Baldcypress, An Important Wetland Tree Species: Ecological Value, Management and Mensuration

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Introduction

China has the largest area of wetlands in Asia and the fourth largest amount worldwide. Wetlands include marshes, swamps, salt marshes, parts of streams, shorelines, and flood plains. It is estimated that wetlands in China cover over 25 million ha, 80% being of the fresh water variety, or 2.6% of the land base (Lu 1990). However, it is recognized that existing wetland inventory information is in need of updating so a comprehensive Asian Wetland Inventory database is being developed under the auspices of Wetlands International (Finlayson et al. 2002). There are major concerns over wetland loss and degradation in China, thus the government has put into implementation the CHINA NATIONAL WETLANDS CONSERVATION ACTION PLAN (CNWCAP) (SFA 2000). Baldcypress (*Taxodium distichum* (L.) Rich.) can be used for wetland remediation and restoration in floodplains, swamps, and along streams, thus it can help meet objectives of the CNWCAP.

Habitat

Baldcypress is a low-elevation tree that prefers swampy, water-logged lands. Cypress swamps are a common forested wetland community type in the southeastern United States. They occur in a variety of wetland environments, including riparian corridors, large contiguous swamps, and small isolated wetlands. Baldcypress also grows along estuaries near the coast but cannot tolerate water containing more than 0.89% salt. Two varieties of cypress, baldcypress (*Taxodium distichum* (L.) Rich. var. *distichum*) and pondcypress (*T. distichum* var. *nutans* (Ait.) Sweet) dominate these wetlands. Baldcypress inhabits high nutrient systems with moderate water flow, such as river swamps, while pondcypress generally occurs in low nutrient, isolated wetlands with low water flow (Brandt and Ewel 1989). Both cypresses are known for their knees, peculiar conical structures that rise from lateral roots. Knees may help to anchor trees because they develop large masses of roots. Tree associates of baldcypress include water tupelo (*Nyssa aquatica* L.), swamp tupelo (*N. sylvatica* var. *biflora* (Walt.) Sarg.), red maple (*Acer rubrum* L.), sweetbay (*Magnolia virginiana* L.), southern magnolia (*M. grandifolia* L.), sweetgum (*Liquidambar styraciflua* L.), and various oaks (*Quercus* spp.), ashes (*Fraxinus* spp.), and pines (*Pinus* spp.) (Wilhite and Toliver 1990). According to Ewel and Odum (1984), the species composition and different kinds of swamps are determined by three environmental factors: hydro-period, nutrient inputs, and fire. Once well established, trees tolerate any amount of freshwater. Cypress can grow quickly in cultivation. Experience with cypress plantations in the southeastern U.S show some plantations can attain 175 m^3/ha at 30 years of age (Wilhite and Toliver 1990). Cypress trees are highly resistant to wind. The extensive root system and buttressed base developed by the trees securely anchor them in soft, wet soils. This is an important consideration for establishment of cypress because southeast Asia is frequented by typhoons. Planted cypress in the northeastern U.S. and southern Canada are known to withstand winter temperatures up to -34°C and show resistance to ice damage. Thus, baldcypress can grow across a wide climatic range for use in wetlands remediation.

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Seed Collection, Sowing, and Outplanting

Cypress is monoecious. Typically, the male catkins shed pollen in March or April and the globose cones mature from October to December. Good seed crops occur at 3- to 5-year intervals. The cones, which turn from green to brownish purple, normally range from 13 to 36 mm in diameter and consist of 9 to 15 four-sided scales. Seeds, one or two per scale, are irregularly 3-angled and 3-winged and resin coated. Cones contain 16 seeds on average. Mature, dry cones are picked by hand. Flailing sticks can be used to knock cones from trees. Cones are then spread in a thin layer for air-drying. The dried cones are broken apart by flailing or trampling. Because seeds are resin coated, separation of cone fragments from seeds is very difficult. Cleaned seeds number from 5,600 to 18,430/kg. Baldcypress seeds show dormancy that can be overcome by cold stratification or submerging in water at 4°C for 90 days (Bonner 1974). Conner and Ozalp (2002) mixed baldcypress seeds with wet sand and stored them in plastic bags between 4 and 8°C for 90 days. Baldcypress seeds keep well in dry storage at 5°C for 1 to 2 years. Pondcypress seeds respond well to 60 to 90 days of stratification at 4°C in peat moss. Tetrazolium staining can be used to determine viability. Seeds should be sown on a sphagnum moss or a wet-muck seedbed. In warm climates, spring sowing of pretreated seeds is the recommended practice. Fall sowing of untreated seeds has proved successful in northern nurseries. Beds should be mulched and kept well watered. The resinous seeds are not generally palatable to rodents or birds so seed predation is usually not a problem. Average size of 1-0 nursery-grown seedlings is 81.4 cm in height and 1.1 cm in diameter. On dry upland sites standard techniques of planting with a dibble or shovel can be used, but these techniques do not work well in standing water. Conner et al. (1999) have developed new techniques for planting in standing water. In the first method, bareroot seedlings had lateral and tap roots pruned to a 23 cm spread. Seedlings were planted by grasping the seedling at the root collar and pushing it into the soft sediment. In the second method, seedlings were again root pruned to a 23 cm spread, then placed in a burlap bag which was then filled with topsoil. The hand-bagged seedlings were planted by placing them directly onto the bottom sediment and securing the stem to a stake driven through the bag to keep the seedling upright. Conner et al. reported excellent survival results.

Ecological Importance and Benefits of Cypress Swamps

There are many ecological benefits from cypress forests. As already mentioned, because the species is windfirm, cypress stands can help prevent or minimize disturbance from gale and even hurricane force winds (Wilhite and Toliver 1990). In general, wetlands perform functions that have environmental importance and social significance (Brinson and Rheinhardt 1998). Table 1 gives a list of some of the functions and values. Cypress forests, of course, can provide wood products. Trees are harvested for two main products: saw timber (dimensional lumber) and landscape mulch. Stumps 25 to 36 cm in diameter can generally be counted on to sprout vigorously if the tree is cut in the fall or winter. They should be no older than 40 to 60 years for coppice regeneration. Cypress swamps provide habitat to many wildlife species. The tops of older trees provide nesting sites for large birds. Cypress domes provide breeding sites for amphibians. Cypress swamps have the potential for use as recreation areas. They help to maintain high regional water tables, provide flood control and groundwater recharge, and they can also be used to provide advanced wastewater treatment for small communities (Ewell 1990).

Table 1. Some functions for wetlands, related effects, and services of value to society.

Function	Effects of Function	Value to Society
Stores surface water over the short-term	Reduced downstream flood peaks	Reduced damage from floodwaters
Maintains a high water table	Maintenance of hydrophytic plant community	Maintenance of biodiversity
Accumulates inorganic sediments	Retention of sediments and some nutrients	Maintenance of water quality
Supports characteristic populations	Maintains habitat	Production of individuals for hunting and viewing

Management

Canopy thinning is considered the best management practice for naturally regenerating cypress. Thinning controls competition and allows overhead light for newly germinated seedlings. Plant cypress on a 2.4 by 2.4 m spacing. Control competing vegetation at an early age by herbicide, water control or cultivation. Thin young stands—plantation or natural—at 15 to 20 years. Higher basal areas can be carried than with pine. Thin from below, leaving from 16 to 25 m^2/ha basal area (Williston et al. 1980).

Mensuration

Baldcypress shows considerable variation in the butt region. Parresol et al. (1987) demonstrated that diameter measurement at 3 meters is superior over the practice of using 'normal diameter' (diameter measured 0.5 meters above butt swell). Taper data were collected on 157 trees in Louisiana. A compatible taper-volume system based on a cubic-cubic segmented polynomial model is presented along with factors for determining biomass and carbon content of boles. The following notation will be used: a = join point; b_i = regression coefficient; d = top diameter inside bark (ib) or outside bark (ob) in cm; D = diameter in cm measured at 3 m; h = height above ground to top diameter d, or height to limit of utilization, in m; H = total height in m; K = $\pi/40{,}000$ for converting diameter squared in cm^2 to area in m^2; v = cubic-meter volume, and $z = (H-h)/H$. The cubic-cubic stem profile equation is:

$$d^2 = D^2\left[z^2(b_1 + b_2 z) + (z-a)^2[b_3 + b_4(z+2a)]I\right]$$
$$\text{where } I = \begin{cases} 1, & \text{if } z \geq a \\ 0, & \text{if } z < a \end{cases} \qquad (1)$$

Merchantable volume (v) for any section of the stem between lower limit h_l and upper limit h_u is obtained by integration of Equation (1), which results in the following function:

$$v = KD^2H\left\{\begin{array}{l}(b_1/3)(z_l^3 - z_u^3) + (b_2/4)(z_l^4 - z_u^4) + (b_3/3)\left[(z_l - a)^3 I_l - (z_u - a)^3 I_u\right] \\ \qquad + (b_4/4)\left[(z_l^4 - 6a^2 z_l^2 + 8a^3 z_l) I_l - (z_u^4 - 6a^2 z_u^2 + 8a^3 z_u) I_u\right]\end{array}\right\} \tag{2}$$

$$\text{where } I_i = \begin{cases} 1, \text{ if } z_i \geq a \\ 0, \text{ if } z_i < a \end{cases} \quad i = l, u$$

The Forest Products Laboratory of the Forest Service in Madison, WI, has determined that the average specific gravity for baldcypress is 0.46. To convert specific gravity to density in kg/m^3 multiply by 1000. Therefore, baldcypress biomass (*m*) in kg can be computed as 460*v*. Finally, carbon content is obtained as 0.5*m*. Table 2 lists the regression coefficients for use in Equations (1) and (2).

Table 2. Coefficients for baldcypress taper-volume equations.

	b_1	b_2	b_3	b_4	a
ib	2.65881	-1.86993	1260.06962	-465.49004	0.82880
ob	3.12253	-2.31694	1234.80653	-456.36746	0.82491

Conclusions

Among conifers baldcypress and pondcypress are unique in being deciduous and having the ability to sprout from stumps. The wood is strong and heartwood is not vulnerable to insects or rot. Alkaline soil can cause chlorosis and some trees are susceptible to gall-forming mites and midges, but generally cypress is very hardy and adaptable. Baldcypress grows in and along flowing water such as river floodplains, stream banks, and lake shores. Pondcypress is adapted to depressions, which form ponds with still or slow-moving water. Cypress is well suited for wetlands remediation. Cypress swamps perform functions that have ecological importance and social value. Benefits include wildlife habitat, recreation, wastewater recycling, flood control and groundwater recharge. Nursery practices for production of seedlings and outplanting techniques are well established. Due to buttressing, diameter measurement at 3 m is recommended. Equations to predict stem profile and bole volume were derived. Conversion factors for biomass and carbon content are available. Establishment and management of cypress forests can help meet the objectives of the China National Wetlands Conservation Action Plan and conservation protocols throughout Asia.

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