Nyssa aquatica L. Water Tupelo

Cornaceae Dogwood family

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Water tupelo *(Nyssa aquatica),* also called cotton-gum, sourgum, swamp tupelo, tupelo-gum, and water-gum, is a large, long-lived tree that grows in southern swamps and flood plains where its root system is periodically under water. It has a swollen base that tapers to a long, clear bole and often occurs in pure stands. A good mature tree will produce commercial timber used for furniture and crates. Many kinds of wildlife eat the fruits and it is a favored honey tree.

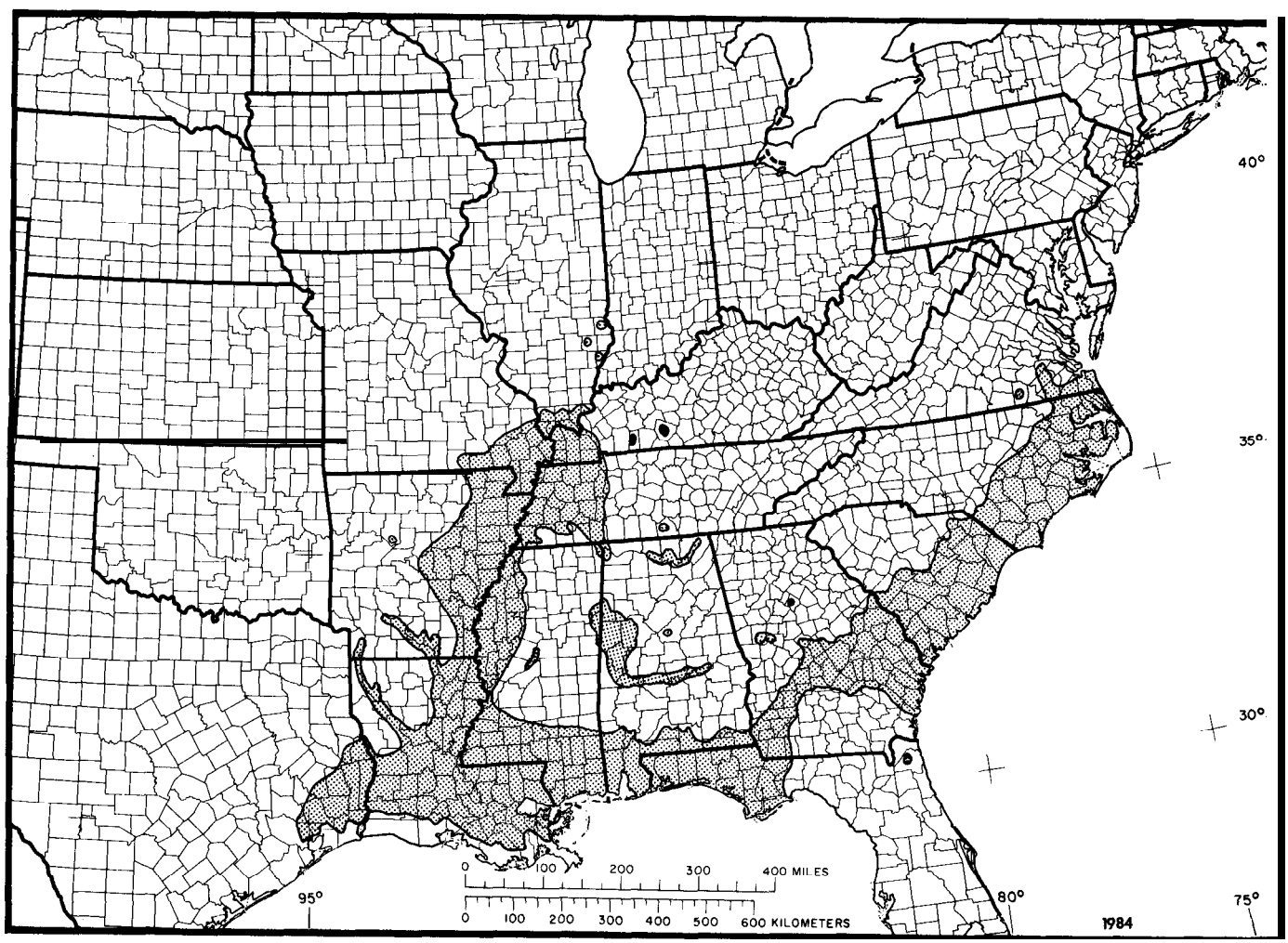

Figure *1-The native range of water tupelo.*

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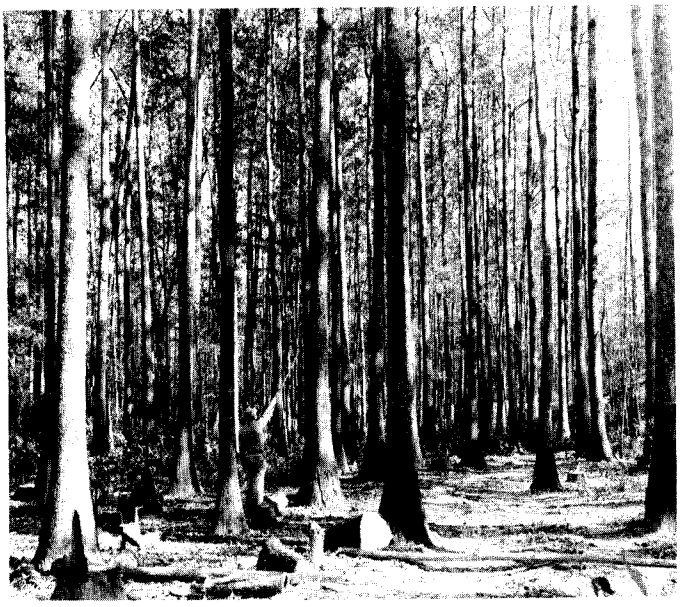

Figure *!2-Water tupelo in Attala County, MS. Before thinning, the stand averaged 53 m^2/ ha (230 ft^2 /acre) of* **basal** area **and 434** *m^3/ha (6,200 ft^3/acre) of* **volume. Trees averaged 30 cm (12 in) in** *d.b.h. and were up to 30 m (100 ft) tall.*

Habitat

Native Range

Water tupelo (figs. 1,2) grows throughout the Coastal Plain from southeastern Virginia to southern Georgia, and from northwestern Florida along the Gulf of Mexico to southeastern Texas. It extends up the Mississippi River Valley as far north as the southern tip of Illinois.

Climate

Annual rainfall throughout the range of water tupelo averages 1320 mm (52 in). Approximately 530 mm (21 in) of rain falls during the primary growing season, April through August. Summer months are normally much drier in the Midsouth (22).

Average summer temperature within the range of water tupelo is 27" C (81° F); average winter temperature is 7" C (45" F). Temperature extremes are 46" to -29" C (115" to -20" F). An average of 231 frost-free days occur annually over its range.

Soils and Topography

Water tupelo grows in low, wet flats or sloughs and in deep swamps. Some of the better sites are in the sloughs and swamps along Coastal Plain rivers of the Southeast, such as the Roanoke and Santee, and in the large swamps of southwestern Louisiana and southeastern Texas. On some sites water may reach a depth of 6 m (20 ft) during rainy seasons and may remain as high as 4 m (13 ft) for long periods *(21)*. Surface water may disappear from water tupelo areas in midsummer or fall, but on better sites soil moisture remains at or near saturation level throughout most of the growing season.

Soils that commonly support water tupelo range from mucks and clays to silts and sands and are in the orders Alfisols, Entisols, Histosols, and Inceptisols. Most are moderately to strongly acidic; subsoil frequently is rather pervious. Site index of water tupelo for several Midsouth soils ranges from 21 to *27* m (70 to 90 ft) at 50 years (4).

Associated Forest Cover

Water tupelo is a major component of the forest cover types Water Tupelo-Swamp Tupelo (Society of American Foresters Type 103) and Baldcypress–Tupelo (Type 102) *(8)*. In stands containing baldcypress ***(Taxodium distichum)*** and water tupelo, baldcypress is usually predominant. In sloughs and moving water, water tupelo usually occupies the deeper parts and baldcypress the margins and more shallow parts. In deep, stagnant water the two species occupy much the same depths *(19)*.

In several other forest cover types water tupelo may be a minor associate: Longleaf Pine-Slash Pine (Type 83), Slash Pine (Type 84), Slash Pine–Hardwood (Type 85), and Baldcypress (Type 101).

Species associated with water tupelo throughout its range are black willow *(Salix* ***nigru),*** swamp cottonwood ***(Populus heterophylla),*** red maple *(Acer rubrum)*, waterlocust ***(Gleditsia aquatica),*** overcup oak ***(Quercus lyrata),*** water oak *(Q.* ***nigra),*** water hickory *(Carya aquatica)*, green and pumpkin ash ***(Fraxinus*** *pennsylvanica* and ***F. profunda),*** and sweetgum ***(Liquidambar*** *styraciflua)*. Swamp tupelo ***(Nyssa sylvatica*** var. *biflora)*, pondcypress ***(Taxodium distichum*** var. ***nutans),*** and redbay *(Persea* ***borbonia)*** are common associates in the Southeast.

Small tree and shrub associates of water tupelo include swamp-privet ***(Forestieru*** *acuminata)*, common buttonbush ***(Cephalanthus occident&s),*** water-elm *(Planera* ***aquatica),*** sweetbay ***(Magnolia*** *virginianu),* Carolina ash *(F.caroliniana)*, poison-sumac ***(Toxicodendron vernix),*** southern bayberry ***(Myrica cerifera),*** and dahoon *(Ilex* ***cassine).***

Life History

Reproduction and Early Growth

Flowering and Fruiting-Water tupelo is polygamo-dioecious. The minute, greenish-white flowers appear before or with the leaves in March or April. Pollen is disseminated by wind and probably by bees. Fruits are oblong drupes about 1 to 4 cm (0.5 to 1.5 in) long, with a thick epicarp and fleshy mesocarp. When mature, September through December of the first year, they are dark purple with conspicuous pale dots. Each fruit contains a boney, ribbed, one-seeded stone. Stones range in color from white to dark brown or gray and some are pinkish white. There are about 990 cleaned seeds per kilogram (2.2 lbs) *(30)*.

Seeds may be sown in fall in the nursery or may be stratified over winter and sown in the spring. For stratifying, seeds are kept in moist sand or plastic bags at 2" to 4" C (35" to 40" F) (30). Up to 30 months' storage does not reduce viability of seeds that have a moisture content of 20 percent or less and are kept in polyethylene bags at a temperature of about 3° C (38° F) (3).

Nursery-sown seeds may be drilled 13 to 25 mm (0.5 to 1 in) deep at the rate of 50/m (15/ft) of row, or they may be broadcast and rolled into the soil. A seedbed density of 110 to 165 seedlings/m^2 (10 to 15 seedlings/ft^2) is recommended. From 25 to 37 mm (1 to 1.5 in) of sawdust mulch is recommended for broadcast seeds.

Seed Production and Dissemination-Forest trees initiate seed production in about 30 years or when they are about 20 cm (8 in) in d.b.h. In a South Carolina study, however, viable seeds were produced by 2-year-old stump sprouts (27). Large trees normally produce good to excellent crops each year. Seeds are dispersed mainly by water. As long as the exocarp is intact, the fruit will float. Seeds submerged continuously in water may remain viable for at least 14 months *(1)*.

Seedling Development-Germination is epigeal. Seeds do not germinate until water recedes, which may be midway to late in the growing season (29). Partially shaded, wet, poorly-drained soils provide the best seedbed. Seeds buried 1 to 3 cm (0.5 to 1 in) deep in the soil have a better chance to germinate and establish seedlings than seeds on the soil surface. Seedling survival and development are best in full sunlight and in soil with a pH below 7.0 (25). Seedling development is better in saturated than in well-drained soil, in moving and aerated rather than stagnant water, and in shallow rather than deep water *(6,7,11,17)*. Provided their tops are above water, seedlings can generally survive continuous flooding even if it persists throughout the growing season. Water tupelo is able to survive where it is too wet for most other species because of anatomical and physiological adaptations such as roots that allow for oxidation of the rhizosphere and controlled anaerobic respiration *(12,18)*.

Vegetative Reproduction-Water tupelo is a prolific stump sprouter. Stumps of cut seedlings 15 cm (6 in) above ground level may be better sprouters than those 1 cm (0.5 in) in height. Sprouts develop adventitiously from the higher stumps and from suppressed buds on lower stumps *(14)*. Survival and development of sprouts from stumps of larger trees are not always satisfactory, and it may be that the occurrence and persistence of stump sprouts are related to timing and duration of flooding. In South Carolina, trees of sprout origin grew as well as seedlings over a 30-year period *(16)*, but in southern Louisiana few stump sprouts survived beyond 6 years (20).

There are no practical techniques for reproducing water tupelo through cuttings or layering.

Sapling and Pole Stages to Maturity

Growth and Yield-Growing season flooding that is just short of continuous may provide near-optimum soil moisture for growth of water tupelo (2). Any drastic change in normal water levels can decrease growth. On a good site in South Carolina, 30-year-old trees of sprout and seed origin averaged about 23 m (75 ft) tall and 33 cm (13 in) in diameter *(16)*. (Note: determination of tree age may be difficult because the species is known to have false rings.) With an abundance of sunlight, trees growing on a good site for 50 to 75 years may reach 51 to 66 cm (20 to 26 in) in diameter above the butt swell, contain from 2 to 3.5 4.9-m (16 ft) logs, and begin development of heartwood (2).

In poorly drained swamps in the southeastern United States, average annual production of water tupelo stands was found to be between 6.3 and 7.0 m^3/ha (90 and 100 ft^3/acre). Ten-year average diameter growth for trees free to grow in unmanaged stands on an average site is about 8 cm (3 in) (28). Growth and yield were tabulated at lo-year intervals for unmanaged stands in the Atchafalaya Basin of southern Louisiana as follows (9):

Age	Average d.b.h.	Height	Total merchantable volume (peeled wood)
yr	*cm*	*m*	*m^3/ha*
30	16.8	14	156
40	24.1	17	243
50	42.2	25	331
	in	*ft*	*ft^3/acre*
30	6.6	46	2,225
40	9.5	56	3,475
50	16.6	81	4,725

Under management, a pure even-aged stand carried to 107 cm (42 in) in diameter above the bottleneck is estimated to have an accumulative total yield of 676 m^3/ha (48,282 mbf/acre, Doyle log rule) in logs and 441 m^3/ha (70 cords/acre). These yields are based on an assumed cutting cycle of from 8 to 15 years (28).

Basal areas between 57 and 69 m^2/ha (250 and 300 ft^2/acre) are not uncommon in pure unmanaged second-growth stands. For a less dense water tupelo stand in Florida, the following volumes were recorded (24) :

Age	Average diameter above bottleneck	Total merchantable volume (outside bark)	Basal area
yr	*cm*	*m^3/ha*	*m^2/ha*
60	31.8	355	38.6
70	34.8	429	44.5
	in	*ft^3/acre*	*ft^2/acre*
60	12.5	5,077	168
70	13.7	6,133	194

Table l-Root characteristics of swamp tupelo and water tupelo as affected by drainage *(13)*

Root characteristic	Roots well aerated	Roots flooded
Morphology	Small diameter and fibrous except at the apex	Succulent with very little branching
Epidermis	Highly suberized	Little or no suberization
Endodermis	Highly organized, with Casparian strips	Poorly organized, Casparian strips not evident
Adventitious water root	None	Prolific just below water line'
Intercellular space in cortex	Abundant	Abundant
Oxidizes rhizosphere in anaerobic conditions	No	Yes

'May be absent on water tupelo under many types of flooding.

Growth and yield of water tupelo in plantations are generally unknown. One small 17-year-old planting at a 1.7 by 1.7 m (5.5 by 5.5 ft) spacing on Falaya silt loam had 89 percent survival. The trees that grew best averaged 13.2 cm (5.2 in) in d.b.h. and were 14.9 m (49 ft) tall (5).

Rooting Habit-Water tupelo commonly grows in saturated soils where its shallow root system is characterized by morphological and physiological adaptations that are essential to survival and growth (table 1).

Reaction to Competition-Water tupelo is classed as intolerant of shade. It will survive codominant but not overtopping competition. Water tupelo develops in pure, very dense, second-growth stands and has a tendency to stagnate. Unless stagnation is prolonged, it responds to thinning.

Damaging Agents-Fire is a major enemy of water tupelo. It scorches the thin bark, allowing entrance of rot-causing fungi. The forest tent caterpillar *(Malacosoma **disstria**)* is a serious enemy in some years and locations. More than 202,350 ha (500,000 acres) of trees along the gulf coast from Louisiana through Alabama have been defoliated by this insect in a single year (26). Trees annually defoliated seldom die but may have 30 percent or less of the annual diameter growth of unattacked trees.

A foliar disease, ***Mycosphaerella nyssaecola,*** has caused premature defoliation, but impact has been negligible.

Special Uses

Since water tupelo is one of the few species that can survive extended periods of inundation, it is favored for planting in very wet microsites, around buildings, in parks, and elsewhere. It is also an important wildlife species. The fruit is consumed by wood ducks, several other kinds of birds, and by squirrels, raccoons, and deer *(10)*. Flowers have some value as a source of tupelo honey. Deer feed on foliage, twigs, and stump sprouts.

Water tupelo wood has fine, uniform texture and interlocked grain. When dried properly, the lumber is used for boxes, pallets, crates, baskets, and furniture. Buttresses of trees growing in flooded areas contain wood that is much lighter in weight than that from upper portions of the same trees. The butt portion is probably best suited for pulping products *(23)*.

Genetics

There is considerable variation in specific gravity and fiber length among stands, between trees within a stand, and within individual trees. Depending on seed source, seedlings grown under similar water regimes have different rates of development *(15).*

No racial variations or hybrids have been recognized for forest-grown water tupelo.

Literature Cited

1. Applequist, M. B. 1959. Longevity of submerged tupelo-gum and baldcypress seed. Louisiana State University, Forestry Note 27. Baton Rouge. 2 p.
2. Applequist, M. B. 1959. A study of soil and site factors affecting the growth and development of swamp blackgum and tupelo-gum stands in southeastern Georgia. Thesis (D.F.), Duke University, Durham, NC.
3. Bonner, F. T., and H. E. Kennedy, Jr. 1973. Storage of water tupelo seeds. Tree Planters' Notes 24:7–8.
4. Broadfoot, Walter M. 1976. Hardwood suitability for and properties of important Midsouth soils. USDA Forest Service, Research Paper SO-127. Southern Forest Experiment Station, New Orleans, LA. 84 p.
5. Broadfoot, W. M., and R. M. Krinard. 1961. Growth of hardwood plantations on bottoms in loess areas. Tree Planters' Notes 48:3–8.
6. Dickson, R. E., and T. C. Broyer. 1972. Effects of aeration, water supply, and nitrogen source on growth and development of tupelo-gum and baldcypress. Ecology 53(4):626–634.
7. Dickson, R. E., J. F. Hosner, and N. W. Hosley. 1965. The effects of four water regimes upon the growth of four bottomland species. Forest Science 11(3):299–305.
8. Eyre, F. H., ed. 1980. Forest cover types of the United States and Canada. Society of American Foresters, Washington, DC. 148 p.
9. Hadley, E. W. 1926. A preliminary study of the growth and yield of second-growth tupelo-gum in the Atchafalaya Basin of southern Louisiana. Lumber Trade Journal 90(10):17–18.
10. Halls, Lowell K., ed. 1977. Southern fruit-producing woody plants used by wildlife. USDA Forest Service, General Technical Report SO-16. Southern Forest Experiment Station, New Orleans, LA. 235 p.
11. Harms, W. R. 1973. Some effects of soil type and water regime on growth of tupelo seedlings. Ecology 54:188–193.
12. Hook, D., and C. L. Brown. 1973. Root adaptations and relative flood tolerance of five hardwood species. Forest Science 19:225–229.
13. Hook, Donal D., and R. M. Crawford, eds. 1978. Plant life in anaerobic environments, p. 311. Ann Arbor Science Publishers, Ann Arbor, MI.
14. Hook, D. D., and D. S. DeBell. 1970. Factors influencing stump sprouting of swamp and water tupelo seedlings. USDA Forest Service, Research Paper SE-57. Southeastern Forest Experiment Station, Asheville, NC. 9 p.
15. Hook, D. D., and J. Stubbs. 1967. Physiographic seed source variation in tupelo-gums grown in various water regimes. *In* Proceedings, Ninth Southern Forest Tree Improvement Conference. p. 61-64. International Tree Seed Laboratory, Macon,GA.
16. Hook, D. D.,W. P. LeGrande, and 0. G. Langdon. 1967. Stump sprouts on water tupelo. Southern Lumberman 215(2680):111–112.
17. Hook, D. D., 0. G. Langdon, J. Stubbs, and C. L. Brown. 1970. Effect of water regimes on the survival, growth, and morphology of tupelo seedlings. Forest Science 16:304–311.
18. Hosner, J. F., and A. L. Leaf. 1962. The effect of soil saturation upon the dry weight, ash content, and nutrient absorption of various bottomland tree seedlings. Proceedings, Soil Science Society of America 26(4):401–404.
19. Johnson, R. L., and W. R. Beaufait. 1965. Water tupelo *(Nyssa aquatica* L.). *In* Silvics of forest trees of the United States. p. 284-286. H. A. Fowells, comp. U.S. Department of Agriculture, Agriculture Handbook 271. Washington, DC.
20. Kennedy, Harvey E., Jr. 1982. Growth and survival of water tupelo coppice regeneration after six growing seasons. Southern Journal of Applied Forestry 6(3):133–135.
21. Klawitter, R. A. 1964. Water tupelos like it wet. Southern Lumberman 290(2609):108–109.
22. Langdon, 0. Gordon, and Kenneth B. Trousdell. 1978. Stand manipulation: effects on soil moisture and tree growth in southern pine and pine-hardwood stands. *In* Proceedings, Soil Moisture-Site Productivity Symposium, Nov. l-3, 1977, Myrtle Beach, SC. p. 221-236. William E. Balmer, ed. USDA Forest Service, Southeastern Area, State and Private Forestry, Atlanta, GA.
23. Laundrie, J. F., and J. S. McKnight. 1969. Butt swells of water tupelo for pulp and paper. USDA Forest Service, Research Paper FPL-119. Forest Products Laboratory, Madison, WI. 11 p.
24. McGarity, R. W. 1977. Ten-year results of thinning and clear-cutting in a muck swamp timber type. International Paper Company, Technical Note 38. Natchez Forest Research Center, Natchez, MS. 5 p.
25. McKnight, J. S. 1965. Hints for direct seeding southern hardwoods. *In* Proceedings, Direct Seeding Workshops, Oct. 5-6 and 20-21, 1965, Alexandria, LA, and Tallahassee, FL. p. 26-35. USDA Forest Service, Atlanta, GA.
26. Morris, R. C. 1975. Tree-eaters in the tupelo swamps. Forests and People 25(1):22–24.
27. Priester, David S. 1979. Stump sprouts of swamp and water tupelo produce viable seeds. Southern Journal of Applied Forestry 3(4):149–151.
28. Putnam, John A., George M. Furnival, and J. S. McKnight. 1960. Management and inventory of southern hardwoods. U.S. Department of Agriculture, Agriculture Handbook 181. Washington, DC. 102 p.
29. Shunk, I. V. 1939. Oxygen requirements for germination of Nyssa aquatica. Science 90:565–566.
30. U.S. Department of Agriculture, Forest Service. 1974. Seeds of woody plants in the United States. C. S. Schopmeyer, tech. coord. U.S. Department of Agriculture, Agriculture Handbook 450. Washington, DC. 883 p.