stem and leaf rusts.

Cultivars, Improved, and Selected Materials (and area of origin)
'Ariba' western wheatgrass was released for dry land hay production, grazing, and conservation seedings in the western part of the Central Plains and in the southwestern United States. 'Flintlock' is a broad-based cultivar. It is recommended for conservation seeding, dry land hay production, and grazing in the Central Plains. 'Barton' is a strongly rhizomatous, leafy ecotype, intermediate in growth between northern and southern types. 'Barton' is relatively disease free and high in forage and seed production. 'Rosana' is a northern type western wheatgrass. Plants are blue-green, leafy, with moderately fine stems. Rhizomes produce a tight sod. 'Rosana' is recommended for reseeding depleted range lands and the reclamation of disturbed lands in the Northern Great Plains. 'Rodan' northern type western wheatgrass is moderately rhizomatous and forms a dense blue-green sward. Leaves are thinner and less heavily veined than other western wheatgrasses. Western wheatgrass seed is available at most farm seed stores.

Prepared By & Species Coordinator:
USDA NRCS Plant Materials Program

Edited: 05Feb2002 JLK; 060802 jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

United States Department of Agriculture
NRCS Natural Resources Conservation Service
Plant Guide

BASIN WILDRYE

Leymus cinereus (Scribn. & Merr.) A. Love

plant symbol = LECI4

Contributed By: USDA, NRCS, Idaho State Office & the National Plant Data Center

Hitchcock (1950)

Alternate Names
Giant wildrye, great basin wildrye, *Elymus cinereus*

Uses
Grazing/rangeland/hayland: Basin wildrye is generally not recommended for spring or summer utilization, because it has an elevated growing point and is easily damaged by overgrazing.

Basin wildrye is palatable to all classes of livestock and wildlife. It is a preferred feed for horses in spring and is considered a desirable feed for cattle, sheep, elk, deer, and antelope in the spring. It is considered a desirable feed for cattle and horses in early summer, late fall, and winter. It reaches its peak production in protein per acre from mid-June through August. Protein levels can be as high as 20 percent and decrease to about 7 to 8 percent protein as it matures and cures.

This species produces large amounts of forage and can be used as standing winter forage. Leaving 10 to 12 inches of stubble height will help reduce grazing damage. It is generally not recommended for haying, because it is difficult to harvest above its natural growing point. Once harvested by grazing or cutting, it produces little regrowth.

Basin wildrye is ideal for providing wind protection in winter calving pastures. It holds its nutrient value well at maturity (7-8% protein) and can withstand heavy grazing and trampling in its dormant state. Its tall stature and stiff stems make this forage accessible in areas of deep snow.

Erosion control/reclamation: Basin wildrye is well adapted to stabilizing disturbed soils. It should not be planted with aggressive introduced grasses. It is very compatible with slower developing natives such as Snake River wheatgrass (*Elymus wawawaiensis*), bluebunch wheatgrass (*Pseudoroegneria spicata*), thickspike wheatgrass (*Elymus lanceolatus* ssp. *lanceolatus*), streambank wheatgrass (*Elymus lanceolatus* ssp. *psammophilus*), western wheatgrass (*Pascopyrum smithii*), and needlegrass species (*Hesperostipa* spp. and *Nasella* spp.). Basin wildrye's drought tolerance, combined with its fibrous root system and fair seedling vigor, make it desirable for reclamation in areas receiving 8 to 20 inches annual precipitation. It is commonly used as a grass barrier to control wind erosion or blowing snow. It has also been planted on hilly cropland as a vegetative terrace for water erosion control.

Wildlife: Because basin wildrye is a tall upright bunchgrass, it is considered excellent cover habitat for small animals and birds, excellent nesting cover for upland birds, and excellent standing winter feed and cover for big game animals.

Status
Consult the PLANTS Web site and your State Department of Natural Resources for this plant's

current status, such as state noxious status and wetland indicator values.

Description
General: Grass Family (Poaceae). Basin wildrye is a large, coarse, robust, perennial bunchgrass, sometimes with short rhizomes. It is a long-lived cool-season native with an extensive, deep, coarse, fibrous root system.

Basin wildrye has long leaf blades (15 to 25 inches) and flat wide (up to 3/4 inch) leaves with long pointed auricles. The reproductive stems are dense, stout, and strongly erect. Seed heads are 6 to 10 inches long. Basin wildrye clumps may reach 3 feet in diameter and stand 3 to 6 feet tall (10 feet under excellent soil and climate conditions). Growing points are 10 to 12 inches above the crown.

Basin wildrye has fair seedling vigor. It is one of the first grasses to initiate spring growth and it produces an abundance of basal leaf growth until the development of seed heads in mid-June to mid-July. Following the development of seed heads, basin wildrye produces very little additional basal leaf growth and rapidly becomes coarse and stemmy. Regrowth does not occur following seed production.

Distribution
It is native to the western Great Plains and Intermountain regions of the western United States. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Adaptation
Basin wildrye is very winter hardy and has a rather broad range of climatic adaptation. It can be found at elevations from 2000 up to 9000 feet. It grows best in areas with average annual precipitation of 8 inches to above 20 inches. 'Trailhead' seeded in areas with as low as 5 inches of rainfall has reproduced to populate areas around the original plots. In lower rainfall areas, basin wildrye grows in run-in areas, along gullies or watercourses, or near sites with high seasonal water tables. It does not tolerate areas with extended periods of inundation. It will tolerate short-term winter flooding. It is susceptible to leaf and stem rust in wetter climatic areas.

Basin wildrye has a broad soil texture adaptation, but it is not adapted to shallow soils. It is most common on deep soils with high water holding capacities.

It is tolerant of low to moderate levels (< 10 mmhos/cm3) of saline and (SAR < 15) sodic soil conditions and slightly acidic soils. Established stands of basin wildrye can tolerate long periods of drought, and it prefers cycles of wet winters and dry summers. It tolerates partial shading and wildfire if soil moisture is not too dry.

It does well as a pioneer plant and establishes seedlings in disturbed areas, such as recent road fills and areas disturbed by wildlife (ex. rodent diggings).

Species often associated with basin wildrye include the big sagebrush complex (*Artemisia tridentata*), juniper species (*Juniper* spp.), needlegrass species (*Hesperostipa and Nassella* spp.), bluebunch wheatgrass, Snake River wheatgrass, thickspike wheatgrass, streambank wheatgrass, Indian ricegrass (*Achnatherum hymenoides*), western wheatgrass (*Pascopyrum smithii*) and Idaho fescue (*Festuca idahoensis*).

Establishment
Planting: This species should be seeded with a disc or deep furrow drill at a depth of 1/4 to 3/4 inch on medium to fine-textured soils and 1 inch or less on coarse-textured soils. Single species seeding rate recommended for basin wildrye is 7 pounds Pure Live Seed (PLS) per acre or 21 PLS per square foot. If used as a component of a mix, adjust to percent of mix desired. For rangeland mixtures, basin wildrye should comprise approximately 10 to 20 percent of the seed mix or 1 to 2 pounds PLS.

For seeding mine lands and other harsh critical areas, the seeding rate should be doubled. When seeding is for a vegetative windbreak, vegetative terrace, or wildlife cover, it is recommended that 3.0 to 3.5 pounds PLS be seeded in 36 to 48-inch rows.

The best seeding results are obtained from seeding in very early spring on heavy to medium-textured soils and in late fall on medium to light-textured soils. Summer and late summer (July to mid September) seedings are not recommended. Seedling vigor is fair, and stands may take 2 to 5 years to fully establish.

Seed production stands may require weed control measures during establishment. Bromoxynil may be applied at the 3-4-leaf stage of grass for early suppression of young broadleaf weeds. Application of 2,4-D should not be made until plants have reached the 4-6-leaf stage. Mow above establishing seedlings when weeds are beginning to bloom will help to reduce weed seed development.

Grasshoppers and other insects may also damage new stands. Use of pesticides may be required. All herbicides and pesticides should be applied according to the label.

Management

Basin wildrye establishes slowly and new seedings should not be grazed until at least late summer or fall of the second growing season. Basin wildrye makes its initial growth in early spring and matures seed by late summer. It reproduces primarily by seed and tillers.

Basin wildrye is palatable to all classes of livestock and wildlife. New stands should not be grazed until plants are at least 10 inches tall. Overgrazing, especially in spring, severely damages basin wildrye, and stubble of at least 10 inches should remain following grazing.

Established stands can be grazed in late spring or fall (leave about 10 inches of stubble to protect plant health). Following grazing, little re-growth can be expected, even when the stand is irrigated. Basin wildrye is a low-maintenance plant requiring little additional treatment or care.

Environmental Concerns: Basin wildrye is long-lived and spreads primarily via seed distribution. It is not considered "weedy" or an invasive species, but can spread into adjoining vegetative communities under ideal climatic and environmental conditions. Most seedings do not spread from original plantings. If they do spread, the rate is slow. Basin wildrye accessions with the same chromosome number (28 or 56) will cross with each other but are not noted for crossing with other native species or basin wildrye genotypes of a different chromosome number.

Seed Production

Seed production of basin wildrye has been very successful under cultivated conditions. Row spacing of 36 inches (seeding rate 3.5 pounds PLS per acre) to 48 inches (seeding rate 3.0 pounds PLS per acre) are recommended. Cultivation will be needed for weed control and to maintain row culture.

For seed production, basin wildrye benefits from low levels of fertilization based on soil tests. Apply approximately 30 pounds actual N per acre on dryland plantings and 60 to 80 pounds actual N per acre on irrigated plantings for optimum production. Seed fields are productive for at least five to seven years. Average production of 150 to 200 pounds per acre can be expected under dryland conditions in 14-inch plus rainfall areas. Average production of 300 to 400 pounds per acre can be expected under irrigated conditions. Direct combining, leaving 24 to 30 inches stubble (to reduce handling of leaves and stems), is the preferred method to harvest basin wildrye. The seed heads have moderate rates of shatter and require close scrutiny of maturing stands to determine optimum harvest date. Seed is generally harvested from mid-August to September. Seed must be dried immediately after combining (12 percent bins / 15 percent sacks moisture content).

Cultivars, Improved and Selected Materials (and area of origin)

Foundation and registered seed is available through the appropriate state Crop Improvement Association or commercial sources to grow certified seed.

'Magnar' (*Leymus cinereus*) was originally collected by the Pullman, Washington, Plant Materials Center (PMC). It was selected by the Aberdeen, Idaho, PMC and released in 1979. It is a selection of vigorous plant types over several generations. It is adapted to the Northwest and Intermountain Regions of the Western United States where precipitation averages 8 inches or above. It has survived in plantings with 7 inches annual rainfall. It prefers deep clayey to loamy to sandy soils and can be found in weakly saline conditions. It is noted for blue foliage, fair seedling vigor and establishment, high forage production, good winter cover, fair winter forage, and ability to survive and thrive under very dry conditions. 'Magnar' is a 56-chromosome cultivar. Certified seed is available, and Breeder and Foundation seed is maintained by the Aberdeen PMC.

'Trailhead' (*Leymus cinereus*) was selected by the Bridger, Montana, PMC and released in 1991. The original collection site was near Roundup, Montana, in a sub-irrigated rangeland community. It is adapted to the Northern Great Plains and Intermountain Regions of the Western United States where precipitation averages 8 inches or above. It has survived in plantings with 5 inches annual rainfall. It was selected for its stand longevity and drought tolerance as compared to other basin wildrye accessions. It prefers deep clayey to loamy to sandy soils and tolerates weakly saline conditions. It is noted for green foliage, fair seedling vigor and establishment, high forage production, good winter cover, fair winter forage, and ability to survive and thrive under very dry conditions. 'Trailhead' is a 28-chromosome cultivar. Certified seed is available, and the Bridger PMC maintains Breeder and Foundation seed.

Washoe Germplasm basin wildrye (*Leymus cinereus*) is a Selected Class germplasm that was released in 2002. It was originally collected in Deer Lodge County, Montana near the old Washoe smelter stack south of Anaconda, Montana. Heavy metal and sulfide fallout from historic copper smelting emissions has elevated heavy metal levels and decreased soil pH in the area. At the collection site arsenic, cadmium, copper, lead, and zinc levels range from moderate to high phytotoxic. Soil pH ranges from 4.6 to 5.6. Washoe Germplasm had better overall height, vigor, and survival compared to 'Magnar' and 'Trailhead' when tested in low pH and heavy metal contaminated soil. Bridger PMC maintains Generation (G) 0 and G1 seed.

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United States Department of Agriculture
NRCS Natural Resources Conservation Service
Plant Guide

NARROWLEAF CATTAIL

Typha angustifolia L.

plant symbol = TYAN

Contributed By: USDA, NRCS, National Plant Data Center & Idaho Plant Materials Center

Alternate Names
flags, rushes, bulrushes, cat o'nine tails, Cossack asparagus, reed mace, baco

Brother Alfred Brousseau
© St. Mary's College
@ CalPhotos

Uses
Caution: This species can be very invasive in disturbed wetlands. Please read about the environmental concerns under Management.

Ethnobotanic: All parts of the cattail are edible when gathered at the appropriate stage of growth. The young shoots are cut from the rhizomes (underground stems) in the spring when they are about 4 to 16 inches long. The base of the stem where it attaches to the rhizome can be boiled or roasted like potatoes. The young flower stalks can be taken out of their sheaths and can be boiled or steamed just like corn. Cattail pollen is a fine substitute for flours. It is a bright yellow or green color, and turns pancakes, cookies or biscuits a pretty yellow color (which children love). The rhizomes and lower stems have a sweet flavor and can be eaten raw, baked, roasted, or broiled. Cattail rhizomes are fairly high in starch content; this is usually listed at about 30% to 46%. The core can be ground into flour. One acre of cattails would yield about 6,475 pounds of flour (Harrington 1972). This flour would probably contain about 80 % carbohydrates and around 6% to 8% protein. Since cattails occur around the world, it is a potential source of food for the worlds' population.

The Klamath and Modoc peoples of northern California and southern Oregon made flexible baskets of twined cattail. Cattails were also twined to form mats of varying sizes for sleeping, sitting, working, entertaining, covering doorways, providing shade, and a myriad of other uses. Lengths of cattail were plied into rope or other size cordage, and cattail rope was used in some areas to bind bundles of tule into tule boats. Air pockets or aerenchyma in the stems provided the buoyancy for good boat-building material.

The Cahuilla Indians used the stalks for matting, bedding material, and ceremonial bundles (Barrows 1967). Some tribes used the leaves and sheath bases as caulking materials. Apaches used the pollen in female puberty ceremonies. After dipping the spike in coal oil, the stalk makes a fine torch. The fluff can also be used as tinder, insulation, or for lining baby cradleboards. The down is used for baby beds (Murphey 1959).

Wildlife: The multitudes of tiny, wind-carried seeds are too small and too hairy to be attractive to birds (Hotchkiss and Dozier 1949). In a few exceptions, the seeds are eaten by several duck species. Cattail rootstocks are much more valuable as food for wildlife than are the seeds. Geese and muskrats prefer the stems and roots. Moose and elk eat fresh spring shoots. Shelter and nesting cover are provided for long-billed marsh wrens, redwing blackbirds, and yellow-headed blackbirds.

Conservation: This plant is used widely for wetland restoration and constructed wetlands for tertiary water treatment. *Typha* species can become invasive in disturbed habitats.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status, and wetland indicator values.

Description
Cattails are herbaceous, colonial, rhizomatous, perennial plants with long, slender, green stalks topped with brown, fluffy, sausage-shaped flowering heads. *Typha angustifolia* plants are 15-30 dm tall. The spike-like, terminal, cylindric inflorescence has staminate flowers above and pistillate flowers below. The naked axis between the staminate and pistillate flowers is generally 1-8 cm. The spike is medium to dark brown. The basal leaves are thin with parallel

veins running their long, narrow length. The leaves are 4-12 mm wide when fresh, 3-8 mm wide when dry.

Typha angustifolia generally occurs in deeper water than *Typha latifolia*. *Typha angustifolia* has fewer and larger rhizomes, resulting in a low rate of cloning but enabling it to grow in deeper water than *Typha latifolia*. *Typha angustifolia* has a higher allocation to sexual reproduction. Cattails spread both vegetatively and by seed, particularly under drawdown conditions.

Distribution

Cattails are always found in or near water, in marshes, ponds, lakes, and depressional areas. They are obligate wetland indicator plant species. Cattails tolerate perennial flooding, reduced soil conditions, and moderate salinity. With influxes of nutrients or freshwater, cattails are aggressive invaders in both brackish salt marshes and freshwater wetlands. Narrow-leaved cattails are found in marshes at elevations <2000 m. They grow throughout North America and Eurasia (Hickman 1993). For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Establishment

Typha species may be planted from bare rootstock or seedlings from container stalk or directly seeded into the soil. Bare rootstock or seedlings are preferred revegetation methods where there is moving water. *Typha* seeds germinate readily and are a cost-effective means to propagate cattail on moist soils. *Typha* species can be invasive in disturbed wetland situations and become a monoculture.

Seed Collections

- Select seed collection sites where continuous stands with few intermixed species can easily be found and obtain permission for seed collection.
- Seeds can be harvested when they are slightly immature. It is important to harvest the staminate stalks before they dry and blow away.
- Harvest by using either hand clippers, cutting the stem off below the seed heads, or by stripping the seed heads off of the stalk. Use a seed cleaner to process the seeds. Dry and store the seeds in brown paper or burlap bags.
- Plant cleaned seed in fall. Plant in clean, weed-free, moist seedbed. Flooded or ponded soils will significantly increase seedling mortality.
- Broadcast seed and roll in or rake 1/4" to 1/2" from the soil surface. Some seed may be lost due to scour or flooding. Recommended seed density is unknown at this time.

Seed Germination in Greenhouse

- Plant in the greenhouse in 1" x 1" x 2" pots, 1/4" under the soil surface. Keep soil surface moist. Greenhouse temperature should be 100° F (plus or minus 5° F). Seeds will begin to germinate after a couple weeks in warm temperatures.
- Plants will be ready in 100-120 days to come out as plugs. By planting seeds in August, plugs are ready to plant in the soil by November. These plants are very small. Growing plants to a larger size will result in increased revegetation success.

Live Plant Collections

- No more than 1/4 of the plants in an area should be collected. If no more than 0.09 m² (1 ft²) is removed from a 0.4 m² (4 ft²) area, the plants will grow back into the hole in one good growing season. A depth of 15 cm (6 in) is sufficient for digging plugs. This will leave enough plants and rhizomes to grow back during the growing season.
- Donor plants that are drought-stressed tend to have higher revegetation success.
- Live transplants should be planted in moist (not flooded or anoxic) soils as soon as possible. Plants should be transported and stored in a cool location prior to planting. Plugs may be split into smaller units, generally no smaller than 6 x 6 cm (2.4 x 2.4 in), with healthy rhizomes and tops. The important factor in live plant collections is to be sure to include a growing bud in either plugs or rhizomes. Weeds in the plugs should be removed by hand. For ease in transport, soil may be washed gently from roots. The roots should always remain moist or in water until planted.
- Clip leaves and stem from 15 to 25 cm (6 to 10 inches); this allows the plant to allocate more energy into root production. Plant approximately 1 meter apart. Plants should be planted closer together if the site has fine soils such as clay or silt, steep slopes, or prolonged inundation.
- Ideally, plants should be planted in moist soils in late fall just after the first rains (usually late October to November). This enables plant root systems to become established before heavy flooding and winter dormancy occurs. Survival is highest when plants are dormant and soils are moist.

- Fertilization is very helpful for plant growth and reproduction. Many more seeds are produced with moderate fertilization.

Management

Heavy grazing will eliminate *Typha* species, as well as other native species, from riparian corridors. However, cattails are fairly resistant to moderate grazing, providing wet soils are not compacted.

Because cattails have relatively little value for ducks, they are often regarded as undesirable weeds in places intended primarily for ducks. It has been found that mowing cattails after the heads are well–formed, but not mature, then following up with another mowing about a month later (when new growth is two or three feet high) will kill at least 75% of the plants. This will enable other emergent vegetation with more palatable and nutritious seeds to become established.

Environmental Concerns: Ecologically, cattails tend to invade native plant communities when hydrology, salinity, or fertility change. In this case, they out-compete native species, often becoming monotypic stands of dense cattails. Maintaining water flows into the wetland, reducing nutrient input, and maintaining salinity in tidal marshes will help maintain desirable species composition. If cattails begin to invade, physical removal may be necessary.

Over the past century, we have dramatically increased the range of this species and have brought *T. angustifolia* and *T. latifolia* together with the production of the hybrid *T. glauca*. This taxon is extremely aggressive and will out-compete either parent. The methods of control include clipping and floocing >12 inches, herbicides, and hydrology management (Melvin 2000). Please contact your local agricultural extension specialist or county weed specialist to learn what works best in your area and how to use it safely. Always read label and safety instructions for each control method. Trade names and control measures appear in this document only to provide specific information. USDA, NRCS does not guarantee or warranty the products and control methods named, and other products may be equally effective.

Cultivars, Improved and Selected Materials (and area of origin)

Please check the Vendor Database, expected to be on-line through the PLANTS Web site in 2001 by clicking on Plant Materials. This species is readily available for native plant nurseries specializing in wetland plants.

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United States Department of Agriculture
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Plant Guide

HARDSTEM BULRUSH

Schoenoplectus acutus (Muhl. ex Bigelow) A. & D. Love var. *occidentalis* (S. Wats.) S.G. Sm.

plant symbol = SCACO2

Contributed By: USDA, NRCS, National Plant Data Center & the Idaho Plant Materials Center

Alternate Names

Alfred Brousseau

Bulrush, tule, black root. Known in some floras as *Scirpus acutus* Bigelow var. *occidentalis* (S. Watson) Beetle.

Uses

Ethnobotanic: Hardstem bulrush is similar to the cattail in edibility, although it is purportedly sweeter. Young shoots coming up in the spring can be eaten raw or cooked. Bulrush pollen is eaten as flour in bread, mush or pancakes. Later in the season, the seeds can be beaten off into baskets or pails, ground into a similar meal and used as flour. The large rhizomes are eaten raw or cooked; sometimes they were dried in the sun, then pounded into a kind of flour. *Schoenoplectus tabernaemontani* (synonym: *Scirpus validus)* , a similar species, has as much as 8% sugar and 5.5% starch in rhizomes, but less than 1% protein (Harrington 1972).

The rhizome (underground stem) is used for the black element in basket design. Rhizomes are obtained by digging around the plant and following them out from the parent plant. Often the green stalks are cut, to make the rooting area more accessible. Bulrushes are called black root by Pomo basket weavers in California; the cream-colored rhizome is dyed black for basketry designs. The rhizomes are soaked from 3 to 6 months with acorns and a piece of iron, ashes or walnut husks until a dark brown to black color is obtained. Rhizomes are then stored in coils to dry, then woven into coiled baskets. Only about the thickness of a toothpick, the split rhizomes are both flexible and strong.

Tule houses were common throughout many parts of California; the overlapping tule matters were well-insulated and rain-proof. Willow poles, arched and anchored into the ground and tied with cordage or bark formed the framework. The walls are thatched with mats of tule or cattail and secured to the frame. In Nevada, tules and willows were bound together in a sort of crude weaving for "Kani", the Paiute name for summerhouse. Tules and cattails were used as insulating thatch for structures matting, bedding, and roofing materials. As thatching material, these bulrushes were spread out in bundles, tied together, then secured in place with poles.

Several California Indian tribes make canoes of tule stems bound together with vines from wild grape. Groups located near the California coast, on mud flats and in marshes, used tule to make large round mud-shoes for their feet so they could walk without sinking. They also make dwellings of tule. Shredded tule was used for baby diapers, bedding, and menstrual padding. Women made skirts from tule. During inclement weather, men wore shredded tule capes, which tied around the neck and was belted at the waist. Duck decoys were made of tule.

Other Uses: Streambank stabilization, wetland restoration, wildlife food and shelter, edible (young shoots, pollen, seeds, rhizomes), basketry, houses, roofing material, matting, bedding, canoes. These native plants are especially good for stabilizing or restoring disturbed or degraded (including logged or burned) areas, for erosion and slope control, and for wildlife food and cover. Bulrushes may be less suitable for general garden use.

Wildlife: The seeds, being less hairy and larger than cattail, are one of the most important and commonly used foods of ducks and of certain marshbirds and shorebirds (Martin et al. 1951). Bulrushes provide choice food for wetland birds: baldpate, bufflehead, mallard, pintail, shoveler, blue-winged teal, cinnamon teal, greater scaup, lesser scaup, avocet, marbled godwit, clapper, Virginia rail, sora rail, long-billed dowitcher, and tricolored blackbird. Canada

geese and white-fronted geese prefer the shoots and roots. The stems provide nesting habitat for blackbirds and marsh wrens. Fresh emergent wetlands are among the most productive wildlife habitats in California. They provide food, cover, and water for more than 160 species of birds and numerous mammals, reptiles and amphibians. The endangered Santa Cruz long-toed salamander and rare giant garter snake use these wetlands as primary habitat. The endangered Aleutian Canada goose, bald eagle, and peregrine falcon use these wetlands for feeding and roosting.

Muskrats have evolved with wetland ecosystems and form a valuable component of healthy functioning wetland communities. Muskrats use emergent wetland vegetation for hut construction and for food. Typically, an area of open water is created around the huts. Muskrat eatouts increase wetland diversity by providing opportunities for aquatic vegetation to become established in the open water and the huts provide a substrate for shrubs and other plant species. Muskrats opening up the dense stands of emergent vegetation also create habitat for other species. Both beaver and muskrats often improve wetland habitat.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description
General: Sedge Family (Cyperaceae). Hardstem bulrush, a deciduous herbaceous plant, is distinguished by their long cylindric stems from 5 to 8 feet tall. The shoots senesce in the winter. The leaves are slender, v-shaped blades that are sheathed around the long stem. The flowers are arranged in a spikelet and resemble orange-brown scales. Hardstem bulrush has a tight panicle with 3 to many spikelets, and the flower bracts are prominently spotted. Bulrushes have clonal growth, with stout rootstocks and long, thick, brown rhizomes (underground stems).

Distribution
For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site. Bulrushes are often dominant emergent vegetation found in marshes and wetlands throughout temperate North America. Hardstem bulrush occurs across temperate North America to British Columbia and east to the Atlantic coast (Hickman 1993).

Establishment
Schoenoplectus species may be planted from bare root stock or seedlings from container stalk or directly seeded into the soil. Germination problems have been reported in the literature for *S. acutus*. Consequently, live plant collections of this species are recommended. Bare rootstock or seedlings are preferred revegetation methods where there is moving water.

Live Plant Collections: No more than 1/4 of the plants in an area should be collected. If no more than 0.09 m^2 (1 ft^2) should be removed from a 0.4 m^2 (4 ft^2) area, the plants will grow back into the hole in one good growing season. A depth of 15 cm (6 in) is sufficiently deep for digging plugs. This will leave enough plants and rhizomes to grow back during the growing season.

Donor plants that are drought-stressed tend to have higher revegetation success. Live transplants should be planted as soon as possible in moist (not flooded or anoxic) soils. Plants should be transported and stored in a cool location prior to planting. Plugs may be split into smaller units, generally no smaller than 6 x 6 cm (2.4 x 2.4 in), with healthy rhizomes and tops. The important factor in live plant collections is to be sure to include a growing bud in either plugs or rhizomes. Weeds in the plugs should be removed by hand. Soil can either be left on the roots of harvested material or removed. For ease in transport, soil may be washed gently from roots. The roots should always remain moist or in water until planted.

Clip leaves and stems from 15 to 25 cm (6 to 10 inches); this allows the plant to allocate more energy into root production. Plant approximately 1 meter apart. Plants should be planted closer together if the site has fine soils such as clay or silt, steep slopes, or prolonged inundation.

Don't flood plants right away, or the seedlings will experience high mortality. If possible, get the roots started before flooding the soils. Ideally, plants should be planted in late fall just after the first rains (usually late October to November). This enables plant root systems to become established before heavy flooding and winter dormancy occurs. Survival is highest when plants are dormant and soils are moist. Fertilization is very helpful for plant growth and reproduction. Many more seeds are produced with moderate fertilization.

Seed Collections: Select seed collection sites where continuous stands with few intermixed species can

easily be found. At each collection location, obtain permission for seed collection.

- Seed is harvested by taking hand clippers and cutting the stem off below the seed heads or stripping the seed heads off the stalk. Hardstem bulrush plants tend to hold the seed for a long period of time after seeds are mature, so harvesting time is more flexible.
- Less than 1/2 hour is required to make a decent collection of 1 to 2 cups of seed. The ease of collection is affected by water depth.
- Collect and store seeds in brown paper bags or burlap bags. Seeds are then dried in these bags.
- Seeds and seed heads need to be cleaned in a seed cleaner like a Crippen Cleaner.
- Plant cleaned seed in fall. Plant in a clean, weed-free, moist seed bed. Flooded or ponded soils will significantly increase seedling mortality.
- Broadcast seed and roll in or rake 1/4" to 1/2" from the soil surface.
- Some seed may be lost due to scour or flooding. Recommended seed density is unknown at this time.

Seed germination in greenhouse:

- Clean seed - blow out light seed. To grow seeds, plant in greenhouse in 1" x 1" x 2" pots, 1/4" under the soil surface. Keep soil surface moist. Put in temperature of 100 degrees F (plus or minus 5 degrees). Seeds begin to germinate after a couple weeks in warm temperatures.
- Plants are ready in 100 - 120 days to come out as plugs. By planting seeds in August, plugs are ready to plant in soil by November. These plants are very small; growing plants to a larger size will result in increased revegetation success.
- In one study, greenhouse propagated transplants of hardstem bulrush appeared more vigorous than wild selected plants (Hoag et al. 1995). However, there were no significant differences in height or shoot density (spread) between greenhouse propagated and wild transplants. Wild collected transplants had a higher percentage of shoots flower and set seed. Greenhouse propagated transplants produced more above ground biomass (were more robust).

Management

Hydrology is the most important factor in determining wetland type, revegetation, success, and wetland function and value. Changes in water levels influence species composition, structure, and distribution of plant communities. Water management is absolutely critical during plant establishment, and remains crucial through the life of the wetland for proper community management.

Traditional Resource Management: The plant must grow in coarse-textured soil free of gravel, clay and silt for the roots to be of the quality necessary for basket weaving. Plants are tended by gathering and reducing the density between plants for longer rhizome production. Sustainable harvesting of plants occurs through limiting harvest in any given area. Fire is used to manage tule wetlands to remove old stems and restore open water to the wetland. This stimulates growth of new shoots from rhizomes and provides a bare soil substrate for seed germination.

Many Native Americans feel the use of herbicides is inappropriate in traditional gathering sites. Bulrush is densely rhizomatous with abundant seed production. In most cases, it will out-compete other species within the wetland area of the site, eliminating the need for manual or chemical control of invasive species. Heavy grazing will eliminate *Schoenoplectus* species as well as other native species.

Cultivars, Improved and Selected Materials (and area of origin)

Please check the Vendor Database, expected to be on-line through the PLANTS Web site in 2001 by clicking on Plant Materials. This species is readily available from most nurseries.

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Plant Guide

COYOTE WILLOW

Salix exigua Nutt.

plant symbol = SAEX

Contributed By: USDA, NRCS, National Plant Data Center, New Mexico Plant Materials Center, & Idaho Plant Materials Center

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Alternate Names
Sandbar willow, gray willow, narrow-leaved willow, dusky willow, pussywillow

Uses
Ethnobotanic: The value of willow as the raw material necessary for the manufacture of a family's household goods cannot be over-estimated. Among the Paiute, every woman carried bundles of long, slender willow which had been scraped white, and coils of willow sapwood that she had gathered and prepared during the winter months when the leaves were gone (Wheat 1967). Willow branches are used as the warp for twined baskets and the foundation in coiled baskets. Willows are used to weave water jugs, cradles for newborn infants, hats, cooking vessels, serving bowls, trays, seed beaters, and storage baskets. Some tribes use willow roots as a sewing strand. Virtually all California tribes use willow in their baskets.

Tribes which use willow, such as *Salix exigua*, include the Chemehuevi, Paiute, Mono, Panamint, Pviotso (Northern Paiute), Shoshoni, Bannock, Ute, Washo, Chiricahua, Jicarilla Apache, Mescalero Apache, Navajo, San Carlos Apache, Western Apache, White Mountain Apache, Havasupai, Maricopa, Yavapai, Hopi, San Juan Pueblo (Tewa), Zuni, Papago, and Pima Indians extending through the American Southwest and Mexico. In Ancestral Puebloan times, willow, along with threeleaf sumac, was the material of choice for manufacturing Native American baskets.

Willow is gathered from the time the leaves fall in autumn until the buds begin to swell in spring. The year-old wands without branches are chosen, and sorted by size and length. The bark can easily be stripped off in the spring when the sap rises. Willow wands with the smallest leaf scars are split and peeled to obtain the tough, flexible sapwood used for the weft in basket weaving. Color variation is achieved by alternating peeled and unpeeled willow sticks in the warp. Ute Indians used to concoct a green dye for coloring buckskin by soaking willow leaves in hot water and then boiling the mixture to concentrate the pigment. Willow roots also have been used by others to manufacture a rose-tan dye.

The Paiute built willow-frame houses covered with mats of cattails or tules. Slender willow withes were woven into tight circular fences as protection from the wind that blew sand into eyes and food. For shade, shed roofs thatched with willows, called "willow shadows", were constructed. In the Pueblo province, coyote willow branches are employed with leaves attached for thatching roofs. Other light construction uses included the tops of storage bins or racks for aerating corn while it dried, such as one recently unearthed at prehistoric Arroyo Hondo Pueblo.

A bed or sleeping bench of willow poles raised high off the ground indicated a wealthy man in the Miwok culture in California's Sierra Nevada. Willow brush was placed radically over the roof timbers of an earth lodge. Boats had eight willow ribs and a gunwale of willow pole along each side. Sweat lodges are made with willow. A women's shinney game was played on a field similar to a football field with five-foot long, sharp willow poles. A ring of rope or string was thrown into an indent in the field and the women had to move it up the field and throw it against a goal post without touching or carrying it on the poles. Counting games are played with willow counting sticks.

Ancestral Puebloans used willow wood for textile loom anchors, rods to control the weaving rhythm, and finishing needles. Bows, arrow points, pot rests, scrapers and cradle parts all were crafted from willow. In later times, Navajo made weaving sticks and arrow shafts from willow along with other straight-grained woods, and Ute Indians made snowshoe frames from dried willow branches. Matting was another early product made from willows.

Other implements made from willow include fire sticks twirled as a spindle to generate enough heat to ignite a flame and what appear to be prayer sticks recovered from various archaeological sites. Willow is still used for making prayer sticks by the Zunis and doubtless by some of the Rio Grande pueblo. Inner bark was used in spring for rope in California (Murphey 1959).

Aspirin is the pharmaceutical equivalent of willow bark tea, which is an effective remedy for headache, fever or sore throat. More than 2,400 years ago, the Greeks learned to use extracts of several native willow species to treat pain, gout, and other illnesses. In more recent times, in 1839, salicylic acid was isolated from wild plants and manufactured synthetically. Early salicylic acid-based products had unpleasant side effects. Sixty years later, the Bayer Company developed a derivative of salicylic acid, called it aspirin, and the rest is history.

Tea made from willow leaves will cure laryngitis. Willow reduces inflammation of joints and membranes. When used as an analgesic, willow treats urethra and bladder irritation, infected wounds, and eczema. Willow is used as an over-all treatment of many diseases, including hay fever, diarrhea, prostatitis, satyriasis, and relief of ovarian pain. A poultice is made for treating gangrene and skin ulcers. For one remedy used by the Paiute, burned willow charcoal was added to water and taken as a tea to stop diarrhea. A San Juan tribal elder said he used willow leaves to make his mouth water and relieve thirst.

Young willow shoots can be stripped of their bark and eaten. The inner bark can be eaten raw, prepared like spaghetti, or made into a flour. The young leaves may be eaten in case of emergency

Other Uses: Ecological diversity, bank and sediment stabilization, maintenance of channel morphology, water quality improvement, ground-water recharge, flood abatement, fish and wildlife habitat, ribs of boats, and games.

Riparian Ecosystem Services and Functions: The riparian zone essentially encompasses those alluvial sediment deposits where river and alluvial ground water supplement that available from local precipitation. High-to-low elevations, north-south and east-west gradients, and steep-to-shallow terrain all influence the relationship between geomorphic and fluvial processes and vegetation community structure. Riparian ecosystem functions include the following:

- Ecological diversity.
- Riparian vegetation traps sediments and nutrients from surface runoff and prevents them from entering the aquatic system.
- Dense matrix of roots in the riparian zone can serve as an effective filter of shallow groundwater.
- Water quality is improved through filtration and trapping of sediment, nutrients (particularly nitrogen dissolved in groundwater), and pollutants.
- Riparian vegetation tends to prevent the river from down-cutting or cutting a straight path (channeling), thus promoting a sinuous course, ground-water recharge, and maintenance of an elevated water table.
- Riparian areas act as a sponge by absorbing floodwaters which is then slowly released over a period of time, which minimizes flood damage and sustains higher base flows during late summer.
- Structurally complex riparian vegetation communities provide many different habitats and support a diverse array of animal species. Different groups of animals occupy or use the different layers of vegetation, and this multi-story arrangement is often present nowhere else in the arid landscapes.
- Canopies of plants growing on streambanks provide shade, cooling stream water, while roots stabilize and create overhanging banks, providing habitat for fish and other aquatic organisms.

Wildlife: Rabbits and many ungulates, including deer, moose, and elk, browse on willow twigs, foliage and bark (Martin 1951). Beavers consume willow branches, while several species of birds eat willow buds and young twigs.

California's riparian forests support a high diversity of breeding birds (Miller 1951). In one study conducted on the Sacramento River, 147 bird species were recorded as nesters or winter visitants' (Laymon 1985). The percentage of breeding individuals that are migratory is very high in the cottonwood-willow habitat. Moister conditions in the cottonwood-willow forest may promote lusher plant growth, higher invertebrate populations and, therefore, more available food for flycatchers, warblers and other migratory, insectivorous birds. Riparian areas support up to 10.6 times the density of migrant birds per hectare as adjacent non-riparian areas (Stevens et al. 1977). Most of these migratory birds belong to

the foliage insect (47%) or air insect (34%) foraging guilds.

Coyote willow is browsed avidly by deer and to some extent by sheep, goats, and cattle, in summer and early fall. Cattle will leave the willow patches when the foliage matures and dries, whereas deer devour the current leafless stem throughout the winter. The browse rating for willow is good to fair for sheep and goats; good to poor for cattle; fair for deer; and fair to useless for horses (Sampson et al. 1981).

Livestock: Riparian ecosystems offer water, shade, and food for domestic livestock. Cattle and sheep congregate in riparian areas, particularly during hot or dry periods. Overgrazing of domestic livestock in riparian areas destroys riparian ground cover, disrupts the reproductive cycle of cottonwood trees, destabilizes streambanks, and thus increases sediment loads to streams.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description
General: Willow Family (Salicaceae). *Salix exigua*, with its long, thin leaves, is the most distinctive of the willow species. The leaves have a very short petiole, and mature blades are 50 - 124 mm long, linear, with an acuminate leaf tip and either a serrate or entire leaf edge. Coyote willow is a shrub < 7 m tall, and spreads clonally by root-sprouting. The catkin inflorescence appears with or after the leaves in the spring, and are 22-70 mm long on leafy shoots 5-110 mm long. The flower bracts are a tawny yellow color.

Distribution
For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site. *Salix exigua* is distributed in wetlands, along alluvial bottomlands and streamsides at elevations lower than 2700 m. Coyote willow is distributed throughout California north to Alaska, east across North America, and south to Arizona and Mexico (Hickman (1993). Mason (1957) says *Salix exigua* is often found at sites of former Indian habitation, and notes this was one of the common basket willows of the Indians

Establishment
Adaptation: Coyote willow dominates the riparian forests of lower terrace deposits and stabilized gravel bars. Willows are found near water; they require a bare gravel or sand substrate with adequate moisture for germination and development. Willows grow very rapidly when their roots are in contact with the permanent water table.

Typically, in California, cottonwoods and willows predominate on the immediate stream banks, whereas valley oaks are spread irregularly over the natural levees farther away from stream banks. In other parts of the American west, temporal gradients occur within a location in the riparian zone. Early pioneer communities such as cottonwood/willow give way to late successional communities such as mesquite or sagebrush, often a consequence of sediment accumulation (Patten 1998). Many similarities among western riparian ecosystems exist because several dominant genera (e.g. *Populus* and *Salix* spp.) are common throughout the West, and many geomorphic and hydrologic processes that influence riparian establishment are similar.

Western riparian ecosystems have been greatly altered by human activity. Riparian forests have been reduced to fragmented, discontinuous patches because of human intervention. For example, estimates are that 70 - 90 percent of the natural riparian ecosystems in the U.S. have been lost to human activities (Warner 1979). Regional losses in these ecosystems have been estimated to exceed 98% in the Sacramento Valley in California (Smith 1977) and 95% in Arizona (Warner 1979). Many factors have contributed to these resource losses, including the following: natural resource use; urbanization; alteration of stream flows through dam construction and ground-water withdrawal; modification of biotic conditions through grazing, agriculture, and introduction of non-native species; and alteration within watersheds (Patten 1998).

Coyote willow roots freely from cuttings, and is an easy species to propagate. Coyote willow is a shrub 3 to 15 feet in height with multiple branches and deciduous leaves. Its architecture is resilient to disturbance such as high velocity floodwaters, sediment deposition, medium to high flooding (anoxic conditions), high winds, heavy precipitation, or pruning from beaver, deer or wildlife. Beaver browsed more than 5,000 willow cuttings to ground level in New Mexico, and all the willow resprouted (Los Lunas Plant Materials Center 1998). These cutting also survived over two months of continuous inundation.

The NRCS Plant Materials Center at Los Lunas in cooperation with the U.S. Fish and Wildlife Service developed a pole planting technique for establishing willow and cottonwood (USDA, NRCS). We reprint this procedure below.

- "Trial planting on well adapted sites indicate more that 80% survival of cottonwood and willow poles when dormant poles are cut and planted between November and February.
- It is essential to monitor the water tables at proposed planting sites for at least one year before planting. Poles planted where the water table fluctuates widely will have lower survival rates than those planted where water table is relatively stable. If groundwater monitoring shows the water level will drop more than 3 feet during the growing season (May-October), another site should be selected. Monitoring of observation wells for at least one calendar year before planting will allow better planting depth to ensure establishment.
- Salt cedar (*Tamarix chinensis*), Russian olive (*Eleagnus angustifolia*), and giant reed (*Arundo donax*) will need to be controlled before poles are planted. However, young cottonwoods and willows can grow successfully in quite small openings in stands of salt cedar. Study of natural stands suggest they will eventually shade out the salt cedar."

Steps for Successful Pole Plantings:

- Select sites as close to the area as possible to conserve genetic diversity. Try to match donor site and revegetation site in terms of soils, elevation, hydro-dynamics, permanent groundwater table, and soil salinity (which should be low).
- Select willow cuttings from a local, native stand in healthy condition. Prune no more than 2/3 of plants in an area. Willow cuttings for pole plantings should generally be at least 1/2 inch in diameter or larger. Select the longest, straightest poles available. Use only two to four-year old wood. The total length of the poles needed depends upon the water table depth (see #7 below).
- Measure water table fluctuations for at least 1 year, preferably longer, to determine the lowest water table depth. Take a reading at least once a month, preferably more often during the driest months of the year.
- Cut poles while dormant during January and February. Remove all side branches except the top two or three.
- Prepare cuttings by trimming off the top to remove the terminal bud, allowing a majority of the energy in the stem to be sent to the lateral buds for root and shot development.
- Soak poles in water for at least 5 to 7 days before planting.
- Dig holes to the depth of the lowest anticipated water table. Sites where the water table will be within one foot of the ground surface during the growing season are better suited for willows than cottonwoods.
- The cuttings should extend several inches into the permanent water table to ensure adequate moisture for sprouting. At least 1/2 to 2/3 of the cutting should be below ground to prevent the cutting from being ripped out during high water flows. Usually, at least 2 to 3 feet should be below ground. It should also be long enough to emerge above adjacent vegetation such that it will not be shaded out.
- Place cuttings in the hole the same day they are removed from the soak treatment. Set the butt as close to the lowest annual water table elevation as possible.
- Electric hammer drills (Dewalt model DW530) fitted with one-inch diameter, 3-foot bits were used to plant thousands of coyote willows in New Mexico. With one drill, two people installed 500 willow per day to a 3-foot depth. A power auger or a punch bar can also be used.
- Coyote willow pole cuttings were generally planted on 10 to 20 foot centers in New Mexico. Areas with a shallow water table (4-6 feet) were generally planted with a higher number of pole cuttings to enhance overall survival of the project; in this case, coyote willow was planted on 1-foot centers or even closer. Often understory species were planted under the canopy of pre-existing overstory (cottonwoods, tree willows) since they are often observed occupying this niche.
- It is critical to ensure the soil is packed around the cutting to prevent air pockets. "Mudding" (filling the hole with water and then adding soil to make a mud slurry) can remove air pockets.
- When necessary, install tree guards around the poles to protect from beavers, other rodents, or rabbits. Coyote willows tend to be fairly resistant to pruning from beavers, so tree guards may not be necessary.
- As buds begin to swell (usually in April or May), wipe them off the lower two-thirds of the pole. This will reduce evapotranspiration water loss and stimulate root growth.

- Exclude the planting area from livestock grazing for at least two to three growing seasons.

There are other techniques for stabilization of banks and erosion control, called bioengineering, which utilize coyote willows. These include brush layers, brush mattresses, brush or tree revetments, brush trenches, vertical bundles, and willow wattles. Often fiberschine, erosion control fabric and hay bales are utilized to stabilize an eroding site. For further information on these techniques, refer to *The Practical Streambank Bioengineering Guide* by USDA, Natural Resources Conservation Service (Bentrup and Hoag 1998).

Establishment From Seed: Willow seeds must be collected as soon as the capsules mature (when they turn from green to yellow) and planted immediately since they retain their viability for only a few days at room temperature. Even under the most favorable conditions, maximum storage is four to six weeks. No dormancy occurs, so germination takes place 12 to 14 hours after planting if the seeds are kept constantly moist willows are difficult to propagate in quantity by seed.

Willows root so readily by either stem or root cuttings that there is little need to use other methods. Hardwood cuttings planted in early spring root promptly.

For natural seed revegetation, coyote willow requires moist soil from spring over-bank flows or capillary wetting of the soil surface for establishment. A number of studies have related components of the reproductive cycle of *Salix* species to floodplain site conditions produced by streamflow and associated fluvial processes. In particular, components of the annual pattern of streamflow, or annual hydrograph, are associated with specific stages of *Salix* seedling emergence and growth. These include the following: 1) flood flows that precede *Salix* seed dispersal produce suitable germination sites; 2) flow recessions following a peak expose germination sites and promote seedling root elongation; and 3) base flows supply soil moisture to meet summer and winter seedling water demand (Shafroth et al. 1998; Mahoney et al. 1998). The combination of root growth and capillary fringe defines the successful recruitment band for seedling establishment, which is usually from about 0.6 to 2 m in elevation above the late summer stream stage (Mahoney et al. 1998). The rate of stream stage decline is also critical for seedling survival and should not exceed 2.5 cm per day.

Management

Traditional Resource Management: Willow is nature's healer. Poles of willow readily sprout, and help to stabilize stream banks and provide habitat. Sweat lodges constructed of willow have been known to sprout and grow, even though the willows were subjected to very high heat.

Willows were traditionally tended by pruning, to produce long straight stems. Willow is gathered only at certain times of the year, beginning in the autumn after the leaves fall. For many weavers, gathering will continue until the following spring when the sap begins to rise again. Some gatherers, once they find a good stand, will cut as much as they can. The willows in many areas have not been tended in a long time, and the stems are old, woody, and twisted. Often basket weavers will prune many willows, sometimes replanting the stems, so there will be nice straight basketry materials the following year.

The Chemehuevi gather shoots, which they have burned several times, until only the living stumps of the willow, remain (Collings 1979). Straight young shoots grow from these stumps in profusion. Each twig is carefully selected. Those finally selected are at least fifteen inches long and between 1/8 and 3/16 of an inch in diameter with as little taper from end to end as possible.

Before gathering, the weavers I have interviewed make offerings of thanks and pray for permission to gather (Stevens, unpublished field notes, 1998). Often tobacco or other offerings are given before beginning to gather.

Basket weavers process materials with their hands and mouths. Herbicides sprayed on willows and along streams have a much higher health risk for humans when they are used for traditional materials. A Washoe basket weaver says, "Sometimes when you take the willows' skins off, they have spots from pesticides." Another weaver says the plants then grow deformed; the shoots don't grow straight and the willows are bumpy and wormy inside (Fulkerson 1995).

Howe and Knopf (1991) conclude that to ensure the survival of willows and cottonwoods in riparian communities, resource managers need to implement strategies to control the spread of exotic species.

Livestock grazing has widely been identified as a leading factor causing or contributing to degradation of riparian habitats in the western United States (U.S. General Accounting Office 1988; Chaney et al. 1990,

Fleischner 1994, Ohmart 1996). Livestock grazing can alter vegetative structure and composition of riparian habitat. Overgrazing, especially by livestock and big game, frequently changes plant species composition and growth form, density of stands, vigor, seed production of plants, and insect production. Livestock grazing can cause the replacement of bird and mammal species requiring the vertical vegetation structure of riparian habitat to species, which are ubiquitous in their habitat preferences.

Slovlin (1984) recommended a 5-year rest from cattle grazing to re-establish healthy stands of riparian vegetation, such as cottonwood and willows. Siekert et al. (1985) reported that spring grazing showed no significant changes in channel morphology, whereas summer and fall grazing did. However, even with limited seasonal grazing, all tree seedlings would be eliminated. Marlow and Pogacnik (1985) recommended fencing riparian habitat, rest-rotation, light grazing (<20% forage removal), and grazing after streambanks have dried to 10% moisture.

Cultivars, Improved and Selected Materials (and area of origin)

Please check the Vendor Database, expected to be on-line through the PLANTS Web site in 2001 by clicking on Plant Materials. Containerized coyote willow saplings are available from most nurseries in the areas where adapted. We recommend using plants from the same region, elevation, climate, soil type, moisture or hydrologic regime as you are replanting.

Coyote willow poles, suitable for transplanting, are available from the NRCS Plant Materials Center at Los Lunas, New Mexico and Tucson, Arizona. The Plant Materials Centers vegetatively propagate these poles from parent stock. Each center maintains parent stock of several ecotypes collected from the center's NRCS service area. These ecotype collections vary in the amount of genetic diversity within ecotypes. These centers can supply poles to NRCS Field and State Offices, and other public agencies.

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Plant Guide

NARROWLEAF COTTONWOOD

Populus angustifolia James

Plant Symbol = POAN3

Contributed by: USDA NRCS National Plant Data Center & the Biota of North America Program

@ PLANTS

Alternate common names

Bitter cottonwood, willow cottonwood, willow-leaf cottonwood, mountain cottonwood, Rydberg cottonwood, smooth-bark cottonwood

Uses

Industry: Wood of narrow-leaf cottonwood is susceptible to decay and warps when cut into lumber. Because of this and its relative scarcity, it is commercially unimportant – used mostly for fenceposts and fuel, less commonly for crating, boxes, pallets, plywood veneer, and pulpwood; wood shavings are used for bedding, insulation, and animal food supplements.

Wildlife: Narrow-leaf cottonwood provides habitat, cover, and food for a diversity of wildlife. Common residents include squirrels, aquatic fur bearers, bears, white-tailed deer, and many bird species. Twigs and leaves are browsed by rabbits, deer, and moose and buds and catkins are eaten by quail and grouse. Beaver cut all sizes of cottonwoods to build and maintain lodges and dams and use the bark for immediate food or storage in winter caches.

Conservation: Narrow-leaf cottonwood is planted as a fast-growing ornamental tree in western US cities. These trees can be used at high elevations and are useful in landscaping on deer winter ranges since deer will not damage them through overbrowsing. The species was early encountered (in1805) by the Lewis and Clark expedition, who observed that horses would not eat it.

The aggressively spreading root system of narrow-leaf cottonwood makes it useful for soil stabilization in erosion control and streambank reclamation projects. This same feature, however, may be a liability in urban areas where the roots may clog drains and sewers.

Ethnobotanic: Native Americans used young cottonwood shoots to make baskets.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description

General: Willow Family (Salicaceae). Native trees up to 15-20 m tall, single-stemmed with slender, upright branches forming a narrowly spreading crown. The bark is yellowish green to grayish brown, smooth on upper portions and furrowed into broad, flat ridges on older lower portions. Leaves are deciduous, simple, alternate, lanceolate to ovate-lanceolate, rounded at base, 5-9(-13) cm long, 1-2.5 cm wide, hairless or nearly so, the margins glandular-toothed, dark green above and slightly paler beneath, turning dull yellow in autumn, the petioles less than 15 mm long, about 1/3 as long as the blade, flattened only near the base. Flowers male (staminate) and female (pistillate), are on separate trees (the species dioecious). Each type is borne in pendent catkins, the female elongating to 6-8 cm long. Fruits are ovoid,

pointed capsules 6-8 mm long, splitting to release the seeds; seeds 2-3 mm long, each with a tuft of long, white, silky hairs ("cotton"), easily blown by the wind. The common name is in reference to the slender leaves.

Variation within the species: No variants have been recognized within the species, but natural hybrids are frequent between narrow-leaf cottonwood and other species:

balsam poplar (*P. balsamifera*) = *P.* x *brayshawii* Boivin (Brayshaw's poplar);

eastern cottonwood (*P. deltoides*) = *P.* x *acuminata* Rydb. (lanceleaf poplar);

Fremont cottonwood (*P. fremontii*) = *P.* x *hinckleyana* Correll.

Distribution
Narrow-leaf cottonwood occurs primarily in mountainous areas from southern Alberta and Saskatchewan south to Oregon and California (east of the Sierra Nevada), Arizona, New Mexico, and Trans-Pecos Texas and in northern Mexico (northeastern Sonora). For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Adaptation
Narrow-leaf cottonwood grows along streambanks in dry mountains, desert shrublands, and prairie grasslands and in coniferous forests with willows and alders, at elevations of 900-2450 meters. It is commonly found on narrow, periodically flooded benches adjacent to streams and smaller rivers. Common associates are Douglas-fir, blue spruce, ponderosa pine, Rocky Mountain juniper, maples, birches, alders, other cottonwoods and aspen; in relatively undisturbed sites, the understory often includes red-osier dogwood, chokecherry, serviceberry, willows, and currants.

Narrow-leaf cottonwood is a pioneer that colonizes sandbars and other fresh alluvium in areas of full sun. Such sites tend to become dominated by a dense, closed canopy of cottonwood. Continual disturbances such as flood and fire allow such communities to persist.

This species flowers in May, before or during leaf emergence and fruits May-July, with seed dispersal in June-July.

Establishment
Flowering begins at about 15 years in narrow-leaf cottonwood. Male and female trees must be grown in proximity if seed is desired. Large seed crops are produced each year but seeds are viable for probably no more than 3 weeks. They establish only if they land on unoccupied, wet, sandy soil in full sun. Flood disturbance along waterways enhances seedling recruitment, and periodic fires may serve the same purpose – removing competing conifers, allowing more light penetration, and exposing mineral soil. Narrow-leaf cottonwood is a fast-growig but short-lived species in natural conditions.

Narrow-leaf cottonwood reproduces vegetatively by sprouting from roots and stumps.

Management
Because of its short period of viability, seed needs to be sown within a few days of ripening in the spring. Otherwise they may be kept viable by drying and storing cold in an airtight container. In a cold frame, sow on the surface or lightly cover the seeds. Plant into permanent positions either in late summer or the following spring, depending on growth of the young plants.

Cuttings of twigs 20–45 cm long and 1-3 cm diameter of the current season's growth, taken during the dormant season, can be placed in a sheltered outdoor bed or directly into permanent positions. Initial growth of un-rooted cuttings may not be as rapid as that of rooted cuttings. Cuttings grown in a mist-propagator also root easily and survive potting. Nursery- or container-grown seedlings and rooted cuttings establish easily and grow rapidly on moist well-drained soils in full sun. Growth may be minimal on wet soils and upland sites.

Beaver activities may inhibit cottonwood regeneration; seedlings and saplings are stripped of bark for food and larger trees are cut for building material. Poorly oxygenated water in stagnant ponds causes a decline in health. Severe grazing by livestock, and associated trampling of seedlings, reduces cottonwood regeneration potential.

The aggressive root systems can invade and damage drainage systems and also may heavily draw available moisture from gardens and building foundations, especially in clay soil. Root suckers also may be considered a maintenance problem, and the profuse production of cottony seed from female plants can be a minor nuisance.

Narrow-leaf cottonwood will produce stump sprouts and root suckers after light to moderate intensity fires. Seedlings, saplings, and young trees are damaged or killed by fire, but they develop more fire-resistant bark after 15-20 years of age. Older trees may be killed by even relatively cool fires, which wound trees and open the way to heartwood decay. Where spruce is climax, periodic fire may contribute to the maintenance of cottonwood stands, but mature bottomland hardwood stands will not persist in the face of fire.

Cultivars, Improved and Selected Materials (and area of origin)

Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under "United States Government." The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

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Plant Guide

FREMONT'S COTTONWOOD

Populus fremontii S. Wats.

Plant Symbol = POFR2

Contributed by: USDA NRCS National Plant Data Center & New Mexico Plant Materials Center

Charles Webber

Alternate Names
Poplar, Alamo cottonwood

Uses
Ethnobotanic: The sweet and starchy sap can be consumed raw or cooked. The bark is bitter, but edible. It can be scraped off and eaten, cooked in strips like soup noodles, or dried and powdered as a flour substitute. The inner bark of cottonwoods and aspens were used for man and horse in hard times. Some Indians preferred it because of its sweetness.

The active biochemical constituents are salicin and populin, the precursors of aspirin that are useful wherever a fever needs reducing or an anti-inflammatory is appropriate (Moore 1979). The bark is the most effective part for tea but is rather bitter; for this reason the leaves are often preferred. Leaf buds make an excellent ointment for burns and skin irritations. A wash of the bark is applied externally for cuts, bruises, abrasions, burns and fetid perspiration, as well as healing chafing sores on horses. A poultice can be used for sprains, muscle pain, and swollen joints. A salve can be made that cleanses and conditions the skin when used regularly. Taken internally, it is an anti-inflammatory agent, reduces fever, indigestion, aids coughs from colds, expels worms and intestinal parasites, is effective against scurvy, heart troubles, back pain, excessive menses, urinary tract infections, is a diuretic, and is used to prevent premature birth.

The Hopi Indians of Arizona consider the cottonwood tree sacred and carve Kachina dolls from the roots of the tree. They believe the rustle of the wind through the quaking leaves to be the gods speaking to people (Strike 1994).

Several California tribes used *Populus* roots to make loosely twined baskets. The Hupa, from Northern California, use cottonwood roots to begin making twined baskets. The Maidu and Yokuts Indians use cottonwood twigs in their basketry (Strike 1994).

Chumash skirts were made of fibers of *Populus* inner bark. Cordage, made from the inner bark of cottonwood or milkweed, held the rest of the fibers hanging freely. Sometimes small teardrop-shaped pieces of asphaltum, shell beads or Pinus seeds were used as weights to make the fibers hang properly. Wintun also used *Populus* fibers for skirts and for padding baby cradles.

Other Uses: Ecological diversity, bank and sediment stabilization, maintenance of channel morphology, water quality improvement, ground-water recharge, flood abatement, fish and wildlife habitat.

Riparian Ecosystem Services and Functions: The riparian zone essentially encompasses those alluvial sediment deposits where river and alluvial ground water supplement that available from local precipitation. High-to-low elevations, north-south and east-west gradients, and steep-to-shallow terrain all influence the relationship between geomorphic and fluvial processes and vegetation community

structure. Riparian ecosystem functions include the following:

- Ecological diversity.
- Riparian vegetation stabilizes sediment, thus preventing excessive soil erosion.
- Water quality is improved through filtration and trapping of sediment, nutrients and pollutants.
- Riparian vegetation tends to prevent the river from down-cutting or cutting a straight path (channeling), thus promoting a sinuous course, ground-water recharge, and maintenance of an elevated water table.
- Structurally complex riparian vegetation communities provide many different habitats and support a diverse array of animal species. Different groups of animals occupy or use the different layers of vegetation, and this multi-story arrangement is often present nowhere else in the arid landscapes.
- Canopies of plants growing on streambanks provide shade, cooling stream water, while roots stabilize and create overhanging banks, providing habitat for fish and other aquatic organisms

Riparian habitat provides living conditions for a greater variety of wildlife than any other habitat type found in California. Use of riparian areas by wildlife species is affected by diversity and volume of foliage, presence of water, availability of "edge" habitat, and high levels of insect populations. Valley-foothill riparian habitats provide food, water migration and dispersal corridors, and escape, nesting and thermal cover for an abundance of wildlife. About 25 percent of the 502 California native land mammal species and subspecies are largely dependent on riparian ecosystems. Additionally, 55 species of mammals are known to use California's Central Valley riparian communities (Trapp et al. 1985). At least 21 mammal species or subspecies have been identified as being particularly vulnerable to loss of riparian habitat (Williams and Kilburn 1984). At least 50 amphibians and reptiles occur in lowland riparian systems (Brode and Bury 1985).

Wildlife: California's riparian forests support a high diversity of breeding birds (Miller 1951). In one study conducted on the Sacramento River, 147 bird species were recorded as nesters or winter visitants (Laymon 1985). The percentage of breeding individuals, which are migratory, is very high in the cottonwood-willow habitat. Humid conditions in the cottonwood-willow forest may promote more lush plant growth, higher invertebrate populations and; therefore, more available food for flycatchers, warblers and other migratory, insectivorous birds. Riparian areas support up to 10.6 times the density of migrant birds per hectare as adjacent non-riparian areas (Stevens et al. 1977). Most of these migratory birds belong to the foliage insect (47%) or air insect (34%) foraging guilds.

Grouse, quail, and other birds eat cottonwood buds and catkins (Martin et al. 1951). Bark, twigs, and leaves are eaten by ungulates and rabbits, while beavers and porcupines relish the bark and wood.

Since European settlement, the nesting riparian forest avifauna has changed significantly. Double-crested cormorants, great blue heron, great egret, Cooper's hawk, bald eagle, yellow-billed cuckoo, willow flycatcher, bell's vireo, warbling vireo, yellow warbler, and common yellow throat have been severely negatively impacted. Parasitism by brown-headed cowbirds has significantly negatively impacted willow flycatcher, Bell's vireo, warbling vireo, yellow warbler and common yellow throat. They burden other species with the task of incubating their eggs and raising their young.

Fremont's cottonwood is one of several species which constitutes the majority of the diet of beavers (*Castor canadensis*) (Stromberg 1993). Beavers, once a dominant aquatic mammal in riparian systems, have been significantly reduced in many riparian areas through trapping, shooting, in-stream flow reductions, and other factors.

Recreation: Recreational use of the riparian zone is many times that of other habitats. People are drawn to the cool, shady environment along flowing streams for camping, picnicking, hiking, birding, photography, hunting, and fishing. These areas contain water, interesting plants and animals, shade, and numerous other enjoyable features in the otherwise arid and semiarid environments.

The impact of recreational use on wildlife varies with the season and with the type, intensity and duration of use. Construction of trails, picnic tables, and docks encourages recreational use and increases conflict with wildlife. Recreational use may also reduce water quality because of proliferation of human wastes.

Livestock: Riparian ecosystems offer water, shade, and food for domestic livestock. Cattle and sheep congregate in riparian areas, particularly during hot or dry periods. Overgrazing of domestic livestock in riparian areas destroys riparian ground cover, disrupts the reproductive cycle of cottonwood trees, destabilizes streambanks, and thus increases sediment

loads to streams. At periods in the year when the soil is not too wet, the leafage, twigs and shoots of Fremont cottonwood are browsed by all domestic grazing animals and deer. The twigs are cropped especially close by sheep, goats, and deer. The browse rating for cottonwood is good to fair for goats; fair to poor for sheep and deer; poor for cattle; and useless for horses (Sampson et al. 1981).

Restoration Concerns: Many land uses in arid watersheds significantly decrease or destroy cottonwood riparian forests. Timber harvest often adversely affects flood flows, which often become larger and flashier and carry increased sediment. Buffer strips can help reduce sedimentation rates and flood velocities.

Stream diversion for irrigation may reduce surface flows to a level insufficient to maintain cottonwood vegetation. Ground water pumping lowers local and regional water tables and reduces stream flow, which can eliminate or weaken riparian vegetation.

Runoff from hardened urban watersheds is immediate and intense, and sometimes actually lowers nearby riparian water tables as it causes rapid erosion and down-cutting in stream channels.

Two introduced weedy riparian species that continue to be recommended and distributed by commercial plant nurseries are Russian olive (*Eleagnus angustifolia*) and tamarisk or salt cedar (*Tamarix chinensis*). Intensive or poorly timed livestock grazing and dam-induced changes in flood timing and magnitude often favor the survival of these introduced species and allow them to displace native species. These species are very difficult to remove from human-impacted landscapes and are more competitive than cottonwood.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description
Willow Family (Salicaceae). Fremont's cottonwood is a native tree growing in riparian areas near streams, rivers and wetlands in the American Southwest. Fremont's cottonwood trees range from 12 to 35 meters in height, and trunk diameter ranges from 0.30 to 1.5 meters. The bark is smooth in younger trees, becoming deeply furrowed with whitish cracked bark with age. The leaves are cordate (heart-shaped) with white veins and coarse crenate-serrate teeth on the margins. The leaves have petioles 1/2 to equal the blade length, laterally compressed near the blade which causes the leaves to flutter in the wind. These trees are dioecious, with flowers in drooping catkins, which are 4 to 14 cm long. Cottonwoods bloom from March-April. The fruit is an achene, which is attached to a silky hair, en masse looking like patches of cotton hanging from the limbs, thus the name cottonwood. The seeds are wind dispersed.

Distribution
For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site. *Populus fremontii is* distributed throughout the Southwest, extending from California eastward to Nevada, Colorado, Arizona, Texas, New Mexico, and southward into Mexico. This species occurs throughout California and is most abundant in the San Joaquin and Sacramento Valleys. According to Hickman (1993), cottonwood occurs in alluvial bottomlands and streamsides at elevations less than 2000 m.

Establishment
Adaptation: Cottonwoods dominate the riparian forests of lower terrace deposits and stabilized gravel bars. Cottonwoods are found near water. They require a bare gravel or sand substrate with adequate moisture for germination and development. Cottonwoods grow very rapidly when their roots are in contact with the permanent water table; they can grow as much as 12 to 18 feet in 3 years.

In California, common associates are valley oak (*Quercus lobata*), interior live oak (*Quercus wislizenii*), California walnut (*Juglans hindsii*), and California sycamore (*Platanus racemosa*). Box elder (*Acer negundo*), Oregon ash (*Fraxinus latifolia*), alder (*Alnus rhombifolia*), and willow (*Salix gooddingii, S. exigua, S. lasiandra, and S. laevigata*) are particularly prevalent in the subcanopy. Understory species are mostly shrubs, including elderberry (*Sambucus mexicana),* buttonbush (*Cephalanthus occidentalis),* blackberry (*Rubus* spp), and California rose (*Rosa californica*). Lianas such as poison oak (*Rhus diversiloba*) and California grape (*Vitis californica* are) are a dominant feature. Herbaceous vegetation is 1% cover except in openings where tall forbs may occur.

Typically, in California, cottonwoods and willows predominate on the immediate stream banks, whereas valley oaks are spread irregularly over the natural levees farther away from the river. In other parts of the American west, temporal gradients occur within a

location in the riparian zone. Early pioneer communities such as cottonwood/willow give way to late successional communities such as mesquite or sagebrush, often a consequence of sediment accumulation (Patten 1998). Many similarities among western riparian ecosystems exist because several dominant genera (e.g. *Populus* and *Salix* spp.) are common throughout the West, and many geomorphic and hydrologic processes that influence riparian establishment are similar.

Western riparian ecosystems have been greatly altered by human activity. Riparian forests have been reduced to fragmented, discontinuous patches because of human intervention. For example, estimates are that 70 - 90 percent of the natural riparian ecosystems in the U.S. have been lost to human activities (Warner 1979). Regional losses in these ecosystems have been estimated to exceed 98% in the Sacramento Valley in California (Smith 1977) and 95% in Arizona (Warner 1979). Many factors have contributed to these resource losses, including the following: natural resource use; urbanization; alteration of stream flows through dam construction and ground-water withdrawal; modification of biotic conditions through grazing, agriculture, and introduction of non-native species; and alteration within watersheds (Patten 1998).

Restoration: Use of an ecosystem model of riparian restoration has been used to create a functioning and self-sustaining habitat. The long term objective is to create a framework within which natural selective forces can operate to create a self-sustaining, functioning riparian habitat that not only provides habitat for a complete assemblage of riparian species, but which is also capable of long-term regeneration and recovery following natural disturbances (Baird 1989). Careful design, monitoring, and adaptive management are key components to successful restoration. The structure and dynamics of the plant community as well as species composition are designed and monitored, as well as landscape position.

Live Plant Collections: Fremont's cottonwood is a pioneer or colonizing species and a prolific seed producer (Stromberg 1993). Fremont's cottonwood propagates primarily from seed rather than asexually. Cottonwood can also sprout shoots from lateral buds when the apical meristem is prostrated by floodwaters, snapped off in high winds, or pruned by beaver, deer, or other wildlife.

Flooding is the primary disturbance in Fremont's cottonwood forests. Seed germination and tree establishment coincides with flood events. Fremont's cottonwood seed germinates only during spring and early summer. This seasonal restriction is due to: 1) early spring seed dispersal; 2) short periods (1 to 5 weeks) of seed viability; and 3) rapid seed germination (Shafroth et al. 1998). These traits help synchronize germination with high stream flows in spring. Moist soil is necessary for both germination and establishment of Fremont's cottonwood.

During this century most of the major rivers in the West were dammed. The presence of these dams changed riparian habits in ways unfavorable to cottonwood regeneration. In particular, the dams altered the timing and volume of water flowing through riparian areas. The dams reduce floodplain inundation during spring, and spring flooding is necessary for cottonwood regeneration.

Spring over-bank flows or capillary wetting of the soil surface in areas with shallow water tables, moistens the soil which is necessary for Fremont's cottonwood establishment. A number of studies have related components of the reproductive cycle of *Populus* species to floodplain site conditions produced by stream flow and associated fluvial processes. In particular, components of the annual pattern of stream flow, or annual hydrograph, are associated with specific stages of *Populus* seedling emergence and growth. These include the following: 1) flood flows that precede *Populus* seed dispersal produce suitable germination sites; 2) flow recessions following a peak expose germination sites and promote seedling root elongation; and 3) base flows supply soil moisture to meet summer and winter seedling water demand (Shafroth et al. 1998; Mahoney et al. 1998). The combination of root growth and capillary fringe defines the successful recruitment band for seedling establishment, which is usually from about 0.6 to 2 m in elevation above the late summer stream stage (Mahoney et al. 1998). The rate of stream stage decline is also critical for seedling survival and should not exceed 2.5 cm per day .

Cottonwoods grow rapidly and can reach medium/large tree height in about 20 to 25 years. Cottonwood forests could occur as rapidly as 25 - 30 year (Grenfell 1988). Shrubby riparian willow thickets may last 15 to 20 years before being overtopped and shaded out by cottonwoods. Cottonwood or willow tree habitats close to river channels that receive a good silt infusion, without major disruptive flows, tend to be self- perpetuating.

Cottonwood is susceptible to mistletoe. In certain instances cottonwood can be invasive. Its shallow root system can disrupt sidewalks or pavement.

Artificial Establishment: Fremont's cottonwood establishment from seed is difficult and seldom used. Fremont's cottonwood propagation is possible from hardwood, root cuttings and through tissue culture (Pope et al. 1990). Fremont's cottonwood establishment from transplanted containerized saplings is costly and risky unless the saplings are irrigated. The NRCS Los Lunas Plant Materials Center, in cooperation with the U.S. Fish and Wildlife Service, developed a pole planting technique for establishing Fremont's cottonwood (USDA, NRCSa). We reprint this procedure below.

"Trial planting on well adapted sites indicate more that 80% survival of cottonwood and willow poles when dormant poles are cut and planted between November and February.

It is essential to monitor the water tables at proposed planting sites for at least one year before planting. Poles planted where the water table fluctuates widely will have lower survival rates than those planted where water table is relatively stable. If groundwater monitoring shows the water level will drop more than 3 feet during the growing season (May-October), another site should be selected. Monitoring of observation wells for at least one calendar year before planting will allow better planting depth to ensure establishment.

Salt cedar (*Tamarix chinensis*) and *Arundo donax* will need to be controlled before poles are planted. However, young cottonwoods and willows can grow successfully in quite small openings in stands of salt cedar. Study of natural stands suggest they will eventually shade out the salt cedar."

In six riparian restoration projects carried out in California, competition from exotic weed species was a key factor in mortality and site failure (Baird 1989). With the addition of water, weeds grew so vigorously that plants smaller than a 5-gallon pot was out-competed. One way to avoid this was to remove the surface soil, although this has the disadvantage of removing nutrients, mycorrhizal fungi, bacteria, and insect and invertebrate populations critical to a healthy habitat. They also used a cover crop of native wildflowers, hand-broadcast over the site to aid in weed control. On wetter, heavier soils this does not seem to provide effective weed control.

There is considerable evidence that fertilizing a restoration site in southern California favors exotic weeds over native plants (Grime and Hunt 1975; Grime 1978; t. John 1987 and 1988). Inoculation with mycorrhizal fungi enabled seedlings of some species to better utilize limited supplies of both water and nutrients. Baird (1989) achieved inoculation through large (1.2 m deep by 2.8 m wide) root balls of mature trees brought in from riparian sites. Smaller, more economical soil plugs scattered throughout the site serve the same purpose. The number of soil plugs needed to ensure the establishment of soil flora is directly related to the distance of the restoration site from a similar, mature community.

Management

Howe and Knopf (1991) conclude that to ensure the survival of cottonwood riparian communities along the Rio Grande, resource managers need to implement strategies to enhance cottonwood regeneration and survival, and control the spread of exotic species.

Decadent age structures in cottonwood forest consist of stands composed of large old trees but few saplings or small trees. Several studies have implicated unregulated livestock grazing as an important cause of decadent age structures in cottonwood forests (Brotherson et al. 1983; Fenner et al. 1984; Rucks 1984; Shanfield 1984). Glinski (1977) showed a negative correlation between grazing levels and Fremont's cottonwood recruitment. Several studies showed fewer cottonwood seedlings in grazed than in non-grazed areas (Crouch 1979; Reichenbacher 1984).

Livestock grazing has widely been identified as a leading factor causing or contributing to degradation of riparian habitats in the western United States (U.S. General Accounting Office 1988; Chaney et al. 1990, Fleischner 1994, Ohmart 1996). Livestock grazing can alter vegetative structure and composition of riparian habitat. Overgrazing, especially by livestock and big game, frequently changes plant species composition and growth form, density of stands, vigor, seed production of plants, and insect production. Bull and Slovlin (1982) attributed to livestock grazing the paucity of deciduous woody vegetation that was required by some bird species along Oregon streams.

Schulz and Leininger (1991) found that bird species are differentially affected by cattle grazing in riparian areas. Livestock grazing causes the replacement of bird and mammal species requiring the vertical

vegetation structure of riparian habitat to species, which are ubiquitous in their habitat preferences. Previous heavy cattle grazing changed the bird and small mammal community composition through reduction of shrub and herbaceous cover.

Riparian zones can be managed for non-game species richness by maintaining high structural diversity of vegetation. Species that are sensitive to grazing pressure should be monitored as indicators of habitat change. Johnson (1985) pointed out the need to coordinate range and wildlife habitat management to ensure the existence of sensitive wildlife species that are negatively impacted by livestock grazing. Woody plant species increase rapidly when riparian areas are protected from livestock grazing. The woody structural component of the vegetation is essential for wildlife species that are obligate inhabitants of riparian habitat, and in providing hiding cover and stabilizing streambanks for fish habitat.

Slovlin (1984) recommended a 5-year rest from cattle grazing to re-establish healthy stands of riparian vegetation such as cottonwood and willows. Siekert et al. (1985) reported that spring grazing showed no significant changes in channel morphology, whereas summer and fall grazing did. However, even with limited seasonal grazing, all tree seedling would be eliminated. Marlow and Pogacnik (1985) recommended fencing riparian habitat, rest-rotation, light grazing (<20% forage removal), and grazing after streambanks have dried to 10% moisture.

Cultivars, Improved and Selected Materials (and area of origin)

Containerized Fremont's cottonwood samplings are available from most nurseries in the areas where adapted. We recommend using plants from the same region, elevation, climate, soil type, moisture or hydrologic regime as you are replanting.

Contact your local Natural Resources Conservation Service (formerly Soil Conservation Service) office for more information. Look in the phone book under "United States Government." The Natural Resources Conservation Service will be listed under the subheading "Department of Agriculture."

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For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

GREEN ASH

Fraxinus pennsylvanica Marsh.

Plant Symbol = FRPE

Contributed by: USDA NRCS East Texas Plant Materials Center

Robert H. Mohlenbrock @ USDA-NRCS PLANTS Database/USDA SCS. 1989. Midwest wetland flora Field office illustrated guide to plant species. Midwest National Technical Center, Lincoln.

Alternate Names

Alternate names include: red ash, swamp ash, or water ash (Kennedy, 1990).

Uses

Livestock: Green ash stems are browsed by livestock (Johnson, 1971). Cattle utilize green ash habitats for shade, water, protection, and shelter during calving season (Gucker, 2005).

Wildlife: Green ash seeds, stems, and foliage provide cover and food for several small animal species including rabbit. Both game and nongame bird species use this habitat for food, nesting sites and roosts (Gucker, 2005). Black birds, finches, grosbeaks, and cardinal feed on ash fruits (Twedt and Best, 2004). In a study by Hopkins (2004), the Coopers hawk and mountain bluebird nested only in green ash woods.

Residential: Green ash is popular as a shade tree in residential areas because of its good form and adaptability to a wide range of sites.

Windbreak: Green ash is used frequently in windbreaks and shelterbelt plantings. It is recommended to plant the tree in the central rows of multi-row windbreaks (Dickerson, 2002).

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g., threatened or endangered species, state noxious status, and wetland indicator values).

Description

General: Green ash is a native spreading, round topped tree which grows to a height of 70 feet or more. The deciduous leaves are pinnately compound, 8 to 12 inches long, with 5 to 9 leaflets. The leaflets are oblong, lustrous green on both sides or somewhat paler beneath. The twigs are pale gray along with brown bark. The fruit (samara), usually containing one seed, is light colored, 1 to 2 inches long and ¼ to 1/3 inch wide with a wing (Vines, 1960).

Distribution: For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Habitat: Green ash is found in areas with 15 to 60 inches of yearly precipitation. It is found growing naturally in bottomlands subject to frequent flooding or overflow (Stewart and Krajicek, 1973). Green ash is moderately tolerant to shade. Some woody species associated with green ash include box elder (*Acer negunda*), red maple (*A. rubrum*), pecan (*Carya illinoensis*), eastern cottonwood (*Populus deltoides*), black willow (*Salix nigra*), and American elm (*Ulmus americana*) (Kennedy, 1990).

Adaptation

Green ash grows on clay to sandy or silt soils (Stewart and Krajicek, 1973). It will also perform well when planted on neutral to alkaline medium to coarse textured upland sands and loams with good moisture (Kennedy, 1990). The species has a wide range of adaptation from eastern Montana, Great Plains, and eastern half of the United States (Vines, 1960).

Establishment
Soil analysis should be performed prior to planting to determine the necessary levels of nitrogen, phosphorus and potassium. Green ash has shown severe chlorosis when grown on a soil with a pH of 8.1 (Wright, 1965). Tests on a riverfront site in Mississippi have shown that green ash grew well on silt loam soils with pH ranging between 7.5 and 8.0 (Kennedy, 1990). Gilmore and Boggess (1963) noted that hardwoods such as green ash need better quality planting sites than pine (*Pinus* sp.).

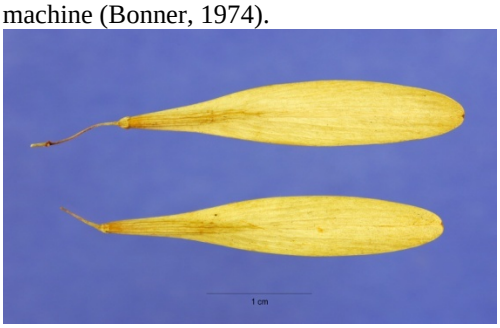
Management
Green ash does not grow as fast as red maple (*Acer rubrum*) or elm; therefore it may be crowded out over time. Control the surrounding vegetative competition to maintain green ash (Dickerson, 2002). If this species is being used in a landscape, prune established trees every three to four years to maintain good form and structure (Colorado State University, 2011)

Pests and Potential Problems
Insects will feed on green ash. Oystershell scale (*Lepidosaphes ulmi*) can cause serious damage to seedlings and small trees in the Northeast. Carpenterworm (*Prionoxystus robiniae*) bores into large branches and trunks, allowing the entrance of fungi. The brown headed ash sawfly (*Tomostethus multicinctus*) and the black headed ash sawfly (*Tethida barda*) also cause damage. The ash borer (*Podesesia syringae*) damages the stems, thereby degrading lumber quality and contributing to decline in shelterbelt plantings (Solomon, 1975 and Wright, 1965).

The emerald ash borer (*Agrilus planipennis*) has been detected in Michigan, Ohio, Pennsylvania and Canada. The beetle is responsible for the loss of millions of ash (*Fraxinus* sp.) trees. The beetle lays eggs between bark layers and crevices. After about one week, larvae hatch and begin to feed on an infected tree's inner bark and phloem. The larvae change to prepupa and overwinter in the tree. The following spring, after pupation, adults emerge from holes they made in the tree. Symptoms include: branch dieback, branching on the tree trunk and vertical bark slits (USFS, 2004).

A fungus (*Mycosphaerella fraxinocola*) creates a leaf spot which may lead to defoliation of young trees. Rust fungal infections can distort petioles and small twigs. Green ash in Texas and Oklahoma has shown susceptibility to *Phymatrotrichum omnivorum* which causes root rot (Wright, 1965). Older trees may be attacked by a fungus, *Polyporus fraxinophilus*, which attacks wood and turns it into a yellow pulp (Vines, 1960).

Seeds and Plant Production
Green ash seeds begin to fall as soon as they ripen in the fall (Wright, 1965). Color can be an indicator of maturity. The samaras don't change color from green to yellow or brown until the embryo is full grown (Bonner, 1974). If picked slightly green, keep the samaras from overheating (Kennedy, 1990). Seed clusters can be collected by hand or with pruners and seed hooks. Another method is to shake the limbs and collect the dried samaras on a sheet beneath the tree. Spread out the samaras for uniform seed drying. After drying, the samara clusters can be broken apart by hand, flailing, or running them through a brush machine (Bonner, 1974).



Green ash samaras. Steve Hurst @USDA-NRCS PLANTS database

Watch for damage to the samaras by the ash seed weevil. The greatest damage has been reported in seed harvested in the northeast and Great Plains, with less amounts in the south (Bonner, 2008). Remove the stems and trash by fanning or air screen cleaners. Cleaned seed of seed lots collected from the Midwest and Great Lakes region averaged 17,260 seeds per pound. In contrast, cleaned seed collected in Arkansas and Mississippi averaged 20,950 seeds per pound (Bonner, 2008).

Dry the seeds down to between 7 and 10 percent moisture for storage. Seeds stored in sealed containers at this moisture level at 41° F kept their viability for seven years in a study by Barton (1945). Some green ash seeds may germinate the following spring, while others may be dormant for several years. Dormancy could be a combination of internal factors and seedcoat effects (Bonner, 2008).

Germination of seeds collected from the northern part of the range includes a two-step process of warm stratification for 16 weeks at 68° F and then cold stratification for 16 weeks at 38° F. A one hour resoak in water should be completed weekly in the warm phase and every 2 weeks in the cold phase. Usually only cold stratification is needed for seed collected in the southern part of the range. Seed dormancy may also be affected by seed age. Older stored seeds appear more dormant than those that are freshly collected (Bonner, 1974).

Seeds may be sown in the fall to stratify in the nursery bed. Sow at approximately 80 to 100 seed/m (25 to 30/ft) of row with a row spacing of 15 to 30 cm (6 to 12 in.) apart. Cover the rows with burlap or greenhouse shade cloth until germination begins. Densities of 110 to 130 seed/m^2 (10 to 12ft^2) are recommended to grow high quality seedlings (Kennedy, 1990). Nursery seedlings normally develop no side branches during the first year of growth. However, by the second year a small number may develop. Some young trees may have a single straight stem until they are 15 ft. (5m) tall (Wright, 1965).

Mature height varies among green ash depending on the location. In the northern part of its range, green ash may reach heights of 50 to 60 feet and breast height diameters of 18 to 24 in. On quality sites in the southern part of its range, trees may grow up to 120 ft. in height and reach a breast height diameter of 24 to 30 in. (Putnam, Furnival, and McKnight, 1960).

Cultivars, Improved, and Selected Materials (and area of origin)

This is not a complete listing of green ash cultivars and releases. Please consult your local nursery for more information concerning releases adapted to your area. 'Patmore' was introduced by the Patmore Nursery, Brandon, Manitoba, Canada. This variety is pyramidal to oval shaped and is a seedless male tree. 'Summit' was introduced by the Summit Nursery, Stillwater, Minnesota. This male variety has an upright, narrow growth habit. 'Marshall's Seedless' has a rounded growth form and less cold hardy than 'Patmore' or 'Summit' (Colorado State University, 2011). Dakota Centennial® Ash (*F. Pennsylvania* 'Wahpeton') is an upright, fast growing male tree introduced by North Dakota State University, Fargo, North Dakota.

'Kindred' is a male tree introduced by the late Ben Gilbertson, Kindred, North Dakota. 'Bergeson' is a patented variety introduced by Bergeson Nursery, Fertile, Minnesota.

'Cardan' is a seed strain cultivar released by the USDA-NRCS Plant Materials Center, Bismarck, North Dakota and USDA Northern Great Plains Research Laboratory, Mandan, North Dakota (North Dakota State University, 1999 and Dir, 1990). 'Oahe' and Prairie Harvest germplasm are releases by the USDA- NRCS Plant Materials Center, Bismarck, North Dakota.

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Natural Resources Conservation Service

Plant Fact Sheet

ROCKY MOUNTAIN JUNIPER

Juniperus scopulorum Sarg.

Plant Symbol = JUSC2

Contributed by: USDA NRCS Plant Materials Program

USDA NRCS Bridger Plant Materials Center
Bridger, MT

Uses

Erosion control: Plant Rocky Mountain juniper in the outer rows of multi-row plantings where it will not be overtopped by taller trees. It can be used in single-row windbreaks when a dense, medium height barrier is desired.

Wildlife: This species provides food and cover for numerous birds and mammals. Winter food and protection is particularly important for pheasant, mule deer, and whitetail deer.

Recreation and Beautification: The year-long coloration and attractiveness to wildlife makes this species useful for recreational plantings. It tends to stay green all winter.

Status

Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description

Juniperus scopulorum Sarg., Rocky Mountain juniper, is a small evergreen tree to 35 feet, often with an irregular crown. A native of western North America, it occurs in mixed or pure stands of open scrub woodland over Wyoming and Colorado at elevations of 5,000 to 7,500 feet, often on dry, rocky ridges. It does well in cultivation, adapted to a wide range of soils and moisture conditions, and is winter hardy, slow growing and very long lived.

Fruits blue with whitish bloom, fleshy "berries" (cones), 1/4 inch in diameter, ripening the second season, seeds 1 to 2 inches each cone, bony-coated; flowers small, cone-like, borne separately on male and female plants; leaves opposite, scalelike, covering older twigs closely in alternating pairs to ¼ inch long, pale to dark green, on new shoots awl shaped, sharp pointed and spreading; stems short, often dividing near ground, branches thick and ascending, bark red to gray-brown, furrowed, thin and shreddy, branchlets very slender; roots deep, widely spreading.

Adaptation and Distribution

Below 7,500 elevation; water relations 10 precipitation equivalent; tolerant of droughty and moist, well-drained sites.

Rocky mountain juniper is distributed throughout the West. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment

Seedling should be planted in a firm weed free bed at a spacing of 3 to 6 feet. Seedling should placed in a hole or furrow large enough to contain the entire root system without bending.

Management

Care should be taken to protect young seedlings from feeding damage by small rodents, rabbits, and deer. Weeds and other competing vegetation must be controlled during the first and second years of establishment.

Pests and Potential Problems

Rocky Mountain juniper is relatively free of serious insect and disease problems. It is the alternate host for the cedar-apple rust disease which does very little harm to this species, but causes serious damage to apples and other pome fruits.

Cultivars, Improved, and Selected Materials (and area of origin)

Bridger-Select (Northern Great Plains composite) was developed as a selected pre-varietal release. Seedlings of Rocky Mountain juniper are available from most commercial nurseries in the Rocky Mountain area.

Prepared By & Species Coordinator:

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Edited: 05Feb2002 JLK; 060801 jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

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Natural Resources Conservation Service

Plant Guide

BOXELDER

Acer negundo L.

Plant Symbol = ACNE2

Contributed By: USDA NRCS National Plant Data Center & the Biota of North America Program

Robert Mohlenbrock
USDA, NRCS, Wetlands Science Institute
@ PLANTS

Alternate common names
Ash-leaf maple, California boxelder, western boxelder, Manitoba maple

Uses
The wood of Boxelder is light, soft and weak, and of low commercial value. It is used for pulp and rough lumber, usually mixed with other bottomland species, and has been used for boxes and crates, low-quality furniture, and interior finishing.

Boxelder produces sap high in sugar content and can be used to produce syrup sometimes called "mountain molasses." Native Americans used the cambium for food, boiled down the sap for syrup and candy, and made a tea from the inner bark to induce vomiting. The new branches were used to make charcoal for ceremonial painting.

The trees are useful for quick growth in naturalized riparian plantings, but they are short-lived and disease-prone. The species was once planted in the U.S. as a street tree and ornamental cultivars have been developed (including forms with red fall color, variously variegated leaves, and without seeds). It is not now commonly planted in the U.S., where its removal is sometimes more of a challenge. The quick growth of this species, however, and its tolerance to urban conditions, allows it to contribute to shade and rapid re-greening in disturbed city sites, particularly in the Great Plains and the West, because of its drought and cold tolerance. Boxelder can be used temporarily until replaced by slower growing but longer lasting trees.

Boxelder was once widely planted in shelterbelts in the Great Plains to reduce wind erosion and dust storms, but these shelterbelts have largely been removed. Its fibrous root system and prolific seeding habit make it valuable for erosion control in some parts of the world. The seeds are important winter food for birds and small mammals, deer browse young plants.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status, and wetland indicator values.

Description
General: Maple Family (Aceraceae): Boxelder is a native tree growing to 20 m tall, with broad rounded crown, usually developing a shallow, fibrous root system; bark light gray-brown with shallow fissures, becoming deeply furrowed; twigs slender, shiny green, usually glabrous but sometimes hairy. The leaves are opposite, 13-20 cm long, pinnately compound with 3(-5 or more) leaflets 5-10 cm long and 3-6 cm wide, long-pointed, coarsely toothed and often shallowly lobed. The flowers are yellow-green, about 5 mm long, the male (staminate) flowers fascicled, the female (pistillate) flowers in drooping racemes; most trees are either male or female (the species is essentially dioecious), but bisexual flowers occur on a few trees (technically polygamo-

dioecious). Fruits are winged nutlets (samaras) in a pair, 2.5-4 cm long, clustered on long stalks. The common name refers to the resemblance of leaves to those of ash (*Fraxinus*). Boxelder, its other often used common name, refers to a resemblance to elder (*Sambucus*) and the use of the soft wood for box making.

Boxelder is unusual among American maples in having compound leaves. Apart from the opposite leaves, seedlings and young saplings of Boxelder bear a remarkable resemblance to poison ivy (*Toxicodendron radicans*) and are often mistaken for it by beginning naturalists.

Variation within the species:
Substantial variation occurs over the range of the species; numerous forms and varieties have been described, but only six varieties currently recognized (in some treatments, for example, see McGregor 1986). These are primarily distinguished by coloration of the branches, twig and fruit pubescence, and leaflet number.

Var. *arizonicum* Sarg. – Arizona and New Mexico
Var. *californicum* (Torr. & Gray) Sarg. – California
Var. *interius* (Britt.) Sarg. – midwest US into the western states
Var. *negundo* – the eastern half of the US, with naturalized western outlyers
Var. *texanum* Pax – south-central US
Var. *violaceum* (Kirchn.) Jaeger – north-central US and most of Canada

Distribution
Boxelder is the most widely distributed of all American maples – its native range extends from the east coast of the U.S. to California, and from Alberta to southern Mexico and Guatemala. The range is relatively continuous in the eastern U.S., but broken into small areas in the West and toward Central America. It has become naturalized in areas far outside of its native range, including Europe. It is not known from northern North America. For current distribution, please consult the Plant Profile page for this species on the PLANTS Web site.

Adaptation
Boxelder is natively a tree of river bottoms and disturbed sites on heavy, wet soils, often seasonally flooded (up to 30 days). It is one of the most common bottomland trees throughout its range, usually following the pioneer species of cottonwood and willow in colonizing alluvial bottoms, then growing with silver and red maples, American elm, American sycamore, and sweetgum. Populations in native habitats have decreased because of clearing of bottomland forest for agriculture, but they have greatly increased in urban areas. Success of the species on disturbed urban sites owes to its prolific seed production and wide dispersal, ease of germination, tolerance of low oxygen conditions, and fast growth on clay or heavy fill. Boxelder also is found as a pioneer species on disturbed upland sites where a seed source is nearby.

Flowering: March-May (with or just before the leaves), fruiting: August-October. The flowers are wind pollinated but also visited by bees.

Establishment
Flowering in Boxelder is in early spring and large quantities of seed are produced each year, beginning on trees 8-11 years old. The seeds ripen in autumn, fall continuously from autumn until spring, and are light, large-winged, and widely wind-dispersed. They over-winter and germinate the following spring. Best germination follows stratification for 60-90 days at 33° F.

Boxelder seeds germinate in shade or full sun but seedlings begin to die off after 1-2 years unless openings are formed. Successful seedbeds vary greatly. Trees are fast growing, producing up to 1-inch diameter annual growth for the first 15-20 years. Early growth is best in full sun but tolerant of partial shade. Young trees commonly produce stump and root sprouts. Average longevity is about 60 years; maximum longevity is rarely more than 100.

Management
Boxelder is tolerant to stressful sites and requires little special care, but it is relatively short-lived and the branches of older trees are susceptible to ice and wind damage. Boxelder is highly sensitive to 2,4-D and also is susceptible to fire and mechanical damage because of its thin bark.

The boxelder bug is a common associate of boxelder throughout most of its range. The nymphs feed mainly on female (pistillate) trees in leaves, fruits, and soft seeds. The trees are not greatly damaged but the insects sometimes invade human habitation in large numbers with the onset of cold weather.

Cultivars, Improved and Selected Materials (and area of origin)
Boxelder is available at most nurseries within it distribution.

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