

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 visitors (Laymon 1985). The percentage of breeding individuals that are migratory is very high in the cottonwood-willow habitat. Moist conditions in the cottonwood-willow forest may promote 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.

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 than 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 shoot 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)

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.

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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