

ELEMENT STEWARDSHIP ABSTRACT
for

Casuarina equisetifolia

Australian Pine

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The Nature Conservancy
Element Stewardship Abstract
For *Casuarina equisetifolia*

I. IDENTIFIERS

Common Name: AUSTRALIAN PINE, SHEA (SHE)-OAK, BEEFWOOD, HORSETAIL TREE, CASUARINA, SCALY BARK OAK, COMMON IRONWOOD, SWAMP OAK, GAGO, GOAGO, GAGU, AGOHO, GAOGAO, AGAS, NGAS, NGASU, WHISTLING PINE

General Description:

The angiosperm family, Casuarinaceae, includes 4 genera and 82 species (Woodall and Geary 1985). All *Casuarina* species have evergreen, needlelike foliage and woody cones. They are fairly stout-trunked, rough-barked, fast-growing trees with nearly erect or semi-spreading main branches and slim branchlets. The tufts of deciduous, jointed, grooved, green twigs resemble pine needles but separate easily at the nodes where the true leaves are seen as tiny, pointed teeth ringing the joint (Morton 1980). Their midveins run down to the next node and form more or less distinct ribs. Such scales cannot perform most of the functions of normal leaves. These are taken over by the needles. However, the scales are helpful in an environment where fresh water is scarce; the lack of typical leaves and the structure of the needles retard the escape of water. (Barrett 1956)

Male flowers are borne in slender, cylindrical spikes at the twig tips.

Each flower is subtended by 3 or 4 bracts and consists of a single stamen. The female flowers occur in lateral heads on non-shedding branchlets and the fruits form woody cones when ripe. In moist soils at certain sites in Australia and elsewhere, one third or more of the trees are well nodulated by nitrogen-fixing bacteria (Morton 1980, Burger 1971, Kunkel 1978, Langeland 1988, Woodall and Geary 1985, Long and Lakela 1971).

Seven Australian and one East Indian species of *Casuarina* were introduced into the United States before 1924, beginning with seeds brought from France in 1898 by the U.S. Dept. of Agriculture explorer, Dr. W. T. Swingle. Some seeds were distributed under erroneous names and problems of misidentification have continued since (Morton 1980, Woodall and Geary 1985).

Australian Pines were observed by botanists in Mexico prior to 1852. They were introduced into Barbados about 1870, into Hawaii before 1895, and were naturalized in the West Indies and Florida before 1920 (Morton 1980).

The most common *Casuarinas* established in southern and central Florida include three species: *Casuarina equisetifolia* L. (*C. litorea*, L.), *C. cunninghamiana* Miq., and *C. glauca* Sieb. ex Spreng. (*C. lepidophloia*, *C. cristata*). The presence of hybrids is a cause of uncertainty in readily distinguishing these species at a distance. Natural hybridization and differences in

nomenclature make American literature on the subject confusing (Woodall and Geary 1985, Long and Lakela 1971).

Casuarina equisetifolia: (Australian Pine, Beefwood, Horsetail Tree)

(Long and Lakela 1971, Barrett 1956) Leaf teeth, 6-8, occasionally brown tipped but usually becoming gradually whiter toward tip and edges. Longitudinal rib corresponding to leaf midvein sharp; stomatal trench at bottom of furrow prominent, filled with often exerted hairs. Branchlet diameter 0.7-0.8 mm. Secondarily thickened twigs dark gray, rough, with persistent, recurved leaf-teeth (Woodall and Geary 1985).

Monoecious. Staminate spike terminal, 0.6-2.5 cm long, with floral bracts enveloping stamens not visible around teeth before anthesis. Cones usually abundant, 10-20 mm in diameter, slightly longer than wide, covered while green with continuous mat of white hairs that turn rusty with age. The samara is 6-8 mm long and pale brown. Typically does not form root suckers, coppices weakly from low stumps, but may coppice well from stumps taller than 1 m (Woodall and Geary 1985).

This is the tallest species of the genus in Florida (up to 40 m). Drab olive foliage diffuse, primarily from widely spaced branches. Lateral branches originating low on stem often overtake the leader, producing a very broad somewhat flat-topped mature tree (Woodall and Geary 1985).

Casuarina cunninghamiana:(Australian River Oak) (Barrett 1956) The 7-10 leaf teeth are sharply pointed, mostly appressed with a narrow, brown, central portion and a gray tip. The longitudinal rib corresponding to leaf midvein is distinct and the stomatal trench between ribs is poorly defined with individual hairs rarely visible at X 25. Branchlets are thin, with a diameter of 0.4-0.7 mm. The teeth on the secondarily thickened twigs are not persistent, leaving a smooth, usually reddened bark.

Dioecious. The staminate spike is terminal, very long (1-5 cm) and the nodes are densely packed. The floral bracts enveloping stamens are prominent around the teeth even before anthesis. The cones are small, as long as wide, with thin glabrous, bracteoles. The samaras are 3-5 mm long; dull gray-brown. This tree does not commonly form root suckers; coppicing response in Florida has not been examined.

The largest *Casuarina* in Australia (35 m), but the smallest and least vigorous in Florida (10-15 m). Bole terete, without buttresses or flutings. The bark is hard and thick, light to dark gray.

Casuarina glauca:(Brazilian Oak, Scaly-Bark Beefwood, Swamp She(Shea)-Oak, Black She(Shea)-Oak) (Morton 1980, Long and Lakela 1971, Barrett 1956) The 10-14 leaf teeth are either entirely brown or with a brown ring where teeth unite. In the latter case, gray tips are occasionally missing due to abrasion. Longitudinal ribs and furrows are vague and the stomatal trenches indistinct. Branchlets range in diameter from 0.8-1.0 mm. The secondarily thickened twigs are brownish gray and rough from persistent leaf-teeth.

Dioecious. Staminate spike not clearly demarcated, terminal but occasionally with normal internodes distal to fertile segment, 1-2 cm long; floral bracts enveloping stamens not visible between teeth before anthesis. Cones not confirmed in Florida; in Australia, cones are 10-20 mm in diameter, slightly longer than wide, and often pubescent when young. The samaras are 3-5 mm long, grayish or pale brown. Root suckers ubiquitous, even in absence of mother tree injury. Readily coppices from stump.

In Florida, this is a moderately tall (20+ m) tree, usually single stemmed. The strong tendency for lateral branches in the upper two-thirds of crown to curve upward and become vertical combined with sometimes very long branchlets, makes the crown profile smooth and relatively narrow. Foliage of root suckers often joins lower branches such that open-grown trees may have "crown" extending to ground. Foliage a lustrous deep green, contrasting strongly with the smooth gray branches. Bole typically fluted several meters high, buttressing insignificant. Bark tight and pebbly-textured, pale brownish gray. The parallel longitudinal fissures develop on larger stems; even on old trees with rough bark, plates between fissures on upper stem recall the originally smooth bark (Woodall and Geary 1985).

Commercial applications: Early promoters of *Casuarina* species in Florida envisioned a wide variety of applications, including hardwood, pulpwood, and tannin, as well as the abundant sprouts serving as a source of forage for cattle. *Casuarinas* have proven inadequate for every one of these applications, although there have been reports of the tannin being used for curing alligator skins and preserving fishing lines. While cattle readily eat the sprouts in Australia, they are recognized as high in tannin, astringent, and constipating, and are used for hardship fare only. It is now known that tannin interferes with digestive system utilization of protein, results in weight deficits, and is carcinogenic.

Although hard, heavy, and strong, with a fine texture and tightly interlocked grain, the wood is brittle, difficult to plane smooth, and prone to crack and split. Seasoning results in heavy and uneven shrinkage, severe cupping, surface checking, casehardening, and other defects. The logs are difficult to saw; saws tend to heat, chatter, and veer off course producing offsize timber with little market value. (Morton 1980). Despite these drawbacks, researchers in Egypt still express some hope for technological uses of *Casuarina* woods (Badran and Tawfik 1971).

In Puerto Rico, the wood is used mainly for fenceposts and poles, rough barns, and other structures. In Africa and India, it is used for beams and posts, fenders against wharves, pilings, oars, masts, and mine props. Samoans have fashioned the wood into spears and war clubs (Vietmeyer 1986).

Although reportedly durable in salt water, the wood is very susceptible to drywood termites and not long-lasting in the ground (Vietmeyer 1986).

The most widely agreed upon and valuable application of *Casuarina* appears to be as firewood, especially in third world countries such as India and China. While reportedly difficult to start burning, it will burn when green and the ashes retain heat for a long time. It has a calorific value of 4,950 cal., 8,910 Btu's and has been called "the best firewood in the world" (Vietmeyer 1986).

Because of its tenacious resistance to salinity and desiccation, several third world countries, including Senegal, China, and Egypt, employ *C. equisetifolia* in forestation projects. The object of planting these trees as windbreaks is to reduce wind velocity, evaporation, and wind erosion in order to protect crops and homes, and control movements of sand dunes. After the trees have reached their ultimate size and maturity the wood may then be used (Badran and Tawfik, 1971). Researchers have shown that *C. cunninghamiana* showed significant rates of sorption indicating considerable potential for use in urban and industrial areas having air quality problems (Elkiey and Ormond 1987). A common practice in China is to plant *Casuarina* when a field has become infertile because of overplanting. This gives the field much needed rest, restores fertility because of the plant's ability to fix atmospheric nitrogen, and provides a cash crop of highly saleable firewood when mature.

Despite problems experienced frequently in Florida along shorelines (see Biology/Ecology section), Somalia, Vietnam, and other nations have established similar programs to reforest vast lengths of coastal dunes (Vietmeyer 1986).

Indian researchers recommend the use of *Casuarina*-pulp for papermaking, although some long-fibered pulp such as bamboo is needed for blending in order to make paper on fast-running machines (Maheswari et al. 1979).

It is suggested that *Casuarinas* are good candidates for biomass energy plantations, as well as for pulp and other industrial products, because of their nitrogen-fixing ability (Woodall and Geary 1985).

Several minor uses include the utilization of wood ash in making soap, the extraction of dye from the bark, and the administration of the astringent bark decoction as a remedy for diarrhea and dysentery, as a lotion for beri-beri, and as a gargle to relieve sore throat (Morton 1980).

II. STEWARDSHIP SUMMARY

III. NATURAL HISTORY

Habitat:

There are 15 species of *Casuarina* distributed throughout the tropical and subtropical zones of both hemispheres (Woodall and Geary 1985). The family is native to Australia, with extensions into southeast Asia, India, New Guinea, Mascarene Island, New Caledonia, and Fiji. *Casuarinas* are cultivated in many other countries because of their ready adaptability to a variety of environmental conditions, and also for their rapid growth capacity (Digiamberardino 1986). In the U.S., *C. equisetifolia* is common in central and south Florida and California. It was introduced and widely cultivated in Florida for coastal landscaping but has fallen into disfavor in the past 20 years because of its invasive growth habit and aggressive choking of indigenous vegetation (Barrett 1956).

***Casuarina equisetifolia*:** No other species in the family extends farther beyond Australia than this. In its native range it is often the only tree present in the beach vegetation where it mainly

occurs. It is restricted to a narrow coastal strip including foreshore dunes and sandy flats immediately behind. Given unrestricted introductions around the world that provide opportunity for gene exchange among otherwise isolated gene pools, identification to subspecies in Florida may be futile (Woodall and Geary 1985).

Casuarina equisetifolia is probably the most invasive species in south Florida; it freely selfseeds in disturbed areas, and once established, may inhibit the growth of native species. It is rarely seen in northern Florida because of its intolerance to long periods of cold weather, but it occurs throughout south Florida (from Orlando south) on sandy shorelines, pinelands, and in the Everglades, above the water table or mean high water line. It frequently colonizes disturbed sites, such as filled wetlands, road shoulders, cleared land, and vacant lots. Although *C. equisetifolia* doesn't do well in areas of prolonged flooding, it is extremely resistant to salt spray and grows rapidly during hot weather (Digiamberardino 1986).

Casuarina cunninghamiana: In its native range along the east coast of Australia it occurs mainly as pure stands along freshwater streams in narrow belts subject to periodic flooding. It is distributed on both sides of the Great Dividing Range in eastern Australia at altitudes up to 1,000 m. The distribution pattern implies tolerance of frequent light frosts and intolerance of continuously waterlogged soils (Woodall and Geary 1985).

Casuarina cunninghamiana is the hardiest of the Casuarinas; it is found mostly in the central to northern regions of Florida where it has been known to survive temperatures as low as -8.8°C. *C. cunninghamiana*'s poor tolerance of salt spray and salt water inundation limits distribution along beaches (Digiamberardino 1986).

Casuarina glauca: In its native range this species is found in a narrow belt along the southeastern coast of Australia, commonly fringing mangroves along estuaries or other flats under tidal influence. Sometimes it is found in association with *Melaleuca quinquenervia* and *Eucalyptus robusta*, the latter dominating on less poorly-drained, fresh-water sites, and the former dominating sites intermediate in flooding and salinity. *C. glauca* is eventually replaced by *C. cunninghamiana* upstream. It may also be found on steep slopes with skeletal soils near the coast of its native range. It does tolerate salt spray (Woodall and Geary 1985).

Casuarina glauca was originally planted in Florida as a supplement to *C. equisetifolia*, but was later discovered to be not as tolerant of salt in the air or soil as *C. equisetifolia* and therefore did not become established on the beaches of south Florida (Digiamberardino 1986). *C. cunninghamiana* and *C. glauca* showed comparable salinity resistance, which was surprising since the former is usually found in or close to freshwater streams, whereas *C. glauca* grows at the margins of estuarine swamps or in other notably periodic saline environments (Vietmeyer 1986).

BIOLOGY: The pre-ripe fruit color for the genus is green to gray-green, becoming brown when ripe. In warm climates, flowering and fruiting occur throughout the year, and consequently, time of seed collection varies from place to place. The peak of the flowering period appears to be April through June, with fruiting from September through December.

Minimum seed bearing age is 4-5 years, although there are reports of 1-2 years in stress environments (Morton 1980). Good seed crops occur annually (Schopmeyer 1974). Seeds in a moist medium have germinated after exposure to light for 6 hours per day for 4 to 6 weeks. No pre-germination treatment is needed (Schopmeyer 1974).

In the Everglades, *C. equisetifolia* (the only naturalized species in the U.S.) flowers twice a year beginning 3 to 5 years after germination. It flowers February through April and September through October, with fruits ripening in June and December. Seeds remain fertile for a few months to a year and germinate under conditions of adequate moisture and porous soil in 4-8 days. Young seedlings are extremely sensitive to drought, flood, and fire (Wodehouse 1972). A single 4 or 5 year old tree is able to produce thousands of seeds that are borne by winds to new colonization sites (Morton 1980).

Stem analysis of 3 different species of *Casuarina* indicates that they vary with respect to rates of growth during the different growth stages (Badran and Tawfik 1973). Growth is most rapid during the first 7 years, and then declines. Maximum growth is reached in 20 years with a maximum life span of 40 to 50 years. In Florida, growth rates have ranged from 3 to 5 feet a year under stress conditions, to over 10 feet a year under cultivation (Morton 1980). The fastest growth rate was reported from Barbados where a height of 30 feet was attained in 2 years. On less than optimum sites in India, the trunks become hollow and misshapen and trees die in about 25 years. Observations of old forest trees in Malaya lead to age estimations up to several hundred years (Morton 1980).

A study performed by Shafiq et al. (1974) demonstrated that variations in the light intensity that seedlings were exposed to had little effect on the height of individuals but was directly reflected in the dry weights of the leaves, branches and stems and the fresh weight of roots as well as stem diameter.

In its native range ants are by far the most important post-dispersal seed predator of *Casuarina pusilla* in woodland sites of southeast Australia. Ant predation appears to limit seedling recruitment in the absence of fire (Andersen 1987). A study by Andersen (1988) of pre-dispersal seed losses to insect predation on *C. pusilla* suggests that traditional techniques for assessing pre-dispersal seed losses to insects must be "seriously questioned". Anderson indicates that insects had two important effects on seed production that could not be determined by assessing mature fruits and seeds, implying there may be pre-dispersal insect predation which is as yet undetected.

Casuarina species are capable of forming symbiotic N_2 -fixing associations with the soil actinomycetes, *Frankia*. This symbiotic association results in N_2 fixation rates comparable to nodulated legumes. It accounts to a large extent for the capacity of *Casuarina* to occupy nitrogen poor sites such as disturbed areas and desert or coastal dunes, and for its use in land reclamation, dune stabilization, and the establishment of forested stands (Ng 1987).

Ecology: The prolific suckering of *C. glauca* creates an impenetrable thicket and its widespread root-system disrupts pavements and lawns, and will enter the joints of sewer

lines and water main pipes to eventually clog and break the pipes. Many trees with broad "pancake" root systems shallowly perched on the limestone of south Dade county were blown over and blocked escape routes during the hurricane of 1945. Trees planted as windbreaks in fruit groves fell in rows on top of the trees they were supposed to protect during that same storm (Morton 1980).

Naturalists at the Everglades were among the first to warn of the threat posed by Casuarinas. Prior to Hurricane Donna in 1960, *C. equisetifolia* was present in only scattered locations, but the disturbed areas newly created by the hurricane brought on an explosion of invasive activity. In 1980, Casuarinas numbered in the hundreds and thousands on several Florida Bay keys and on beaches from Cape Sable to the Ten Thousand Islands. Now one can expect to find pioneers on any sandy area above the high tide mark (Morton 1980). It is concluded from observation by experts that Casuarinas' inhibition of any undergrowth is the result of an aggressive and dense colonization habit and possibly to the production of phytotoxic exudations (Klukas 1969, Digiamberardino 1986, Okuda et al. 1982). In an experiment by Fernald and Barnett (1988), seedlings of indigenous species planted beneath a Casuarina canopy on spoil islands in the Indian River near Vero Beach, Fl. had a 54% survival rate. This implies that deterrents Casuarina presents to pioneers, whether physical, mechanical, or chemical, may be overcome or circumvented by introducing plants at the seedling stage. If phytotoxins are produced by Casuarina, they may only be inhibitory to germination. Even when Casuarina is planted along the highway there are rarely more than a dozen plant species growing below the canopy and the majority of these are other exotics (Austin 1978).

Along beaches, the presence of indigenous species that help stabilize dunes is critical in preventing erosion. Where Casuarina has taken over, erosion has accelerated (Digiamberardino 1986). Very young Casuarina seedlings are capable of trapping sand because of their close scrubby growth, but once Casuarina grows beyond the sapling stage, it ceases to trap sand because of the lack of low, shrubby vegetation around the trunk. Casuarina monocultures are usually flat without dune-swale topography and lack diversity in understory vegetation. The shallow root systems of the trees makes them susceptible to toppling during storms (Digiamberardino 1986).

The presence of Casuarina stands in Florida usurps nesting places in the only remaining nesting areas in the United States for the American crocodile, and in one of the most productive nesting areas remaining for loggerhead and green sea turtles. Terrestrial fauna are not exempt from threats posed by the spread of Casuarina. Areas inhabited by the Gopher Tortoise are threatened with invasion by Casuarina, which would result in the departure of the tortoise (Klukas 1969). A study by Mazzotti et al. (1981) on the effects of Casuarina on small mammal populations showed an absence of breeding animals trapped in Casuarina habitat sample sites. This is particularly significant because small rodents are an important link between plants and other animals, especially raptors, snakes, and medium-sized mammals.

Very few native songbirds find the Casuarina to be a resource of any value with the exception of migrating gold finches which feed on the seeds.

Apart from the hazards that *Casuarina* presents to its habitat and to other plants and animals, it also poses a problem to humans because it is a source of respiratory irritation. *Casuarina* pollen can cause allergic reactions symptomized by eye irritation, runny-nose, and hoarseness or sore throat (Morton 1980).

IV. CONDITION

V. MANAGEMENT/MONITORING

Management Requirements:

- 1) All possible effort should be made to eradicate this pest when present.
- 2) Reduce invasion opportunities by avoiding disturbance of natural habitats or by replanting with natural vegetation as quickly as possible when areas have been disturbed.
- 3) Maintain natural abiotic conditions (eg. fire regimes, periodic flooding, etc.) to combat invasive pioneers.
- 4) Extreme efforts should be made to eliminate this pest in areas where it is threatening other listed species.
- 5) All efforts should be made to increase public awareness regarding the threat that this plant poses to the natural systems of Florida. Too often the public regards it as a welcome source of shade and verdancy consequently creating barriers to its removal.
- 6) Legislative bodies should be lobbied (solicited) for financial and legislative support for the eradication of *Casuarina*.

VI. RESEARCH

Management Research Programs:

Blister disease caused by *Trichosporium visiculosum* Butler is fast spreading and may wipe out *Casuarina* from Hyderabad and other parts of Andhra Pradesh in India (Begum and Rizwana 1979). This root fungus is encouraged by excessive watering and crowding (Morton 1980).

The Lymantriid moth, *Lymantria xyliana*, is one of the worst pests of *Casuarina equisetifolia* and *C. glauca* in China (Li et al. 1981).

There has been a high rate of root rot in Florida *Casuarinas* caused by *Clitocybe tabescens* (Rhoads 1952). This has occurred primarily on higher, well-drained, light sandy soils where oak and other hardwood trees were predominant before clearing. This fungus is known to attack 210 species of plants belonging to 137 genera and 59 families.

Stem canker and die-back attributable to the fungus *Diplodia natalensis* have affected trees in Puerto Rico.

Ants have been a major source of control in both Puerto Rico and India probably explaining why *Casuarina* has not over-run Puerto Rico as it has started to do in Florida.

Nursery seedlings in India are attacked by *Brachytrupes achatinus* (cricket), *Arbela tetraonis* (a bark-eating caterpillar), *Coelosterna scabrata* (a longicorn) and the grubs of *Oryctes rhinoceros* (the rhinoceros beetle).

Management Research Needs:

- 1) Continuing research on an effective, host specific phytofagous fauna or biocide.
- 2) Continuing research on developing a plant-specific herbicide that is highly biodegradable, is easily applied, and has low man-power requirements. It must effectively kill the whole plant, including the roots, in order to prevent root suckering and growth from stumps.

- 1) Prescribed burning where larger trees have taken hold.
- 2) Herbicide application in recommended doses with hack and squirt or basal bark applications.
- 3) Manual removal of seedlings and saplings.
- 4) Any procedure necessary to remove this pest without putting at risk other plants, animals, or systems.

An industry-wide survey instituted by the Exotic Pest Plant Council (Langeland 1988) of current eradication methods employed against *Casuarina* disclosed that a 2% mixture of Garlon 4 in diesel oil applied using the basal bark method or the hack and squirt method is most commonly used. In the basal bark method, the herbicide is applied with a small sprayer in an 18 inch band around the tree 6-12 inches above the ground. Follow-up treatment may be necessary for large trees. The hack and squirt method is self-explanatory and recommended for improving results. Another herbicide frequently used is Garlon 3A by Dow. It is generally applied by injection or spraying in an undiluted form on freshly cut stumps. The general consensus is that seedlings, saplings and young trees are best removed manually. Fire is reported to be effective only in dense stands with sufficient dry fuel on the ground. Caution recommends follow-up treatments.

Lou Whiteaker (1988 pers. comm.), botanist at the south Florida Research Center in Everglades National Park, reports that they have mapped the distribution of *Casuarina* in the park employing high resolution false infra-red aerial photographs. These maps convey a picture of concentrated dominance of *Casuarina* in the southeastern section of the park at levels no longer financially feasible to fight. For this reason, that section is left as is and control efforts are focused on areas of new invasion critical in the preservation of ranked species habitat, e.g., American crocodile or loggerhead turtle nesting areas. The Garlon 4 herbicide technique described above is most frequently used at the Everglades.

The Department of Natural Resources (Stevenson 1984) promotes the use of Garlon 4 as well. They recommend a mixture of 1 part Garlon 4 to 50 parts diesel oil sprayed on the bark in an 18 inch band completely around the tree approximately 6 to 12 inches above the ground. Retreatment one month later has been found to be necessary. Application "into cuts", as in the hack and squirt method is said to provide a faster kill, especially for larger trees. They suggest that treating exposed roots may also be helpful. The reader is cautioned to avoid scraping the ground surface so as not to create seed bed conditions.

These priorities and methods were settled upon at the Everglades after having tested and subsequently stopped the use of 2,4,5-T and 2,4,D as being less specific and less effective and Dimethylarsinic acid solution as less lethal. Fire is found to be effective on trees larger than 3 to 4 inches in diameter without any incidence of resprouting. Trees smaller than 3-4 inches dbh have been observed to re-sprout from the lower stump and root area. They have yet to institute a study to determine whether several successive fires at 2 to 3 year intervals would successfully eliminate re-sprouting altogether.

Morton, in her 1980 article on Casuarina, discusses the lengthy list of techniques that Florida Power and Light has employed to control Casuarina on the berms at the Turkey Point plant. Techniques employed ranged from helicopter spraying with 2,4D and Dicamba to spot gun spraying. According to site superintendent, Earl Baker (1988 pers. comm.), such techniques have since been discontinued in favor of the more cost effective and greatly reduced manpower requirements of mechanically removing all vegetation from the berm with an amphibious machine capable of maneuvering in the canals and getting to the berms. All the plowed materials are piled together and burned. Up until four years ago such a machine was unavailable. It should be noted that except in some cases where a listed species (e.g., American crocodile nesting habitat) is involved the power company perceives the plant as an artificial system where the first priority is efficient plant functioning. There is minimal concern by FPL for re-establishment of endemic plant community members at this particular spot.

Freda Posin (1988 pers. comm.), Director of Blowing Rocks Preserve, owned by The Nature Conservancy, relates her experience with Casuarina eradication: A total eradication program of all Casuarinas on the preserve led to removal of the remaining dead trees after girdling and spraying. The decision to pull out the 200-300 stumps with a dbh of 2-3" and remove them from the site was made as an alternative to burning in place based on the impact that burning would have on the soil. Experience showed that burning would change the pH of the soil, making it too alkaline for the endemic species that were to be used in a revegetation program. The stumps were removed to a large trench and burned until an unusually dry period increased the risks associated with fire beyond an acceptable limit. The remaining stumps were buried in trenches dug to below the low tide mark thereby discouraging the stumps from re-sprouting or any persistent seeds from germinating. Prior to replanting with natural vegetation the area was raked clean of all residual debris to eliminate any sources of phytotoxic exudations.

Casuarina has no natural enemies in its North American distribution and has a phenomenal growth rate that outpaces most other plants. These characteristics explain Casuarina's ability to outcompete all native endemics. It produces thousands of wind born seeds per plant and reproduces prodigiously via coppicing to produce close, impenetrable stands. A monotypic stand is a sterile system that harbors few native plants or animals. Present eradication techniques are costly, require many man-hours for application, and result in the addition of harmful chemicals to the ecosystem. All possible means should be employed to remove and eradicate Casuarina from present locations. Research efforts to develop safe control or eradication techniques should be supported financially and legislatively. Public education efforts should be made to discourage promotion of this plant as a cultivated ornamental. Private, non-

profit, and governmental organizations should be tapped for legislative, educational, research and financial participation and support.

VII. ADDITIONAL TOPICS

VIII. INFORMATION SOURCES

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IX. DOCUMENT PREPARATION & MAINTENANCE

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