

Chamaecyparis thyoides (L.) B.S.P. Atlantic White-Cedar

Cupressaceae Cypress family

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Atlantic white-cedar (*Chamaecyparis thyoides*), also called southern white-cedar, white-cedar, and swamp-cedar, is found most frequently in small dense stands in fresh water swamps and bogs. Heavy cutting for many commercial uses during this century has considerably reduced even the largest stands so that the total volume of this species growing stock is not currently known. It is still considered a commercially important single species in the major supply areas of North and South Carolina, Virginia, and Florida.

Habitat

Native Range

Atlantic white-cedar (fig. 1) grows in a narrow coastal belt 80 to 210 km (50 to 130 miles) wide from southern Maine to northern Florida and west to southern Mississippi. Atlantic white-cedar forests, however, have always been of minor importance because the scarcity of suitable sites makes distribution of the species within the coastal belt exceedingly patchy. White-cedar is most important commercially in southeastern New Jersey, southeastern Virginia, eastern North Carolina, and northwestern Florida (1,3,8,9,11).

Climate

The climate throughout most of the range of white-cedar is classed as humid but varies widely in other respects. Average annual precipitation is 1020 to 1630 mm (40 to 64 in) and is well distributed throughout the year. The frost-free season is from 140 to 305 days. Temperature extremes range from -38° C (-36° F) in Maine in winter to highs of over 38° C (100° F) during the summer in most sections (6).

Soils and Topography

White-cedar grows on wet ground or in swamps, sometimes on sandy soils, but usually on muck, formerly called peat. Soils include the orders of Spodosols and Histosols. The muck ranges from a

few centimeters to 12 m (40 ft) in depth and is generally acid, with pH often between 3.5 and 5.5. White-cedar is absent or uncommon in areas where muck is underlaid by clay or contains appreciable amounts of silt or clay (6).

As its range is restricted principally to coastal areas and to wet or swampy ground, Atlantic white-cedar usually grows at low elevation. In southeastern New Jersey these typically range from about 1 m (3 ft), where white-cedars border the tidal marsh, to 43 m (140 ft) in some inland stands. The species currently grows in at least one upland bog in northern New Jersey at an elevation of 457 m (1,500 ft).

Associated Forest Cover

Because Atlantic white-cedar grows characteristically in pure stands it is found mostly in one forest cover type, Atlantic White-Cedar (Society of American Foresters Type 97) (5), but is listed as an associate in six other types: Pitch Pine (Type 45); Slash Pine-Hardwood (Type 85); Baldcypress (Type 101); Water Tupelo-Swamp Tupelo (Type 103); Baldcypress-Tupelo (Type 102); Sweetbay-Swamp Tupelo-Redbay (Type 104). Over its great latitudinal range, however, several other species of trees have been found growing with it. These include red maple (*Acer rubrum*), black gum (*Nyssa sylvatica*), yellow birch (*Betula alleghaniensis*), eastern white pine (*Pinus strobus*), gray birch (*Betula populifolia*), pond pine (*Pinus serotina*), eastern hemlock (*Tsuga canadensis*), and loblolly-bay (*Gordonia lasianthus*).

Many nonarborescent plants also grow with white-cedar. In a study of sixteen 0.04-hectare (0.1-acre) plots in southern New Jersey, the most common species of 25 shrubs associated with it were sweet pepperbush (*Clethra alnifolia*), swamp azalea (*Rhododendron viscosum*), highbush blueberry (*Vaccinium corymbosum*), dangleberry (*Gaylussacia frondosa*), and sweetbells leucothoe (*Leucothoe racemosa*). In a North Carolina study, fetterbush lyonia (*Lyonia lucida*) was the most common shrub, but sweetbells leucothoe, highbush blueberry, and sweet pepperbush were also present (6).

Life History

Reproduction and Early Growth

Flowering and Fruiting-White-cedar is monoecious, but the staminate and pistillate flowers are

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Chamaecyparis thyoides

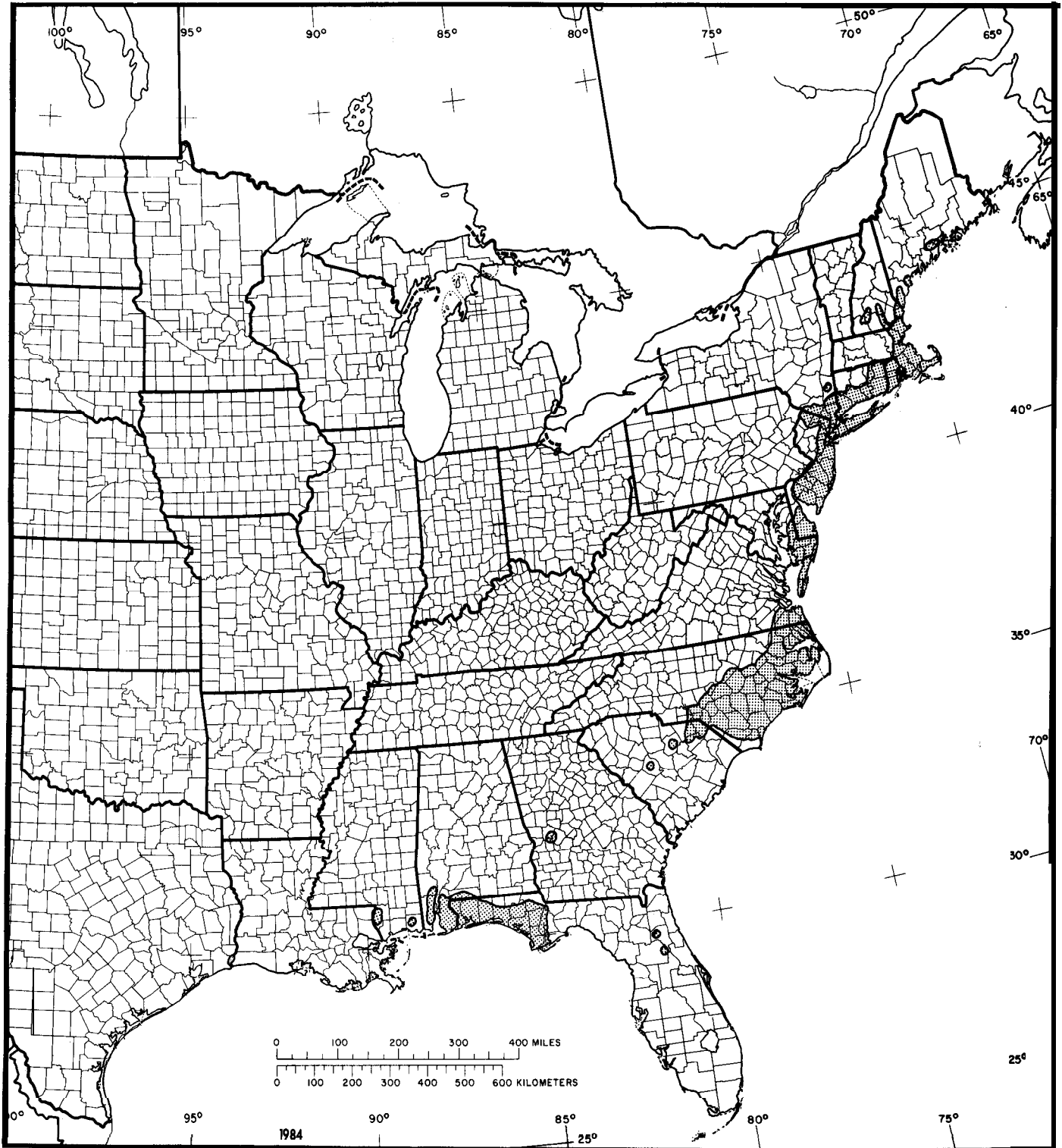


Figure 1-The native range of Atlantic white-cedar.

produced on separate shoots. The flower buds are formed in the summer and, though minute, are discernible in the fall or winter. In New Jersey, the brownish staminate buds are only about 1 mm (0.04 in) long or wide in February. The greenish pistillate buds at the ends of short shoots are about the same size. When mature, the four-sided, oblong, staminate flowers are about 3 mm (0.1 in) long, and the pistillate flowers are about that wide. Pollen shedding usually occurs in early April in southern New Jersey.

The cones mature at the end of the first growing season. Full-grown cones are spherical, about 6 mm (0.2 in) in diameter and contain 5 to 15 winged seeds (6). Seeds are rounded, slightly compressed, about 3 mm (0.1 in) long, and have winged margins about as broad as the seeds. There are about 1,014,000 seeds per kilogram (460,000/lb) (12).

Seed Production and Dissemination-Under favorable conditions, some 3-year-old Atlantic white-cedars bear mature cones. In one planting of 1,300 2-year-old seedlings, 2 percent of the trees had mature cones at the end of the first growing season in the field. In another planting, 20 percent of the 3-year-old seedlings produced one or more cones, and one tree had 64; but these seedlings were relatively large, 28 cm (11 in) tall. Seedlings only 10 cm (4 in) tall produced no cones (6).

Natural reproduction in open stands starts bearing seed at 4 or 5 years, in dense stands at 10 to 20 years (6).

Cone production varies appreciably with tree size and crown class. Intermediate or crowded stems produce markedly fewer cones than open-grown or dominant trees of the same size. In one comparison of clumped and open-grown trees, the larger, mostly dominant trees in the clumps were fully as productive as open-grown trees of the same size; but the intermediate and smaller clumped trees were much less productive than their open-grown counterparts (4). Average numbers of cones per tree for some selected sizes were as follows:

Parent trees	Clumped trees no. of cones	Open-grown trees
1.5 to 2.1 m (5 to 7 ft) tall	4	52
8 to 10 cm (3 to 4 in) d.b.h.	1,074	2,891
13 to 18 cm (5 to 7 in) d.b.h.	4,540	4,218

White-cedar usually produces fair to excellent seed crops each year. Under one mature stand the catch in seed traps was 19.77 million seeds per hectare (8 million/acre) in 1 year and 22.24 million/ha (9 million/acre) the next year (6).

Natural seed dissemination begins in October in New Jersey and most of the seeds are released before

the end of the winter. In one study, 39 percent of the crop fell by November 15, more than 60 percent by December 15, and 93 by March 1 (6).

Seed dispersal is influenced by weather conditions. In one series of observations, rain showers of 4 mm (0.16 in) or less caused only partial closing of some cones, whereas rains of 11 mm (0.45 in) or more caused all cones to close (6).

Wind distributes most of the white-cedar seeds, although some may be further scattered by floating on water. Probably because the seeds are so small and have relatively large wings, the rate of fall is slow-0.02 m (0.6 ft) per second in still air. Calculations based on this rate of fall indicate that a wind of 8 km/h (5 mi/h) would carry most seeds from a 15-m (50-R) tree about 183 m (600 ft). Records of seed traps around and under white-cedar stands showed that most of the seeds fall directly under the stands. Where surrounding vegetation was of comparable height, no seeds were trapped beyond 20 m (66 ft) from the stand's edge.

In a study of seed distribution from isolated trees, 60 percent of the seeds fell at a distance greater than the height of the tree, even though the catch per trap decreased greatly with increased distance. Because of prevailing winds during dry periods, 80 to 85 percent of the seed catch was on the east side of the source (6).

Seedling Development-The viability of white-cedar seeds varies from very low to a high of nearly 90 percent. In some tests, the average was 84 percent (12). One cutting test of New Jersey seeds from a poor crop yielded only 8 percent sound seeds, but actual germination from a good crop the following year reached 76 percent. Viability of seeds from trees 3 to 4 years old may be low; in two tests only 3 to 25 percent of such seeds germinated (6).

Germination is epigeal, but delayed germination is common. Half the seeds sown in the fall in a nursery may not germinate until the second year. Consequently, stratification for 90 days at 4° C (40° F) before sowing has been recommended (12). Some of the seeds produced by mature stands remain viable for an unknown length of time when stored in the forest floor. In a New Jersey study of sites protected from additional seedfall for 1 year, the surface 2.5 cm (1.0 in) of forest floor was found to contain 642,000 to 2,718,000 viable seeds per hectare (260,000 to 1,100,000/acre), with nearly an equal amount in the 5-cm (2-in) muck layer underneath (6).

A fair amount of light is necessary for good germination of white-cedar seeds, but in one study, light intensity had to be less than 16 percent of full sunlight before germination was greatly reduced. Some

germination occurred under a hardwood overstory where light intensity was only 1 percent of full sunlight (6).

Favorable moisture conditions are highly important for the germination and establishment of Atlantic white-cedar seedlings. In one experiment with artificial seeding, 49 percent of the seeds germinated in clearcut plots under typical swamp conditions, whereas in similar plots on drier but still poorly drained sites, only 16 percent germinated on exposed soil. As seedlings develop a very short taproot, the successful establishment of white-cedar requires not only adequate surface moisture for seed germination, but also available moisture within reach of the comparatively shallow root systems.

Suitable seedbeds include moist rotting wood, sphagnum moss, and muck, which are all common in many swamps, and moist mineral soil. A thick litter of pine needles, or the leaves of shrubs and hardwood trees, is unfavorable. On one poorly drained site with a thick litter, removing the litter from seed spots increased germination from less than 1 percent on untreated areas to 13 percent on the cleared spots. Stocking of spots was 3 and 81 percent.

Dense slash is extremely unfavorable for white-cedar establishment. In studies of natural reproduction on cutover areas, slash-free spots had at least 28 times as many seedlings as spots covered with dense slash (6).

The microrelief of swamps also greatly affects seedling establishment. Spots where water stands on the surface during much of the year are unfavorable for both seed germination and seedling survival. Suitable conditions are limited to the hummocks above the usual water table, but on these hummocks seedlings may die during dry periods from insufficient moisture. In general, the younger or smaller the seedlings are, the greater the mortality from either drowning or drought.

Relatively open conditions are essential for good survival and growth of white-cedar seedlings. At light intensities of 4 to 6 percent of full sunlight, as under mature white-cedar stands in New Jersey, seedlings survive for only 1 to 3 years. Partial cuttings that thin the overstory enable white-cedar reproduction to live longer, but not as long as competing hardwoods and shrubs. Under a light intensity of 77 percent, the initial growth of white-cedar seedlings was about twice that under a 16-percent intensity and almost 4 times that under a 4-percent intensity. Hence, only relatively open areas, such as abandoned cranberry bogs and clearcuttings, provide the conditions necessary for white-cedar seedlings to compete successfully with hardwood and shrub associates (6).

Open-grown Atlantic white-cedar seedlings may reach an average height of 6 cm (2.5 in) on unfavorable sites (such as sandy, poorly drained soils or cranberry bogs) and 15 to 25 cm (6 to 10 in) on favorable sites in the first year. In contrast, seedlings growing in swamps under heavy shade may reach a height of only 2.5 cm (1 in) and a taproot length of only 5 cm (2 in) during the same time.

On favorable open sites, seedlings add 0.2 to 0.3 m (0.6 to 0.9 ft) to their height during the second year, and about 0.3 m (1 ft) a year for a few years thereafter. Under these conditions, stems 3 m (10 ft) tall may be 7 or 8 years old in the South and about 10 years old in the Northeast. On less favorable sites, however, they may grow to heights of only 1.2 to 2.1 m (4 to 7 ft) in 15 years (6).

Vegetative Reproduction-White-cedar seedlings or saplings, if severely browsed or otherwise injured, will sometimes develop shoots from lateral branches or from dormant buds on the stem. One white-cedar seedling girdled by meadow mice produced 26 sprouts 2 to 10 cm (1 to 4 in) long at its base. Seedlings of this species when repeatedly browsed by deer may develop multiple stems through layering. From one such seedling 1 m (3 ft) tall, 14 additional stems 0.2 to 1.0 m (0.5 to 3.3 ft) tall developed. Growth of the layered stems is slow, however (6).

Sapling and Pole Stages to Maturity

Growth and Yield-On good sites white-cedar grows 0.3 to 0.5 m (1.0 to 1.5 ft) in height each year and 0.25 to 0.40 cm (0.10 to 0.15 in) in d.b.h. until trees are 40 to 50 years old. After 50 years, height growth slows, while diameter growth continues at about the same rate for an additional 50 years. Height growth essentially ceases at 100 years (6).

Although white-cedar trees are relatively small, the basal area and volume of stands tend to be high because of the high stand density. On the basis of three 0.1 ha (0.25 acre) plots, one stand in Gates County, NC, had 68 m²/ha (294 ft²/acre) of basal area, 85 percent of which was white-cedar. Most of the trees of these plots were between 5 and 36 cm (2 and 14 in) in d.b.h. According to yield tables, basal areas may reach more than 69 m²/ha (300 ft²/acre). On areas with a site index at base age 50 years of 14 m (45 ft), 50-year-old stands may have 56 to 57 m²/ha (245 to 250 ft²/acre) of basal area and a total volume, including stumps and tops, of 322 m³/ha (4,600 ft³/acre). On a site index of 12 m (40 ft), a 60-year-old stand may have 4,200 stems per hectare (1,700/acre), yielding about 220 m³/ha (35 cords/acre) to an inside-

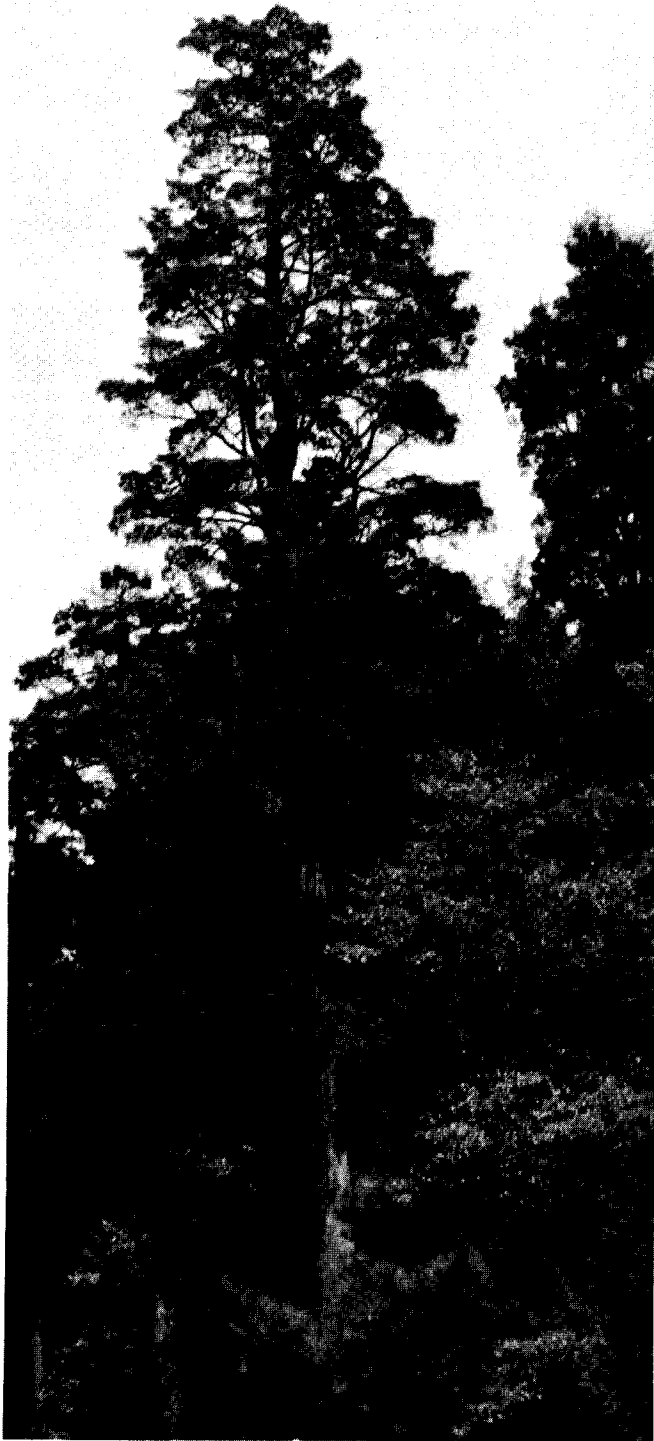


Figure 2-Atlantic white-cedar on Lebanon Experimental Forest, NJ.

bark top diameter of 10 cm (4 in); a 10-year-old stand on a site index of 21 m (70 ft), 865 trees per hectare

(350/acre) and 693 m³/ha (110 cords/acre). The yield to an inside-bark top diameter of 15 cm (6 in) is 600 m³/ha (42,900 fbm/acre, International rule) at 60 years, and 1000 m³/ha (71,500 fbm/acre) at 100 years, both on a site index of 21 m (70 ft) (6).

In southern New England (lat. 41° to 42° N.), mature white-cedars (fig. 2) reach heights of 12 to 18 m (40 to 60 ft) and a d.b.h. of about 41 cm (16 in), although some have grown to 122 cm (48 in). Optimum development—a maximum height of 37 m (120 ft) and a d.b.h. of 152 cm (60 in)—apparently occurred in the Virginia-North Carolina section at lat. 34° to 37° N. The maximum sizes for white-cedar in Alabama (approximately lat. 31° N.) are somewhat less: 24 to 27 m (80 to 90 ft) high, with d.b.h. rarely more than 61 cm (24 in) (6).

Potentially, white-cedar is a relatively long-lived species. According to one source, some trees have reached 1,000 years of age, although stand age rarely exceeds 200 years (6).

Rooting Habit—Atlantic white-cedar has a shallow root system. In swamps where the lower soil layers are permanently saturated with water, the roots are confined chiefly to the upper 1 to 2 feet of peat. Where the water table occurs at lower levels and the soils are more deeply aerated, the roots often penetrate to greater depths.

The small taproot formed during the first year is subsequently lost in the development of the strong superficial lateral roots. These are numerous but do not become large. Because of its characteristically shallow root system and weak root hold in the spongy organic soils, white-cedar cannot withstand severe winds, and many mature trees are felled in storms. Trees which have grown in dense stands on swamp peat never become windfirm, and consideration must be given this fact in planning the harvest of this species.

Reaction to Competition—Atlantic white-cedar is more tolerant of shade than associated species such as gray birch and pitch pine, but much less tolerant than red maple, blackgum, sweetbay, and other hardwoods that form the climax on swamp sites in its range. It is most accurately classed as intermediate in tolerance to shade. White-cedar reproduction can grow through, and eventually overtop, scattered to moderately dense shrubs such as highbush blueberry, although in the process the cedar shoots may become extremely slender, almost like grass. White-cedar is not sufficiently tolerant, however, to grow through dense shrub thickets or through a hardwood overstory (6).

Damaging Agents-Crown fires kill white-cedar. Composition of the succeeding stand varies according to (1) the degree to which the forest floor is burned, (2) the age of the burned stand and thus the amount of viable seed stored in the forest floor, (3) the proximity to other sources of white-cedar seed, and (4) the stocking of hardwoods and shrubs in the understory. If fire burns deep enough to eliminate trees of all kinds, a pond (or open bog) or a cover of leatherleaf (*Chamaedaphne calyculata*) may result. If the hummocks remain above the water table, a new stand of Atlantic white-cedar or hardwoods usually develops.

White-cedar on typical swamp sites is shallow rooted and subject to windthrow, especially in stands that have been opened by partial cuttings. Wind, often aided by snow or ice, is beneficial to hardwood understory development at times when white-cedar stands are gradually opened by the periodic windthrow or breakage of scattered trees; but extensive wind damage in one storm favors development of another white-cedar stand. Along the coast, salt water brought in by storm tides kills stands of various species, sometimes permitting a pure white-cedar stand (developing from seeds stored in the forest floor) to follow one composed largely of hardwoods (6).

Few fungi attack Atlantic white-cedar, and damage is not usually serious. *Keithia chamaecyparissi* and *Lophodermium juniperinum* attack white-cedar foliage; *Gymnosporangium ellisii* sometimes causes a broomlike development of branches; *G. biseptatum* occasionally causes a spindle-shaped swelling of stems or branches. Roots may be attacked by *Armillaria mellea*, *Heterobasidion annosum*, or *Phaeolus schweinitzii*. The latter and *Fomitopsis cajanderi* may attack heartwood, although the heartwood of Atlantic white-cedar is very resistant to decay (7).

White-cedar has no serious insect enemies, although larvae of the common bagworm (*Thyridopteryx ephemeraeformis*) may feed on its foliage.

Special Uses

The lightweight, straight-grained wood of Atlantic white-cedar is easily worked, resistant to decay, and shrinks and warps very little during seasoning. These characteristics probably govern its use today as much as they did in colonial times. In those times it was used for shingles, barrels, tanks, and small boats. Today it is still used where durability, light

weight, and resistance to weathering are important considerations: telephone poles, piling, ties, siding, boat railing, and ice cream tubs. Atlantic white-cedar has limited value for wildlife-white-tailed deer browse its foliage-and is occasionally used as an ornamental (2,4).

Genetics

In some taxonomic treatments of white-cedar, the southern element in Florida, Alabama, and Mississippi has been named as a separate variety, *Chamaecyparis thyoides* var. *henryae* (Li) Little. Of the many horticultural cultivars, at least one narrow, upright form has been described (10).

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