Casuarina L. ex Adans **Casuarina**

Casuarinaceae Casuarina family

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Casuarina species, native to Australia and neighboring areas, have been introduced into many countries. In the United States, three species have been established, primarily in Hawaii, California, and Florida: *C. equisetifolia* L. ex J. R. & G. Forst., *C. cunninghamiana* Miq. and C. *glauca* Sieber ex K. Spreng. Other common names of *Cusuarina* are Australian-pine, beefwood, and horsetail-tree.

Habitat

Range

Casuarina equisetifolia and *C. cunninghamiana* are naturalized to the southwestern and southeastern coastal areas of Florida as far north as Tampa and Titusville, with *C. equisetifolia* particularly prevalent on beaches; *C. glauca* is present throughout the same general area, frequently as very dense stands along roads and fence lines. *Casuarina cunninghamiana* exists as planted trees as far north as Gainesville. In Hawaii, C. *equisetifolia* is common along sandy coasts and lowlands (9).

Climate

In Australia, these species grow in the tropical and subtropical north and east: *C. cunninghamiana* along rivers, *C. glauca* in swamps, and *C. equisetifolia* along the coast.

In Florida, C. *cunninghamiana* and C. *glauca* have a wide tolerance for moisture regimes, as they are present on sites ranging from dry to very wet but not permanently flooded. *Casuarina equisetifolia* performs well on dry sites only; *C. glauca* appears to be the most frost hardy, although it will not withstand long periods below freezing, and C. *cunninghamiana* is intermediate in frost tolerance. There seem to be no climatic barriers to sexual reproduction.

Soils and Topography

All three *Casuarina* species prefer coarse-textured soils of the Entisol, Inceptisol, and Spodosol orders. They show wide latitude in their soil demands and range from dry, sandy beach ridges to wet lake margins, but they withstand inundation for short periods only. In southeastern Florida, the species are particularly prevalent on alkaline, limestone-derived soils. *Casuarina equisetifolia* is tolerant of very saline conditions but grows best in slightly acid sandy soils. All three species tolerate low soil fertility but are quite responsive to fertilization with phosphorus or nitrogen and phosphorus. They reach maximum development in slightly depressional topography where adequate moisture is nearly always available.

Associated Forest Cover

When casuarina is present through natural seeding in Florida, it tends to form pure stands that are often nearly devoid of other vegetation *(4)*. It may coexist with vegetation such as Florida fishpoisontree *(Piscidia piscipula)*, button-mangrove *(Conocarpus erectus)*, myrsine *(Rapanea punctata)*, stopper *(Eugenia* spp.), randia *(Randia* spp.), cocoplum *(Chrysobalanus icaco)*, southern bayberry *(Myrica cerifera)*, redbay *(Persea borbonia)*, and Florida poisontree *(Metopium toxiferum) (3)*.

Life History

Reproduction and Early Growth

Flowering and Fruiting-Casuarina species have been reported to be monoecious *(13)* and dioecious *(6); C. glauca* in Florida has not been observed to bear female flowers. Flowering occurs principally from April to June, with numerous minute narrow and terminal male flowers crowded in rings among grayish scales, and rounded and lateral female flowers occurring in light-brown clusters *(9,13)*. Female flowers are wind poliinated. The multiple fruit, gray brown and 8 to 15 mm (0.3 to 0.6 in) in diameter, ripen from September through December. Seed bearing usually begins by age 5, and good seed crops occur annually *(13)*.

Seed Production and Dissemination-The conelike fruits mature throughout the year, although heavier crops occur in the fall and winter. When the fruits dry from December to March, the samaras, which range in length from 3 to 8 mm (0.1 to 0.3 in), depending on species *(14)*, are released and wind disseminated. Germination of the seeds is epigeal and good on moist, bare soil.

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Seeds may be extracted readily from air-dried fruits. Cleaned seed yields range from 661,000 to 1,653,000/kg (300,000 to 750,000/lb) depending on species and location ***(13).*** Germination of seeds stored for 2 years under conditions ranging from 6 to 16 percent moisture content and -7" to 3" C (20° to 38" F) can be from 40 to 50 percent *(7).* No pregermination treatment is required ***(13).*** Broadcast sowing of seeds, followed by a thin topping of soil or other nursery medium sufficient to give 215 to 323 seedlings/m^2 (20 to 30/ft^2), can result in outplantable seedlings within 3 months.

Seedling development is partly dependent on the presence of a symbiont, the filamentous actinomycete ***Frankia*** spp., which allows casuarina to fix atmospheric nitrogen. Inoculation of nursery-grown seedlings is therefore advisable. This can be accomplished by application of a 10 percent suspension of ground casuarina root nodules with water to the nursery medium *(11,18).*

Figure 1-A Casuarina glauca *specimen near Miami, FL, that shows prolific root suckering. (Courtesy D. L. Rockwood, University of Florida)*

Seedling Development-Under proper conditions, growth of casuarina seedlings is extremely rapid, with growth rates of more than 2 m (6.5 ft) possible the first year. Such rates of growth are observed only when no competing herbaceous vegetation is present and may be possible only when the seedlings have been inoculated with ***Frankia*** spp., as noted earlier ***(11).***

Vegetative Reproduction-The three species show different levels of root suckering: ***C. glauca*** root suckers prolifically ***(fig.*** 1); ***C. cunninghamiana,*** infrequently; and ***C. equisetifolia,*** not at all. Rooting success, as evidenced by preliminary trials with line branches from lower to middle portions of crowns, is satisfactory for ***C. cunninghamiana*** and ***C. glauca*** but low for ***C. equisetifolia.*** Use of rootone and a sand medium typically resulted in rooting as high as 50 percent in the spring. Grafting appears to be successful ***(1).***

Sapling and Pole Stages to Maturity

Growth and Yield-Early growth is rapid, and height increments exceeding 1.5 m (5 ft) per year are common. Mature trees in stands of ***C. cunninghamiana*** and ***C. equisetifolia*** may reach 32 m (105 ft) in height and 41 cm (16 in) in d.b.h.; more commonly, heights of 25 m (82 ft) and diameters of 25 cm (10 in) are attained. Initial survival rates for planted trees are acceptable, averaging over 87 percent. One 35-year-old stand of ***C. glauca*** had a basal area of 90 m^2/ha (392 ft^2/acre) composed of trees averaging 19 m (62 ft) in height and 14 cm (5.5 in) in d.b.h.

Total aboveground dry biomass yields of young natural stands of ***C. equisetifolia*** have been as high as 16.6 t/ha (7.4 tons/acre) per year. Such stands, with densities up to 11,400 trees per hectare (4,600/acre), have trees ranging from 0.6 to 18 cm (0.25 to 7 in) in d.b.h., with an average of 4.3 cm (1.7 in) at an estimated age of 7.5 years.

Rooting Habit-Casuarina has a spreading, fibrous root system that can penetrate quite deeply into the soil if subsurface moisture is available. A very dense mat of adventitious roots may be formed in response to wet conditions. The root hairs become infected by ***Frankia*** spp. and form nitrogen-fixing nodules ***(18).***

Reaction to Competition-Casuarina species are intolerant of shade but capable of rapidly invading new sites and forming pure stands. When young, trees are easily suppressed by some forms of compet-

ing vegetation, especially grasses and sedges, particularly if seedlings are not nodulated and cannot fix atmospheric nitrogen. On a well-prepared palmetto prairie in Florida, for example, newly planted casuarina seedlings failed to survive competition from wiregrass *(Aristida stricta)* that rapidly reinvaded the site. In the Philippines and in the Highlands of Papua, New Guinea, however, casuarina seedlings have been reported to compete aggressively against *Imperata* grass, a weed that makes large areas of the tropics useless for agriculture *(12).* Once casuarina trees dominate a site, however, their heavy root mat and the deep litter layer tend to reduce, even eliminate, competitors.

Damaging Agents-Casuarina appears to have relatively few insect problems. The twig girdler *(Oncideres cingulata)* is harmful only to small trees; damage by the leaf notcher weevil *(Artipus floridanus)* usually is inconsequential; and one species of spittlebug *(Clastoptera undulata)* appears to infest individual trees but causes no serious damage (2). The Australian pine borer *(Chrysobothris tranquebarica)* has on occasion devastated trees 5 years or less in age by girdling the stems *(17).*

The major biological cause of death of casuarina on well-drained, acid, sandy soils is a mushroom root rot *(Clitocybe tabescens) (15); Casuarina cunninghamiana* may be less susceptible than the other species. The incidence of root rot is reduced on wetter sites, with no evidence of the disease in alkaline soils.

Primary nonbiological losses are from lightning and frost. Killing lightning strikes are common to casuarina that are dominant in the south Florida landscape. Freezing temperatures can damage well-established trees; temperatures of approximately -8" C (18" F) kill trees less than 0.5 m (1.6 ft) in height.

Figure 2—*Dense 7.5-year-old stand of* Casuarina equisetifolia near *Indian Rocks Beach, FL. (Courtesy L. F. Conde, University of Florida)*

Special Uses

No commercial use is made of casuarina in Florida, although its pulping properties are acceptable (5) and reputed to be better than those of eucalyptus *(Eucalyptus* spp.) (8). The species have been widely used for shelterbelts and in landscaping as hedges and ornamentals *(1); C. glauca* has been frequently planted for soil stabilization near drainage ditches and lakeshores (fig. 2).

The species are well suited for fuelwood because of their fast growth rates, coppicing potential, and desirable wood properties. Their wood densities of approximately 0.72 are among the highest for Florida trees, their green wood moisture content is relatively low at 60 to 88 percent on an ovendry basis, and their whole-tree energy values are considerably higher than those of other species *(16).* The ash content is 'slightly higher than that of most native American woods, averaging about 2 percent; the ash content of bark is twice this amount. The wood dries rapidly and burns well. Attempts to saw and season casuarina for use as lumber have not been satisfactory *(10).* Casuarina bark has been used in tanning and medicine, and the fruits have been used for novelties and decorations *(13).*

Genetics

The geographic seed origins of casuarina in Florida are not known. Although trees characteristic of each species can be readily located, classification of individual trees is sometimes difficult because a high degree of hybridization is presumed. The three species are found together in much of south Florida and have compatible flowering times. A *C. cunninghamiana* x C. *glauca* hybrid has grown faster than any of the three species *(1).* Studies of individual tree collections of *C. cunninghamiana* and *C. equisetifolia* from four areas in south Florida do not indicate differences among trees, sources, or species for survival through 6 months *(16).*

Literature Cited

1. Badran, 0. A., and M. H. El-Lakany. 1977. Breeding and improving of *Cusuarina* for shelterbelt plantations in Egypt. In Third World Consultation on Forest Tree Breeding. p. 573478. FAO, Rome, Italy.

2. Chellman, C. W. 1978. Pests and problems of south Florida trees and palms. Florida Department of Agriculture and Consumer Services, Division of Forestry, Tallahassee. 103 p.
3. Craighead, Frank C., Sr. 1971. The trees of south Florida. Vol. 1. The natural environments and their succession. University of Miami Press, Coral Gables, FL. 212 p.
4. Crowder, J. P. 1974. Exotic pest plants of south Florida. South Florida Environmental Project, Ecological Report DI-SFEP-74-23. U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, Atlanta, GA. 49 p.
5. Curran, C. E., S. L. Schwartz, and M. W. Bray. 1934. The pulping of cajeput, white mangrove, Australian pine, and Cunningham pine by the sulphate process. Paper Trade Journal 23:288–291.
6. Forestry and Timber Bureau. 1957. Forest trees of Australia. Government Printing Office, Canberra. 230 p.
7. Jones, L. 1967. Effects of storage at various moisture contents and temperatures on seed germination of silk oak, Australian pine, and *Eucalyptus* spp. USDA Forest Service, Research Note SE-83. Southeastern Forest Experiment Station, Asheville, NC. 4 p.
8. Kandell, S. A. E., J. Isebrands, and M. H. Ah. 1980. Evaluation of short rotation ***Cusuarina*** and ***Eucalyptus*** for pulp production. Forest Products Research Society Abstracts 34:24.
9. Little, Elbert L., Jr. 1978. Important forest trees of the United States. U.S. Department of Agriculture, Agriculture Handbook 519. Washington, DC. 70 p.
10. Loughborough, W. K. 1959. A study of the seasoning and allied characteristics of *Casuarina equisetifolia.* Unpublished report. University of Florida, School of Forest Resources and Conservation,Gainesville.
11. Mowry, H. 1933. Symbiotic nitrogen fixation in the genus *Casuarina.* Soil Science 36:409–426.
12. National Research Council. 1984. Casuarinas: nitrogen-fixing trees for adverse sites. National Academy Press, Washington, DC. 118 p.
13. Olson, David F., Jr., and E. Q. P. Petteys. 1974. *Cusuarina. In* Seeds of woody plants in the United States. p. 278-280. C. S. Schopmeyer, tech. coord. U.S. Department of Agriculture, Agriculture Handbook 450. Washington, DC. 883 p.
14. Peattie, D. C. 1925. Casuarinas of America identified by branchlets and seeds. Journal of Washington Academy of Science 13:345–346.
15. Rhoads, A. A. 1952. The destructiveness of Clitocybe root rot on plantings of *Casuarina* in Florida. Lloydia 15:161–184.
16. Rockwood, D. L., J. B. Huffman, and L. F. Conde. 1983. Potential of Casuarina spp. for biomass production in Florida. Silvicultura 8(30):376–377.
17. Snyder, T. E. 1919. Injury to ***Casuarina*** trees in southern Florida by the mangrove borer. Journal of Agricultural Research 16(6):155–171.
18. Torrey, J. G. 1976. Initiation and development of root nodules of *Casuarina.* American Journal of Botany 63:335–344.