Salix nigra Marsh. Black Willow

Salicaceae Willow family

J. A. Pitcher and J. S. McKnight

Black willow *(Salix nigra)* is the largest and the only commercially important willow of about 90 species native to North America. It is more distinctly a tree throughout its range than any other native willow; 27 species attain tree size in only part of their range *(3)*. Other names sometimes used are swamp willow, Goodding willow, southwestern black willow, Dudley willow, and sauz (Spanish). This short-lived, fast-growing tree reaches its maximum size and development in the lower Mississippi River Valley and bottom lands of the Gulf Coastal Plain *(4)*. Stringent requirements of seed germination and seedling establishment limit black willow to wet soils near water courses *(5)*, especially floodplains, where it often grows in pure stands. Black willow is used for a variety of wooden products and the tree, with its dense root system, is excellent for stabilizing eroding lands.

Habitat

Native Range

Black willow (fig. 1) is found throughout the Eastern United States and adjacent parts of Canada and Mexico. The range extends from southern New Brunswick and central Maine west in Quebec, southern Ontario, and central Michigan to southeastern Minnesota; south and west to the Rio Grande just below its confluence with the Pecos River; and east along the gulf coast, through the Florida panhandle and southern Georgia. Some authorities consider *Salix gooddingii* as a variety of *S. nigra,* which extends the range to the Western United States *(3,9)*.

Climate

The climate in which black willow grows best is characterized by an average rainfall of 1300 mm (51 in). Approximately 500 mm (20 in) of this occurs during the effective growing season, April through August. The average maximum temperature is 34" C (93" F) in the summer and 15" C (59" F) in the winter. In parts of its range, black willow survives extremes of 46" to -50" C (115" to -58" F). Geographic distribution appears to be independent of temperature *(4,7)*.

The authors are Director, Hardwood Research Council, Memphis, TN, and Consulting Forester, Stone Mountain, GA.

Soils and Topography

Black willow is most commonly associated with the soil order Entisols, particularly the Haplaquents and Fluvaquents derived from alluvium. Willow grows on almost any soil, but its extensive, shallow roots need an abundant and continuous supply of moisture during the growing season.

The species is most common on river margins and batture land, where it occupies (and usually dominates) the lower, wetter, and often less sandy sites. It is also common in swamps, sloughs, and swales, and on the banks of bayous, gullies, and drainage ditches, growing anywhere light and moisture conditions are favorable. It flourishes at, or slightly below, water level and is not appreciably damaged by flooding and silting *(4)*.

Although prevalent along most of the Mississippi River, it produces the largest and best formed trees on very low, moist sites in the batture of the lower river.

Associated Forest Cover

Black willow is the predominant species in Black Willow (Society of American Foresters Type 95), a temporary, pioneer forest cover type with excellent growth characteristics *(1)*. It is an associated species in the following cover types: River Birch-Sycamore (Type 61), Cottonwood (Type 63), Sycamore–Sweetgum-American Elm (Type 94), Baldcypress (Type 101), Baldcypress-Tupelo (Type 102), Water Tupelo–Swamp Tupelo (Type 103), and Cottonwood-Willow (Type 235).

Other noteworthy tree associates are red maple *(Acer rubrum)*, boxelder (A. *negundo),* red mulberry *(Morus rubra)*, and water locust *(Gleditsia aquatica).* In the areas where willow develops best, swamp-privet *(Forestiera acuminata)*, buttonbush *(Cephalanthus occidentalis),* and water-elm *(Planer-a aquatica)* are the major noncommercial tree associates. Black willow often starts with sandbar willow *(Salix exigua)*, which dies out before reaching more than small pulpwood size.

Life History

Reproduction and Early Growth

Flowering and Fruiting-Black willow is dioecious. No consistently reliable morphological charac-

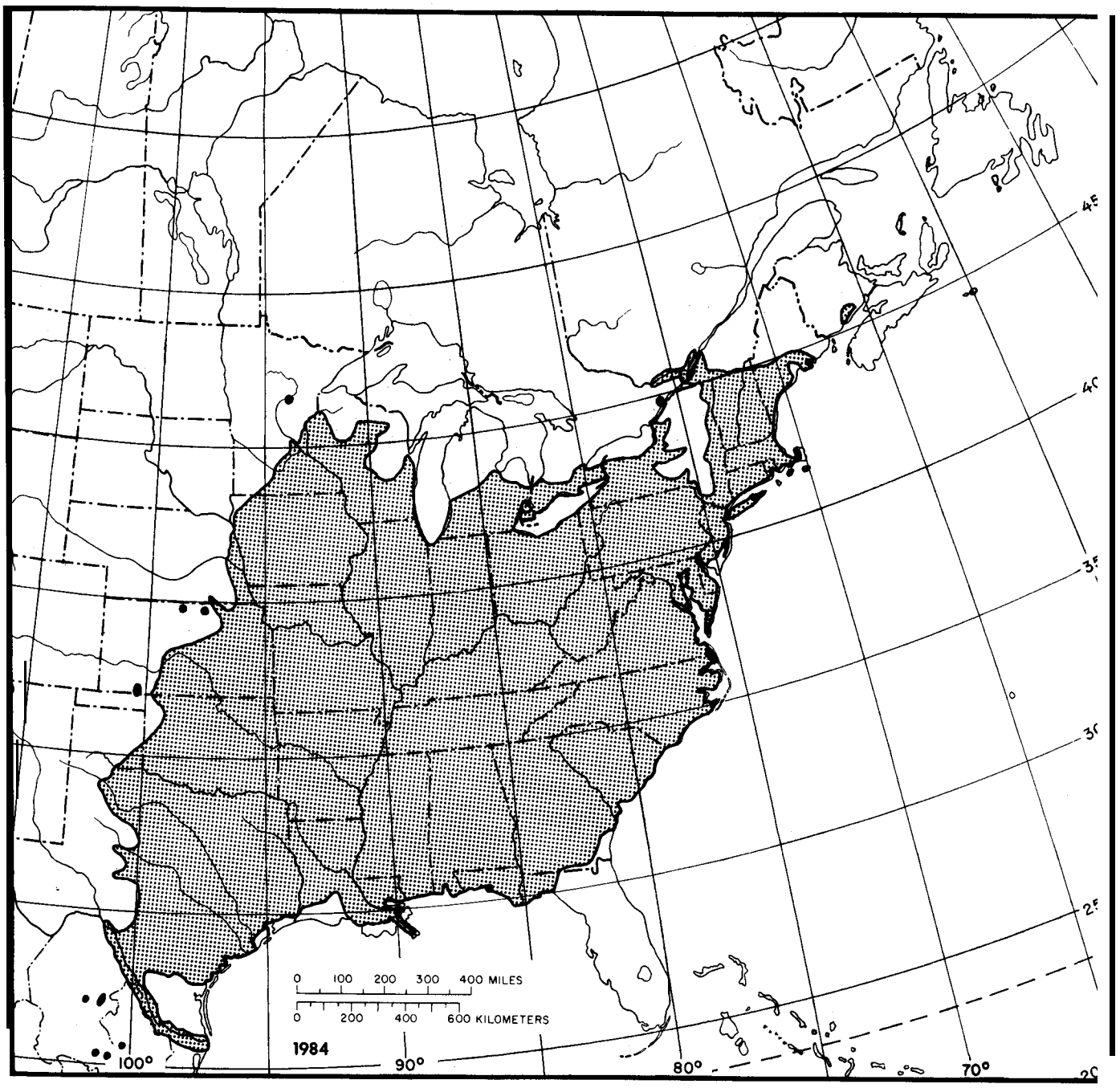

Figure *l-The native range of* ***black willow.***

teristics are associated with the identification of the sexes. Male and female are indistinguishable except during flowering and seed development. In natural stands the sex ratio is probably 1 to 1, as has been determined for other dioecious tree species, including members of *Salicaceae*. Flowering begins in February in the southern portion of the range and extends through late June at the northern limits. The many-flowered catkins usually appear at the time of or immediately preceding leafing out. Pollination is mainly by insects; the flowers contain nectar. Pollen is also carried by winds. The seed ripens quickly; 45 to 60 days after pollination the small (3 to 6 mm or 0.12 to 0.24 in) light-brown capsules

begin to split open and shed minute green seeds that have a hairy covering.

Seed Production and Dissemination-Seed production usually starts when the trees are about 10 years old, although viable seeds can be obtained at younger ages. Optimum seed-bearing age is from 25 to 75 years. The trees have good seed crops almost every year, with only a few interspersed poor crops and rare failures resulting from late freezes after flower buds have begun to open. Large volumes of seeds are produced; they average 5 million/kg (2.3 million/lb). When the seeds fall, the long silky hairs act as wings to carry the seeds very long distances. The seeds are widely disseminated by wind and water.

Seedling Development-Unless the willow seed is floating on water, it must reach the seedbed within 12 to 24 hours because viability is greatly reduced by only a few days of dry conditions. Germination is epigeal. Germinative capacity is usually high and no dormancy is known. Very moist, almost flooded exposed mineral soil is best for satisfactory germination and early development. Full light promotes vigorous growth once the seedling is well established. In a favorable environment, seedlings grow rapidly—often exceeding 1.2 m (4 ft) in height the first year *(4)*.

Seedlings grow best when there is abundant moisture available throughout the growing season. In the Mississippi Valley, average heights are 9.8 m (32 ft) and average breast-high diameters are 6.6 cm (2.6 in) when the saplings are 5 years old (4).

Vegetative Reproduction-Root stocks of very young willow trees sprout prolifically. Propagation by cuttings is the usual method of artificial regeneration. With adequate moisture, good cuttings, and sufficient cultivation to reduce competition from other vegetation, first-year plantation survival can be close to 100 percent. Post-size willow cuttings have been rooted for use in flood projects to prevent gullies (4).

Sapling and Pole Stages to Maturity

Growth and Yield-In natural stands of the lower Mississippi Valley, lo-year-old trees average 15 m (49 ft) in height and 14 cm (5.6 in) in d.b.h. In 20 years the trees will average 22 m (72 ft) and 19 cm (7.5 in); in 40 years, 31 m (101 ft) and 49 cm (19.4 in). The tallest trees are 43 m (140 ft) high; the largest diameters about 122 cm (48 in) *(4)*. Black willows in the North and those on poor sites in the South generally reach a maximum height of 9 to 18 m (30 to 60 ft) and 15 to 46 cm (6 to 18 in) in d.b.h. These seldom furnish a satisfactory saw log.

In well-stocked stands on the best alluvial soils, particularly along the Mississippi River, the tree prunes itself well and produces an acceptably straight trunk which is clear of limbs for an average of 12 m (40 ft). Open-grown willows and willows among small streams and in swamps are generally limby and of limited usefulness. Being a very weak tree, it is especially prone to breakage; almost all large trees have large broken limbs (4).

Unmanaged stands in the South have been estimated to yield 315 m^3/ha (50 cords/acre) at age 25 and 416 m^3 (66 cords) at age 35. The sawtimber volume (Scribner rule) in similar stands has been estimated at 396 m^3/ha (28,300 fbm/acre) at 35 years and 560 m^3/ha (40,000 fbm/acre) at 50 years. Good sites sustain about 30 m^2 of basal area per hectare (130 ft^2/acre) (4).

Black willow is short lived; the greatest age recorded for a sound tree is 70 years and for an unsound tree, 85 years. The average black willow is mature in 55 years *(4)*.

Thinning increases yields and reduces mortality when carried out in relatively young (18 to 24 yr) stands. Growth is best when basal area is reduced by about one-half. Spacing between trees after thinning should average 21 times the mean stem diameter-25.4-cm (lo-in) trees spaced 5.3 m (17.5 ft) apart. If the factor is 18 or less, the spacing is probably too dense; if 24 or greater, the site is probably not fully utilized (2).

Rooting Habit-Willow tends to be shallow rooted, especially on clay-capped alluvial soils. It is seldom found on soil types that undergo seasonal dehydration but is more often present on soils with higher water tables throughout the summer months. Floods may deposit more layers of alluvium in established stands. New roots often develop from adventitious buds formed within the previously exposed trunk. By this means, soil is captured and held to form additional land areas along river courses. Willows also sucker readily. Under certain conditions, an essentially pure willow stand of 1 or more hectares (2.5 acres) may consist of relatively few clones.

Reaction to Competition-Black willow is less tolerant of shade than any of its associates and may most accurately be classed as very intolerant. It usually grows in dense, even-aged stands, in which natural mortality is very heavy from sapling stage to maturity. Trees fail to assert dominance, so willow stands periodically stagnate. Stands not properly thinned may lose up to 50 percent of their volume in

Figure 2—*Twenty-four-year-old* black *willow stand thinned from basal area of approximately 30 to 17* m^2 */ ha (130 to 75* ft^2 */acre).*

5 to 8 years (4). Because of its intolerance and the absence of exposed mineral soil under existing stands, willow does not succeed itself naturally unless fresh sediment is deposited as the stand begins to open up. Thinning should remove the understory trees and must be light to prevent the heavy windthrow and stem breakage, which is common in very open stands. Light, early, and frequent thinning forestalls stagnation and mortality (2). An apparently satisfactory thinning prescription is to leave a stand of about 14.9 to 17.2 m^2/ha (65 to 75 ft^2/acre) of basal area (fig. 2). Heavy epicormic branching may result if weak trees are released.

Damaging Agents-Several insects attack live willow but few cause serious damage. The forest tent caterpillar ***(Malacosoma disstria),*** the gypsy moth ***(Lymantria dispar),*** the cottonwood leaf beetle ***(Chrysomela scripta),*** the willow sawfly ***(Nematus ventralis),*** and the imported willow leaf beetle ***(Plagiodera versicolora)*** sometimes partially, occasionally completely, defoliate willow trees, reducing growth but seldom killing. Stem borers, such as the cottonwood borer ***(Plectrodera scalator)*** attack willows and may kill by girdling the base. Twig borers, like the willow-branch borer ***(Oberea ferruginea)***, feed on the branches and cause deformities that may be undesirable in ornamentals.

Insects are frequently the vectors for disease organisms. Willow blight, the scab and black canker caused by ***Pollaccia saliciperda,*** is transmitted by borers, Members of the genus *Salix* are the only known hosts. ***Phytophthora cactorum*** causes bleeding canker, lesions on the lower trunk that discharge a dark-colored, often slimy liquid. Confined to the phloem and cambium area, it can result in death if the canker girdles the trunk. ***Cytospora chrysosperma*** causes canker in poplar and willow. Under forest conditions, cytospora canker is of little consequence but when trees become weakened by drought, competition, or neglect, losses can be heavy. In nursery beds, losses of up to 75 percent of cuttings have been reported. Leaf rust caused by ***Melampsora*** spp. is common on seedlings throughout the range of black willow. Mistletoes ***(Phoradendron*** spp.) damage and deform but seldom kill willows.

The yellow-bellied sapsucker feeds on sap from holes they peck through the bark; this early injury to the tree degrades the lumber sawn later.

Hot fires kill entire stands. Slow, light fires can seriously wound willow, allowing woodrotting fungi to enter. Once dead, willow deteriorates very rapidly. Top and branch rot account for 86 percent of the cull in willow.

Special Uses

The wood is light (specific gravity 0.34 to 0.41), usually straight grained, without characteristic odor or taste, weak in bending, compression, and moderately high in shock resistance. It works well with tools, glues well, and stains and finishes well but is very low in durability

The wood was once used extensively for artificial limbs, because it is lightweight, doesn't splinter easily, and holds its shape well. It is still used for boxes and crates, furniture core stock, turned pieces, table tops, slack cooperage, wooden novelties, charcoal, and pulp.

Black willow was a favorite for soil stabilization projects in the early efforts at erosion control. The ease with which the species establishes itself from

cuttings continues to make it an excellent tree for revetments.

Ancient pharmacopoeia recognized the bark and leaves of willow as useful in the treatment of rheumatism. In 1829, the natural glucoside *salicin* was isolated from willow. Today it is the basic ingredient of aspirin, although salicyclic acid is synthesized rather than extracted from its natural state.

Genetics

Population differences exist but the magnitude and distribution of the variation of specific characters awaits verification through analysis of provenance and progeny tests. Clonal differences in defoliation of black willow by the cottonwood leaf beetle were noted in experimental plots in Mississippi; feeding was also heavier on the male clones (6). In another study, black willows from two natural stands 160 km (100 mi) apart on the lower reaches of the Mississippi River had significantly different fiber lengths *(8)*.

One or more races of black willow are recognized as varieties by some authorities *(3,9)*. Western black willow *(Salix nigra* var. *vallicola* Dudley) of Southwestern United States and adjacent Mexico was renamed as a species, Goodding *willow (S. gooddingii* Ball). Controversy over whether this is a separate species or a varietal species of black willow still goes on. Two other varieties have been named: *S. nigru* var. *altissima* Sarg. of the Texas gulf coast and S. *nigru* var. *lindheimeri* Schneid. of central Texas.

Although the genus *Salix* is widely distributed and many species occupy sympatric ranges, natural hybrids apparently are not common *(3)*. Putative hybrids are difficult to verify since the identity of one parent is often uncertain. The following willows hybridize with *Salix nigra: Salix alba (S. x hankensonii* Dode), *S. amygdaloides (S. x glatfelteri* Schneid.), *S. bonplandiana, S. caroliniana, S. lucida (S. x schneideri* Boivan), and *S. sericea.*

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