



The state of ironwood (*Casuarina equisetifolia* ssp. *equisetifolia*) decline on the Pacific island of Guam

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Introduction

Indigenous to the region and traditionally pest and disease free, the ironwood tree, *C. equisetifolia* ssp. *equisetifolia* is one of the dominant agroforestry species in the Pacific. Despite the myriad uses and merits of the ironwood tree on Guam, its future is in doubt as its health and survival rate has been in decline since 2002. The status of ironwood trees on the neighboring Mariana Islands of Rota, Tinian and Saipan, as well as other islands in Micronesia is threatened due to their proximity to Guam.

Methods

Research began in earnest September 2008, with the award of a three-year Western Region Sustainable Agriculture Research and Education (WSARE) grant. A list of possible suspects in the decline of Guam's ironwoods was established from a search of the ironwood literature conducted by Dr. Melodie Putnam and others. A survey of ironwood trees was conducted in the fall of 2008 to determine decline occurrence and severity. A GPS assisted survey was conducted along Guam's major thoroughfares as well as a few coastal intersecting roads to beaches, cliffs and parks.

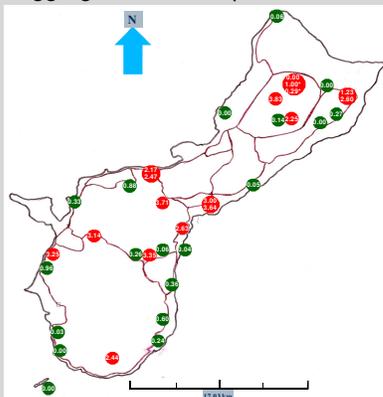
Trees were marked and counted as way points using a GPS receiver, severity of decline scored (0 to 4 scale) and analyzed as weighted mean of the decline index. An international team of researchers was brought to Guam in January 2009 to participate in an "Ironwood Tree Decline Conference".



Conference participants: Back row left: A. Moore, P. Spaine, Z. Mersha, S. Nelson, R. Underwood, K. Pinyongsak, R. Schlub, N. Dilip, L. Yudin; Front row left: J. Smith, A. Badilles.

Results

Decline across the island appears to be spatially random as trees in a state of decline occur throughout Guam. However, severity is likely geoculturally linked as decline is less in natural undisturbed areas and more severe in disturbed plantations such as golf courses, housing subdivisions, schools and commercial lots. Natural forest stands (7/38 sites) showed none to negligible (0.00 – 0.33, mean = 0.06) decline as compared to disturbed plantations (0.00 – 3.71, mean = 1.34). Majority of central east and west urban plantations showed a decline ≥ 2.5 . Trees used as wind breaks on farms in northern Guam have been severely affected – forcing, in some instances, the complete removal of trees. Spatial pattern analysis using a run test showed an aggregated decline pattern on some of the wind breaks.



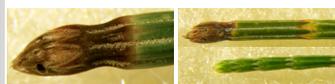
Weighted mean values of decline index of ironwood trees on Guam surveyed since November 2008 (38 sites and total of 1192 trees).



A newly discovered Eulophid wasp.



Eulophid wasp damage to branchlet tips



Branchlet tip damage with exit hole

Damaged (top) and healthy (bottom) branchlets



Guam's birds roost in it.



It benefits farmers by providing trade wind protection, by enriching the soil with nitrogen, and by being an organic mulch source.



It stabilizes Guam's beaches.



Guam's parks and beaches are beautified by its presence.



Ironwood decline ranking for small trees (< 100 cm in circumference at breast height). Evaluation criteria included prevalence, size, and fullness of branches, and branchlet bundles.



Pestalotia sp. culture



Underside of *Ganoderma* conk



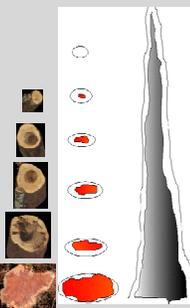
Tube mouths of *Ganoderma* fruiting body and its spherical basidiospores (corner right).



Cross section of severely declined ironwood tree (4.0) with exposed underside of conk. Conk attachments (top right) have been seen as high as 27 ft.



Puddling of white bacterial ooze 24 hours after cutting



Cross-sectional cuts of a tree under decline. Discolored area (%) = 81.2 (base), 65.5 (1.3 m), 29.9 (3.3 m), 38.1 (5.3 m), 0.06 (7.3 m) and 0.00 (9.3 m).

Discussion

Most likely a complex of biotic and abiotic factors are responsible for the decline. Possible biotic candidates include fungi of the genera *Ganoderma*, *Pestalotia*, *Botryosphaeria* and *Fusarium* and several yet unidentified fungi and bacteria. Insects that may play a role in the decline are termites and a newly discovered Eulophid wasp which forms galls in branchlet tips. Among the abiotic factors are the major typhoons, Chataan on July 4 and Pongsona on December 5, 2002 and the intervening severe drought, as well as proximity to urban development. Decline prevalence was highest on plantations (wind breaks, beaches, parks, and golf courses). The healthiest ironwood trees are located on Cocos Island, a Casuarina dominated island just 1.6 miles off the southern tip of Guam, and at Ritidian Point, a National Wildlife Refuge located on the northern tip of Guam.

Acknowledgements: Roger Brown, Glen Alianza, David Mantanona, Dr. James McConnell, Dr. Mary Catherine Aime, Olympia Terral